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WoodEMA, i.a. – International
Association for Economics and
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Forest Products Society

WOOD PROCESSING AND FURNITURE MANUFACTURING CHALLENGES ON THE WORLD MARKET

Proceedings of Scientific Papers

WOOD-BASED ENERGY GOES GLOBAL

Dubrovnik, Croatia
2015

WOOD PROCESSING AND FURNITURE MANUFACTURING CHALLENGES ON THE WORLD MARKET
and
WOOD-BASED ENERGY GOES GLOBAL
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Preface

This proceedings of scientific papers is a compilation of papers given by authors as results of their research conducted recently. These results were presented at the international event titled ADRIATIC WOOD DAYS 2015, held in Dubrovnik, Croatia during the week October 5^{th}-10^{th} 2015. Main organizers of the event which contained six different meetings and conferences were WoodEMA,i.a.. Forest Products Society and Croatian Wood Cluster.

The main goal of the Adriatic Wood Days 2015 event was to exchenge and transfer knowledge of international experts and scientists regarding competitiveness of wood processing and furniture manufacturing enterprises and challenges that occur in front of them on the world market. Scientists and experts from 13 countries of 3 continents (11 European countries, United States of America and India), in 49 articles, presented their points of viewes to organisation, economics, marketing, trade and environmental issues which are important in the market competition of each company.

A particular attention is paid to the aspects concerning sustainable forest management, timber production and trade, woody biomass utilisation, innovations in forestry and wood processing industry, production organization and modelling, responsible purchasing, social responsibility, production of ecofriendly products, competitiveness of the sector, quality issues, human resources, etc.

We believe that the thematic scope and scientific content of the scientific papers will inspire scientists as well as professionals dealing with these particular issues and help to initiate implementation of new ideas and knowledge.

This was 8^{th} WoodEMA meeting in a row, and the first one in co-operation with Forest Products Society, and hopefully one of the many to come. We hope next year we will be able to see some improvement achieved as a result of implementation of the knowledge tranfered at this conference.

Prof. Denis Jelačić, PhD.
WoodEMA secretary

"To have the WoodEMA 2015 annual international scientific conference take place within Adriatic Wood Days 2015 in Dubrovnik is a great opportunity for attendees to develop new contacts among scientific societies, companies, government institutions, non-government organizations, and other forest sector stakeholders from the region, Europe and the World. This kind of event promotes knowledge and technology as well as opens the doors for innovative research and development."

President, WoodEMA, i.a.
Prof. Mikulaš Šupin, Ph.D.

"For the first time, the Forest Products Society, the largest international forest products association based in the United States, is partnering with WoodEMA to provide a unique and valuable conference program. This conference and Adriatic Wood Days in general will be a major event with participants from many countries in the region and beyond."

Prof. Richard P. Vlosky, Ph.D.
President-Elect, WoodEMA, i.a.
Director, Louisiana Forest Products Development Center
Crosby Land & Resources Endowed Professor of Forest Sector Business Development
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DEVELOPMENT OF MARKET WITH WOOD IN SLOVAKIA AND CENTRAL EUROPE

Miloš Gejdoš, Marek Potkány

ABSTRACT

The market with wood and wood products, in the last five years, has more turbulent changes that affected due the overall geopolitical situation in the world, reverberant effects of the global economic crisis and the increasing intensity of incidental fellings in the context of global climate change. The aim of this paper is to evaluate the price development of selected raw-woods assortments from wood species spruce, fir and beech in Slovakia, the Czech Republic, Germany and selected regions of Austria for the period 2009 (8)-2015. Results interpret the impact of individual periods and factors on price developments and the overall development of the wood market in Central Europe. The Article also provides a complex overview of the wood market in Central Europe and its development, together with cause analysis of the development.
Key words: Wood market, raw-wood assortments, incidental felling, economic crisis

1. INTRODUCTION

The current general situation on the market is, except the accidental natural phenomena, influenced by dynamic changes of the economic and political environment. The demand for timber and timber products is linked mainly to development of building activities, as well as to development of the energy sector. There is also dynamic development in the segment of biopolymers. Geopolitical development in last three years (the Arab Spring, the crisis in Ukraine, etc.), together with the increasing intensity and extent of incidental fellings, have a significant impact on the market with timber and timber products. In the paper is analysed the price development of sawlogs of main tree species: spruce, fir and beech, in Slovakia, selected regions of Austria and the Czech Republic in the period of last six years. Analysis of the development offers several alternatives in the future for the wood products producers, for who this assortment is the most important raw material. In the article we want to evaluate current state and perspectives of market development with raw-wood resources and also the structure of assortments supplies development in selected European countries. The aim is also to determine the future prognosis of development and to identify key factors that will influence the future development.

2. MATERIAL AND METHODS

Development of the supplies volumes of raw-wood assortments was evaluated on the basis of data which was obtained from the Green Report issued by the Ministry of Agriculture of Slovakia and also in the Czech Republic [1,2]. Data for Germany were acquired from the 'Holzmarktbericht "[3] and for Austria from "Holzeinschlagsmeldung "[4]. Assessment of price developments was focused on sawlogs from trees spruce, fir and beech in selected regions in Austria, Czech Republic and Slovakia. The analysed period represents the last 6 years (from 2008 to March 2015). The prices in the given period when in the Slovakia has not paid the Euro, were converted into € with National Bank of Slovakia exchange rate [5]. In the case of prices for Czech Republic were calculated with using the exchange rate of the National Bank of the Czech Republic [6]. The prices of assortments for Austria are in the

trade parity on “forest roads”, respectively “Forest warehouse”. Prices in Slovakia and Czech Republic are placed on parity “FCO” (ex-warehouse vendor, respectively “FCA” - loaded truck purchaser). In order to make absolutely correct comparison, it is necessary to the Austrian prices added the transportation costs. Information about price developments have been drawn from the magazine Holzkurier [7], the Czech Statistical Office [8] and the forestry market information system [9].
For full accuracy of the comparison it is to be noted that each country has different specifications and legislation, for this reasons are results in comparing not exactly the same assortments regarding quality parameters.

3. DEVELOPMENT OF THE RAW-WOOD SUPPLIES STRUCTURE

The structure of raw-wood assortments supplies was evaluated for the countries Germany, Austria, Slovakia and Czech Republic for years 2008-2013. The structure of assortments supplies is primarily affected on tree species composition in the forests - broadleaved tree species are more dominant in Slovakia, compared to other countries. Therefore we evaluate the supplies structure of single assortments within the groups of coniferous and broadleaved trees.

3.1 Coniferous Raw-wood Supplies Structure

Table 1 shows the percentage rate of deliveries for each coniferous assortments group in four monitored countries for the previous six years. 2014 has not yet been processed in the statistics. The table does not include the small-volume assortments (eg. sale of standing timber, raw trunks, etc.). In the first three high-quality classes it can be observed the very similar proportion of coniferous wood supplies. The lowest relative shares were, on average, delivered in Slovakia. It's a paradox if we consider the structure of the wood processing segment in Slovakia. Nearly 90% of all wood processors in Slovakia are focused on sawn processing of coniferous wood. Partial impact on this fact has the revision of the technical standard STN 48 0055 from year 2007, which has fundamentally affected the production possibility of the coniferous assortments in I. and II. quality class. Austria reached the best average share in the top quality assortments on the market.

Table 1. Supplies structure of coniferous raw-wood assortments in % (selected countries)

Year/Quality	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
I.-III.quality class						
Austria	67,5	62,6	64,7	64	62,7	62,8
Germany	64,6	62,3	63,5	61,1	61	61,2
Slovakia	58	52,7	58,1	60,9	61,9	59,1
Czech republic	57,2	59,3	59,6	60,1	60,6	59,9
Pulpwood, Industrial wood						
Austria	15,8	18	17,3	17,3	17,3	17,4
Germany	21,8	21,6	21,7	22,3	23,1	22,3
Slovakia	23,2	29	23,8	19,5	22,9	22,5
Czech republic	34,4	32,4	31,5	32,1	30,3	30,5
Fuel wood						
Austria	16,7	19,4	18	18,7	20,1	19,8
Germany	13,6	16,2	14,8	16,6	15,9	16,6
Slovakia	4,4	4,9	3,95	5,11	6,6	8,8
Czech republic	8,47	8,3	8,9	7,9	9,2	9,6

The highest share of coniferous pulpwood supplies in the last 6 years was in the Czech Republic and the lowest again in Austria. These rates were partly affected by regional incidental fellings, which in some cases reduce the market share of better quality assortments. The highest average share of coniferous firewood was delivered in Austria and Germany. In this case the Austrian market is quite specific, since in various regions exist the government grant programs that support the renewable energy sources. It is offen reflected in the prices of firewood and consequently in trading volumes.

3.2 Broadleaved Raw-wood Supplies Structure

Table 2 shows the percentage rate of deliveries of each assortments group of broadleaved assortments in the four countries surveyed in the previous six years in the same structure as in coniferous. The largest share of supplies in quality classes I. to III. was in the last 6 years in Slovakia. This is a result of the high proportion of broadleaved trees from all observed countries. Nevertheless, the share of assortments supplies in the Czech Republic was for the years 2009 and 2011 higher than in Slovakia. This is mainly a consequence of the global economic crisis, when customers in Slovakia significantly pressured to buy assortments of higher quality at price level for lower quality assortments. These shares were subsequently reflected in the supply structure of the lower quality classes. Slovakia has the highest supplies proportion of pulp and industrial wood, as the only relevant broadleaved processor in Slovakia is from this processing sector. The segment of firewood is the same, as by coniferous wood, in the first place Austria for the same reasons that we discuss in the previous subchapter.

Table 2. Supplies structure of broadleaved raw-wood assortments in % (selected countries)

Year/Quality	2008	2009	2010	2011	2012	2013
I.-III.quality class						
Austria	14,4	10,9	10,8	10,8	9,6	9
Germany	29,6	21,9	23,5	24,4	22,9	21,4
Slovakia	38,8	32,4	39,2	36,5	37,6	38,2
Czech republic	32,4	35,7	26,7	40,4	35,4	34,3
Pulpwood, Industrial wood						
Austria	21,7	19,3	18,3	17,7	19,4	20,4
Germany	26,3	26,1	28,6	27,5	31,1	25,4
Slovakia	52,3	57,2	53,1	53	53,1	51,8
Czech republic	31,4	24,8	35,8	17,3	23,5	22,2
Fuel wood						
Austria	64	69,8	70,8	71,5	71	70,6
Germany	44,1	52,1	47,9	48,2	46,1	53,3
Slovakia	7,6	8,2	6,7	8,3	7,8	8,3
Czech republic	36,2	39,5	37,6	42,4	41,1	43,5

4. DEVELOPMENT OF THE SAWLOGS PRICES

The development of sawlogs prices is affected with a large number of factors. The most crucial influence had the intensity and extent of incidental felling together with a local and global economic and political situation. In this chapter we focused mainly on the analysis of the sawlogs prices development, mostly traded wood species, spruce, fir and beech in selected provinces in Austria, Slovakia and the Czech Republic for the period 2008 - May 2015. The influence of certain factors on the wood prices in most countries of Central Europe is very similar. We will focus on analysing the causes of prices, developments in a given period.

4.1 Price Development for the Spruce and Fir Sawlogs

Figure 1 represent the price development for the sawlogs, from wood species spruce and fir in Slovakia, Czech Republic and selected regions of Austria. Spruce sawlogs recorded the most significant price levels in 2007. After global economic crisis and decline in construction activities in some countries in the first half of 2009, prices for this assortment decreased in all monitored countries to minimum levels. Since that time, practically still continuously increase until the end of the year 2014. The development had many causes. For example in Slovakia, it´s unfavorable structure of the processing industry, where 90% is focused only on the processing of coniferous sawlogs, what significantly increase the pressure on the demand regarding to the available volume capacity of this assortment in Slovakia. In Austria and the Czech Republic a several enterprises got into economic problems in 2014 and decreased its production capacities. For the prices of sawlogs this reality didn´t have any significant impact. The situation has been changed after the windstorm Niklas. In fact, every major wind calamity in 10 years negatively affected the prices of coniferous sawlogs. Most enterprises in Austria had at this time still high reserves, which mainly came from the glacier disaster in Slovenia at the beginning of 2014. On the market remained the surplus of wood that was hardly to be sold. The price range for the sawlog assortment in some regions in Austria fell from June 2014 more by 10 € per 1 m³ (Figure 1). In the Czech Republic after the earlier decline at the end of 2014, prices in the first quarter of 2015 began again increase.

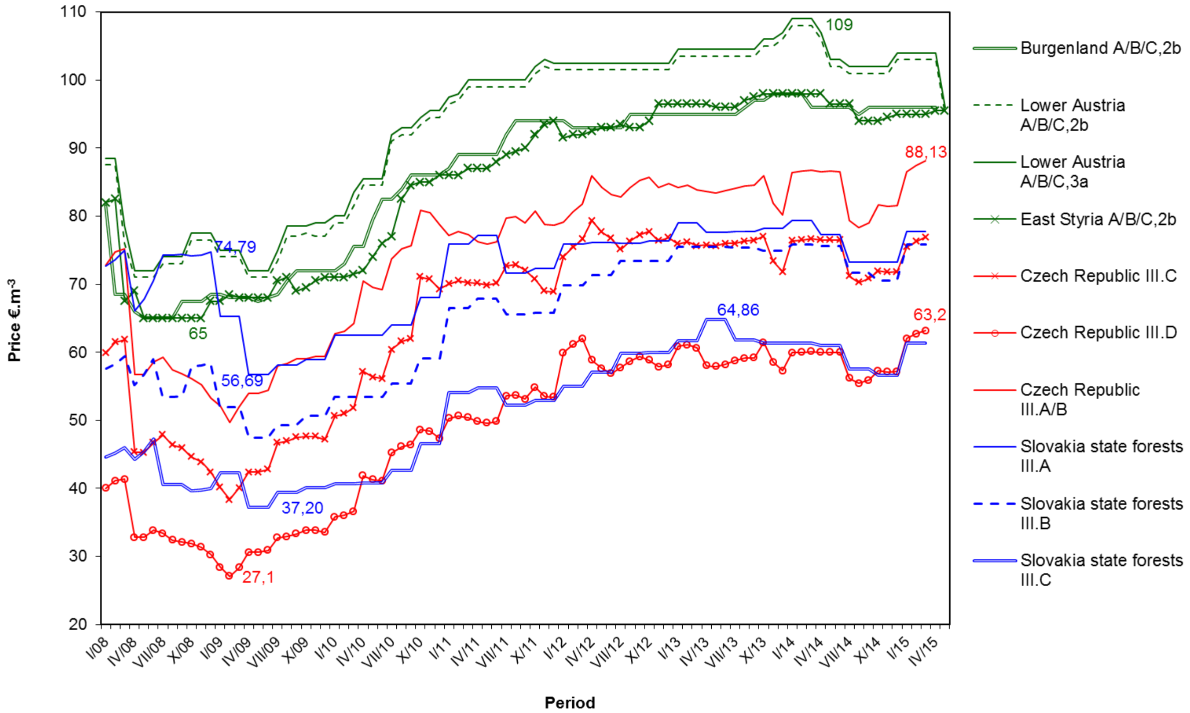

Fig. 1 Development of spruce and fir sawlogs prices in Slovakia, Czech Republic and Austria

4.2 Price Development for the Beech Sawlogs

Figure 2 represents the price development for the sawlogs from wood species beech in Slovakia, Czech Republic and selected regions of Austria. Sawlogs of beech wood recorded the highest price levels and evaluation at the turn of the millennium (??). Since the date the beech wood products become less attractive and in processing industry is beech the ostracized. In terms of Slovakia, where the dominant species in forests is the beech, this trend is particularly unfavorable. Extinct basically all relevant processors for the better beech wood assortments. The highest slovak price levels in the monitored period reached the beech sawlogs just at the beginning of 2009. The minimum was reached in early 2010. At the beginning of 2012, prices have slightly increased and remained at this level basically stable for two years. A similar pattern can be observed in the Czech Republic, although the forests species composition in this country, compared to the Slovak, is significantly different. In Austria the trade with higher quality of broadleaved assortments is seasonal. Since 2013 it has fundamentally changed the methodology of prices information (in Salzburg started to roll out prices for different kind of beech sawlogs assortments), so it was not possible to compare continuously during the entire period. During 2014 it was recorded for a mixed assortment of A/B in different classes of thickness a significant increase of more than 10 € per m^3. Certainly it contributed to various state programs aimed at promoting the beech and products thereof.

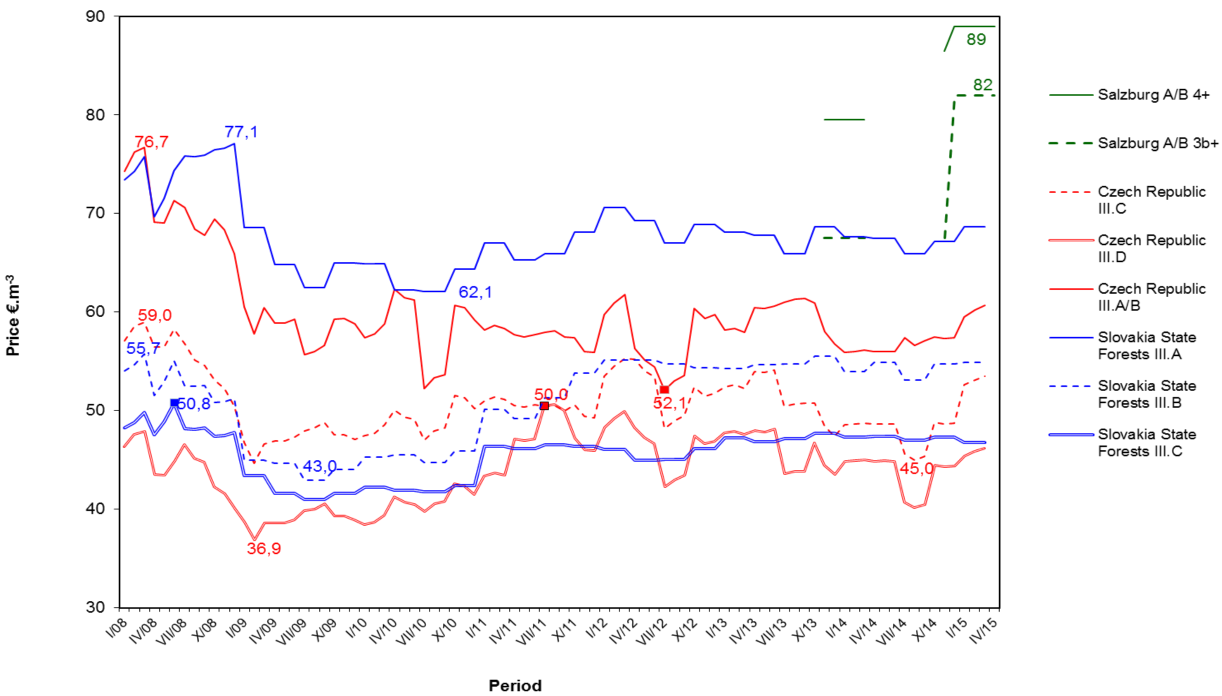

Fig. 2 Development of beech sawlogs prices in Slovakia, Czech Republic and Austria

5. CONCLUSION

In the last five years, prices of wood assortments increased generally. For example, in Germany since 2010, have increased prices of spruce at 24.4%, pine 29.3% and beech 15.2%. The Consumer price index increased in the same period by 6.2% [10]. All indicators suggest that the timber market has been partly recovered after the previous economic crisis. Sale of beech wood and its use is problem in all Europe. Future market developments will be seen in the context of global trade in timber and development of economic indicators that affect it (oil price developments, the evolution of prices for non-renewable energy sources, demographic changes and related building activities etc.). It will also be critical ecological stability of forests and intensity of accidental phenomenon (windstorms, insect infestation), which increased in the last decade. Positive could affect, the timber trade, increase interest in renewable energy sector, development of new wood-based materials, significant progress in the development of biopolymers etc. In Slovakia will strategic application of better quality beech wood. It is currently used mostly only in the pulp and paper industry. The fact of the potential risks and opportunities shows, that the timber market could be still dynamically increasing sector, in the future operating on the principle of sustainability.

REFERENCES

1. Anonymous. 2014. GREEN REPORT 2014. Ministry of Agriculture and rural development, 84 p.
2. Anonymous. 2014. REPORT ABOUT THE FOREST AND FORESTRY MANAGEMENT 2014. Ministry of Agriculture, Czech republic. 136 s., 978-80-7434-153-3.
3. HOLZMARKTBERICHT 2008 – 2014, Federal Ministry of Food and Agriculture, Bonn, Germany, Ministerium für Ländlichen Raum, Ernährung, Landwirtschaft und Forsten, 25 s.
4. HOLZEINSCHLAGSMELDUNG FÜR JAHRE 2008 – 2014, Federal Ministry of Agriculture, Forestry, Environment and Water Management, Vienna, Austria, 88 p.
5. Information on http://www.nbs.sk
6. Information on http://www.cnb.cz
7. HOLZKURIER, years 2008 – 2015
8. Information on http://www.czso.cz
9. Brezinová, M. 2015. AVERAGE PRICES DEVELOPMENT OF ASSORTMENTS AND RAW-WOOD SUPPLIES FOR THE QUARTERS 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015 In: Informačný list Národného lesníckeho centra, Zvolen 9 s.
10. Plackner, H. 2015. SPITZENPREISE FÜR STAMMHOLZ. In Holzkurier, 20(1), 2015, s. 3-4, P.b.b 02Z030586W

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PROJECTIONS OF PRODUCTION FOR CONIFEROUS AND NON-CONIFEROUS SAWNWOOD IN CROATIA FOR NEXT DECADE

Maja Moro, Andreja Pirc Barčić, PhD, Ksenija Šegotić, Kristinka Liker, Darko Motik

ABSTRACT

Wood processing is one of the most significant segments in Croatian wood industry. On the basis of established values for period 1993-2013, in this paper we discuss a possibility to predict trends in production of coniferous and non-coniferous sawnwood in Croatia. The data of production values of coniferous and non-coniferous sawnwood through analyzed period are gathered from Croatian Bureau of Statistics and FAO base. In order to predict the future trends of coniferous and non-coniferous sawnwood production for Craotia, dynamic economic analysis of time series data was performed. Prediction is limited to year 2023, because of turbulences in this market and the length of analyzed time series.

Key words: coniferous and non-coniferous sawnwood, production, time series models, forecasting

1. INTRODUCTION

Croatia has a long tradition of wood industry, based on high-quality resources. Almost half of the Croatian territory is covered by forests and forest land. According to Kersan-Škabić (2014), wood industry in Croatia accounts for about 0.8% of GDP, employs one-third of employees in the manufacturing industry and accounts for 7% of Croatian exports. This sector is dominated by small and medium enterprises, with large number of small companies and only six large enterprises. Export and import of wood products are mostly oriented toward EU member states (Italy, Germany, Slovenia and other). The main problem is that 64% of wooden export consists of raw wood material (sawn timber and elements) while furniture export accounts for only 35% of total wood export. The share of furniture import is 61%, while wood and wood products represent 39% of total wood import (Croatian Bureau of Statistics, 2013).

According to Fair and Case (1989), interpreting economic data and forecasting the future economic values are under the influence of environment and government policies, starting from the basic economic theories that operate in the market. A number of statistical techniques are used to estimate economic variables of interest to a manager. In some cases, statistical estimation techniques employed are simple. In other cases, they are much more advanced (Mansfield, 1997). According to Kotler (2001), the key to survival and growth of an organization is in ability to adapt its strategy to rapidly changing enviroment.

In this paper we discuss a possibility to predict trends in production of coniferous and non-coniferous sawnwood in Croatia on the basis of established production values for period 1993-2013. For that purpose, dynamic economic analysis of time series data was performed. Prediction is limited to year 2023, because of turbulences in this market and the length of analyzed time series.

2. MATERIAL AND METHODS

The data of production values for coniferous and non-coniferous sawnwood through analyzed period 1993-2013 are gathered from Croatian Bureau of Statistics (CBS/DSZ, different years), Ministry of Finance and Financial Agency (FINA) and FAO base (FAOSTAT, different years). According to

Hanke and Reitsch (2001), it is known that future projections of development can not predict the detail movement of market indicators, they are only a rough indication of the future course, assuming that the macroeconomic policies won't change significanty. By using mathematical and statistical models we got a picture of what happened in the (near) past, what is the current situation, and planned and future course of events, i.e. the movement of each variable in the (near) future (Rozga and Grčić, 2000).
For the purposes of forecasting future trends in coniferous and non-coniferous sawnwood production, the dynamic economic analysis of time series data was performed. Two types of time series models were built: models based on average rates of change (models A) and linear trend models (models B).

3. RESULTS AND DISCUSSION

The data of coniferous sawnwood production values (CS) and non-coniferous sawnwood production values (NS) in Croatia through analyzed period 1993-2013 are shown in Figure 1.

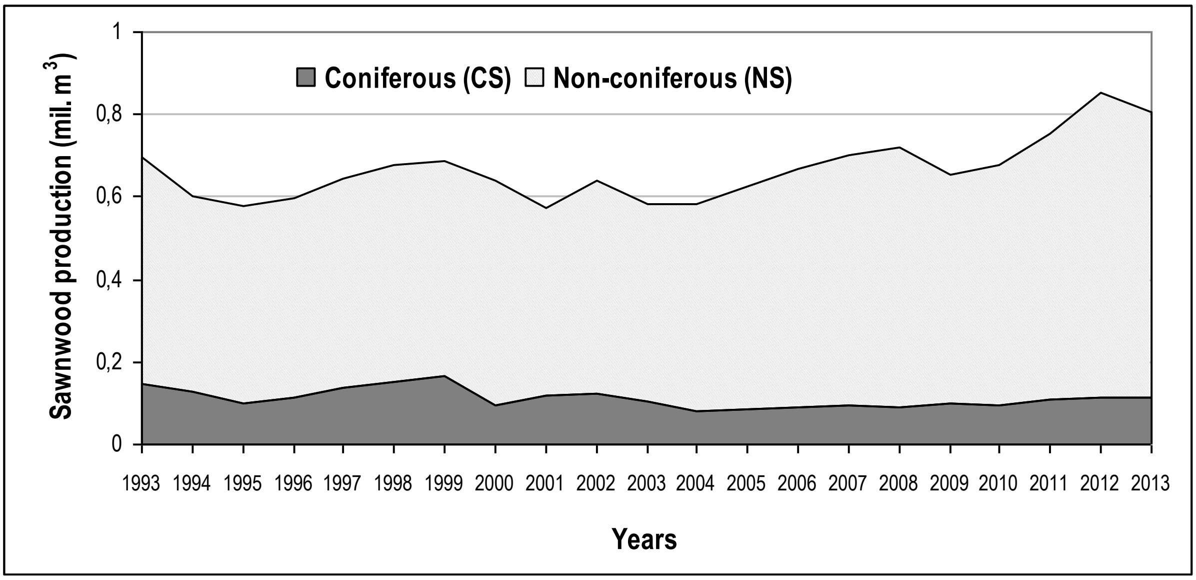

Figure 1. Coniferous and non-coniferous sawnwood production in Croatia

Descriptive statistics were determined for annual values of coniferous and non-coniferous sawnwood production. In the analyzed period 1993-2013 there were produced almost 14 millions m^3 of sawnwood, of which 2,4 millions m^3 of coniferous sawnwood (16,9%) and 11,6 millions m^3 of non-coniferous sawnwood (16,9%). Looking at the overall sawnwood production, average is 0,7 millions m^3, range in size from 0,57 millions m^3 (in 2001) to 0,85 millions m^3 (in 2012). Average coniferous sawnwood production is 0,12 millions m^3, range in size from 79 thousand m^3 (in 2004) to 166 thousand m^3 (in 1999). Average non-coniferous sawnwood production is 0,55 millions m^3, range in size from 456 thousand m^3 (in 2001) to 736 thousand m^3 (in 2012). All results of descriptive analysis are given in Table 1.

Table 1. Descriptive Statistics for coniferous and non-coniferous sawnwood production in m³

Descriptive Statistics	Coniferous sawnwood production (CS)	Non-coniferous sawnwood production (NS)	Total sawnwood production (TS)
Valid (N)	21	21	21
Mean (m^3)	112.238	552.524	664.762
Std.Dev. (m^3)	23.492	74.258	74.028
Coef.Var. (%)	20,9	13,4	11,1
Range (m^3)	87.000	280.000	277.000
Median (m^3)	110.000	540.000	653.000
95% Confidence Level (m^3)	10.694	33.802	33.697

For the annual values of coniferous and non-coniferous sawnwood production in the analyzed period 1993-2013 we calculated the individual indices based on year 2009 (I_{2009}) and belonging rates of change (S*), also chain indices (V) and belonging rates of change (S**). Results of these analysis are given in following Table 2.

Table 2. Individual and chain indices with belonging rates of change for coniferous and non-coniferous sawnwood production in period 1993-2013

Year	Coniferous sawnwood production (CS)				Non-coniferous sawnwood production (NS)			
	I_{2009}	S*	V	S**	I_{2009}	S*	V	S**
1993	146	46	-	-	100	0	-	-
1994	127	27	87	-13	86	-14	86	-14
1995	100	0	79	-21	86	-14	101	1
1996	114	14	114	14	88	-12	101	1
1997	139	39	122	22	91	-9	104	4
1998	154	54	111	11	94	-6	103	3
1999	166	66	108	8	94	-6	99	-1
2000	95	-5	57	-43	99	-1	105	5
2001	118	18	124	24	82	-18	83	-17
2002	122	22	103	3	94	-6	114	14
2003	103	3	84	-16	87	-13	93	-7
2004	79	-21	77	-23	91	-9	104	4
2005	84	-16	106	6	98	-2	107	7
2006	89	-11	106	6	105	5	107	7
2007	97	-3	109	9	109	9	104	4
2008	91	-9	94	-6	114	14	104	4
2009	100	0	110	10	100	0	88	-12
2010	93	-7	93	-7	106	6	106	6
2011	110	10	118	18	116	16	110	10
2012	115	15	105	5	133	33	114	14
2013	115	15	100	0	125	25	94	-6

According to the individual indices based on year 2009, the biggest increase in coniferous sawnwood production occurred in 1999, when production were 66% greater than in 2009, while the biggest decrease occurred in 2004, when production were 21% lower than in 2009. According to the chain indices, the biggest increase in coniferous sawnwood production occurred in 2001, when production were 24% greather than in 2000, while the bigest decrease occurred in 2000, when production were 43% lower than in 1999.

The biggest increase in non-coniferous sawnwood production, according to the individual indices based on year 2009, occurred in 2012, when production were 33% greater than in 2009, while the biggest decrease occurred in 2001, when production were 18% lower than in 2000. According to the chain indices, the biggest increase in non-coniferous sawnwood production occurred in 2002 and 2012, when production were 14% greather than in 2001 and 2011, while the bigest decrease occurred in 2001, when production were 17% lower than in 2000.

According to the individual indices (based on year 2009), the biggest increase in total sawnwood production occurred in 2012, when production were 30% greater than in 2009, while the biggest decrease occurred in 2001, when production were 12% lower than in 2009. Movement of basic indices for total production of coniferous and non-coniferous sawnwood in the analyzed period 1993-2013 are shown in Figure 2.

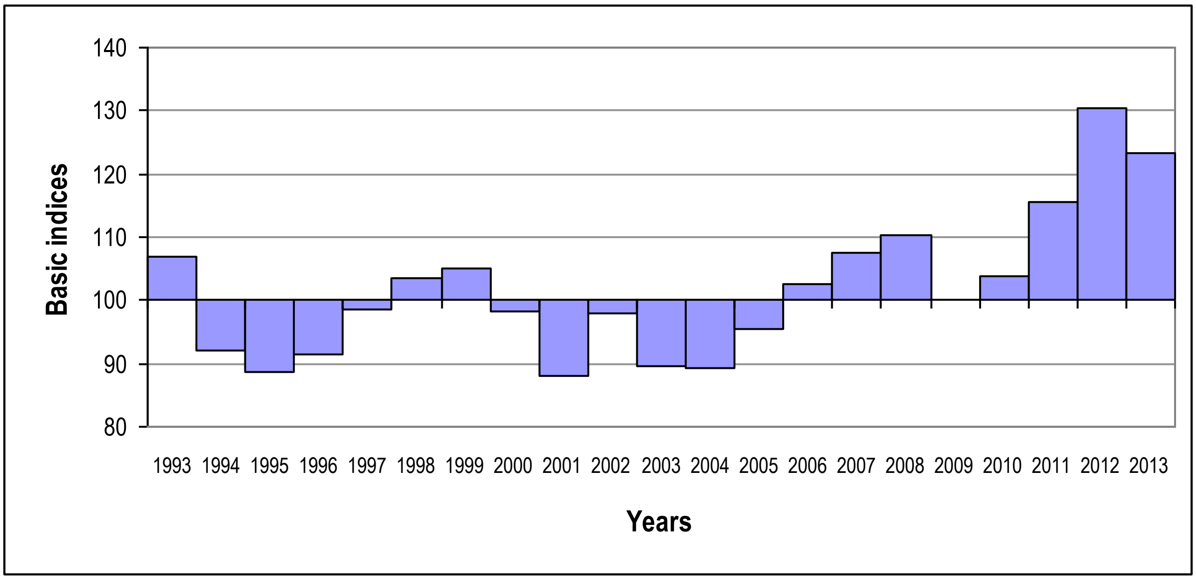

Figure 2. Basic indices for coniferous and non-coniferous sawnwood production in Croatia

Based on the average rate of change for coniferous sawnwood production ($\overline{S} = -1{,}186\,\%$) and average rate of change for non-coniferous sawnwood production in the observed period ($\overline{S} = 1{,}113\,\%$), models A for prediction of future values for sawnwood production were developed.

Correlation analysis to determine the degree of correlation between the values of sawnwood production as dependent variables and time (*t*) as independent variable was used. We found that the direction and strength of the correlation relationship was negative for coniferous sawnwood production (r_{CS}=-0,4936), but positive and relatively high for non-coniferous sawnwood production (r_{NS}=0,7792), so we developed linear trend models (models B) for prediction of future coniferous and non-coniferous sawnwood production values. According to models B, the expected linear decrease in the annual coniferous sawnwood production for Croatia is 1,9 thousand m^3 and the expected linear increase in the annual non-coniferous sawnwood production is 9,3 thousand m^3.

In all models A and B, *t* is mark for the *time*, where *t* = 0 compared to year 1993, *t* = 1 for year 1994; ... , *t* = 17 to year 2010, etc. Unit for predict values of sawnwood production (coniferous and non-coniferous) in Croatia is thousand m^3. Constructed models A and B for predicting the future values of coniferous and non-coniferous sawnwood production are shown in Table 3.

Table 3. Models A and B for calculating the future sawnwood production values for Croatia

Models	Coniferous sawnwood production (CS)	Non-coniferous sawnwood production (NS)
A	$\hat{P}_A^{CS}(t) = 146 \cdot 0{,}988^{(t-1)}$	$\hat{P}_A^{NS}(t) = 553 \cdot 1{,}011^{(t-1)}$
B	$\hat{P}_B^{CS}(t) = -1{,}869 \cdot t + 130{,}9$	$\hat{P}_B^{NS}(t) = 9{,}325 \cdot t + 459{,}3$

Calculated predicted values by models A and models B for coniferous and non-coniferous sawnwood production in Croatia for period 2014-2023 are shown in Table 4.

Table 4. Predicted sawnwood production values for Croatia by models A and B

	Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Coniferous sawnwood production (CS)	model A	113,6	112,3	111,0	109,6	108,3	107,1	105,8	104,5	103,3	102,1
	model B	91,7	89,8	87,9	86,1	84,2	82,3	80,5	78,6	76,7	74,9
Non-coniferous sawnwood production (CS)	model A	697,7	705,4	713,3	721,2	729,3	737,4	745,6	753,9	762,3	770,7
	model B	655,1	664,4	673,7	683,1	692,4	701,7	711,0	720,4	729,7	739,0

Comparison of existing values and calculated predicted values by models A and models B for coniferous sawnwood production in thousand m^3 are shown in Figure 3, while the comparison of existing and calculated predicted values by models A and B for non-coniferous sawnwood production in thousand m^3 are shown in Figure 4.

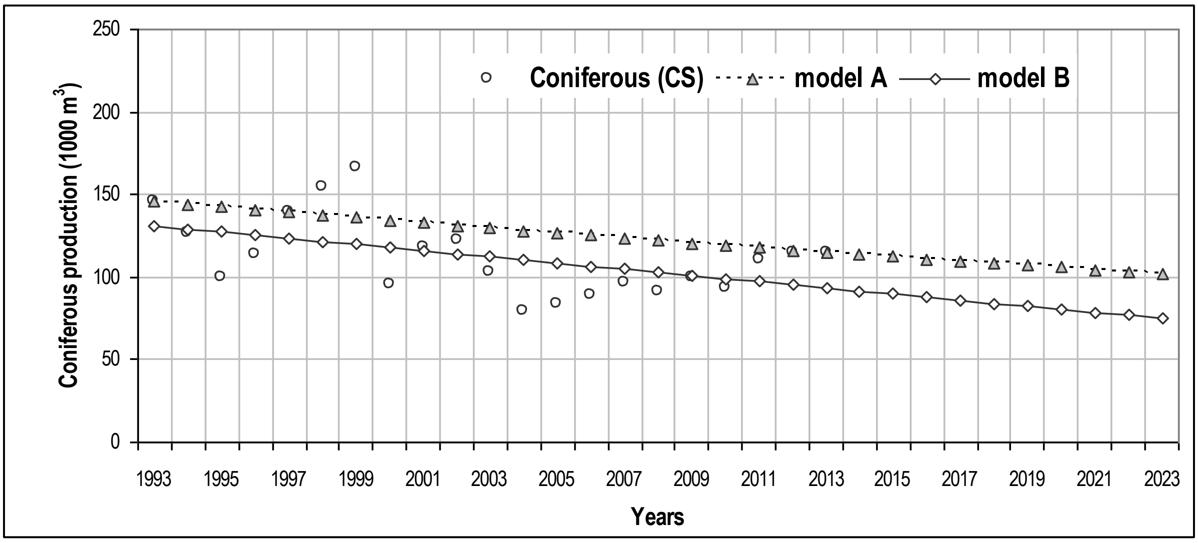

Figure 3. Projections for coniferous sawnwood production in Croatia

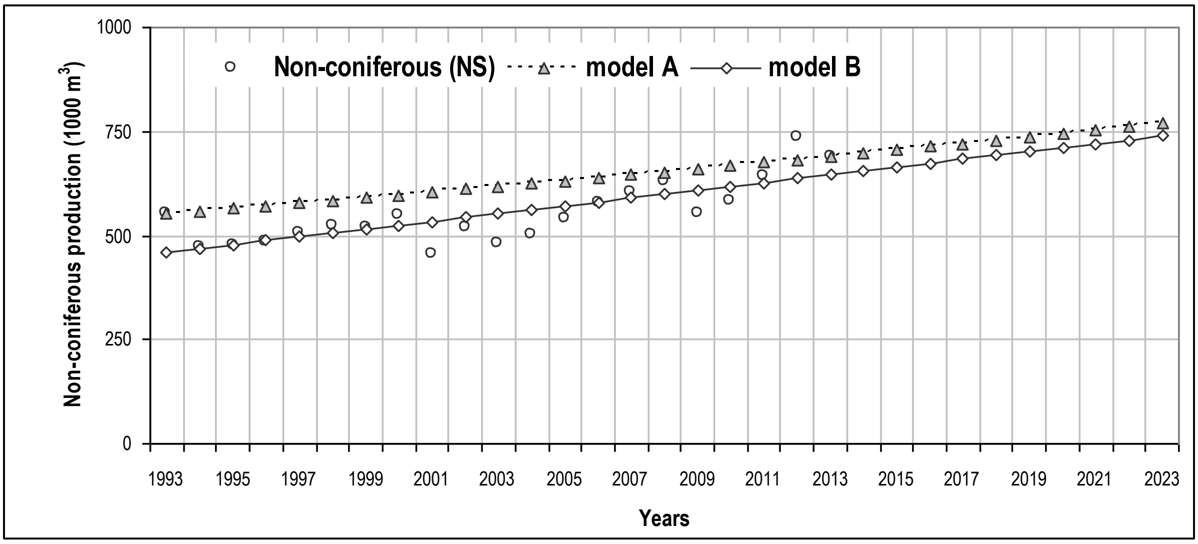

Figure 4. Projections for non-coniferous sawnwood production in Croatia

4. CONCLUSION

Looking at the overall sawnwood production, average is 0,7 millions m^3, range in size from 0,57 millions m^3 (in 2001) to 0,85 millions m^3 (in 2012). Average coniferous sawnwood production is 0,12 millions m^3, range in size from 79 thousand m^3 (in 2004) to 166 thousand m^3 (in 1999). Average non-coniferous sawnwood production is 0,55 millions m^3, range in size from 456 thousand m^3 (in 2001) to 736 thousand m^3 (in 2012).

Average rate of change for coniferous sawnwood production is negative (-1,186%) and average rate of change for non-coniferous sawnwood production is positive (1,113%) in the observed period. According to linear trend models, the expected linear decrease in the annual coniferous sawnwood production for Croatia is 1,9 thousand m^3 and the expected linear increase in the annual non-coniferous sawnwood production is 9,3 thousand m^3.

Assuming that the macroeconomic policies of Croatia will not be altered, and assuming that the models for predicting future values of coniferous and non-coniferous sawnwood production satisfy all statistical and theoretical terms, constructed models A and models B could become a great help for a future actions in this field.

REFERENCES

1. CBS/DSZ (different years): YEARBOOKS, Official website of the Croatian Bureau of Statistics, http://www.dzs.hr.
2. Fair, R.C., Case, K.E. (1989): PRINCIPLES OF ECONOMICS, Prentice-Hall.
3. FAOSTAT (different years): YEARBOOKS, Official website of the Food and Agriculture Organization of the United Nations Statistics Division, http://faostat3.fao.org.
4. FINA - Financijska agencija Republike Hrvatske (different years): http://www.fina.hr.
5. Hanke, J.E., Reitsch, A.G. (2001): BUSINESS FORECASTING, 4th Edition, Allyn&Bacon, Boston.
6. Kersan-Škabić, I. (2014): CROATIAN WOOD INDUSTRY – CLUSTERS, COMPETITIVENESS AND PERSPECTIVES OF DEVELOPMENT IN THE FRAMEWORK OF EUROPEAN UNION MEMBERSHIP, Poslovna Izvrsnost Zagreb, No. VIII/2, 57-77.
7. Kotler, P. (2001): UPRAVLJANJE MARKETINGOM: ANALIZA, PLANIRANJE, PRIMJENA I KONTROLA, Mate, Zagreb.
8. Mansfield, E. (1997): PRINCIPLES OF MICROECONOMICS, 9th Edition, W.W. Norton & Co., New York.
9. Rozga, A., Grčić, B. (2000): POSLOVNA STATISTIKA, Veleučilište u Splitu, Split.

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THE COMPETITIVENESS OF CONIFEROUS AND NON-CONIFEROUS LOGS IN SLOVAKIA

Martina Kalamárová, Ján Parobek, Erika Loučanová

ABSTRACT

The paper focuses on the competitiveness analysis of the selected wood commodities (coniferous and non-coniferous logs) within the EU - 27 for the period 2009 to 2013. The assessment of the competitiveness is a very complex process and it can be analyzed in many ways. Therefore, widely accepted indices of revealed comparative advantages, RCA indicators, are used in the paper to analyze the competitiveness. These indicators allow detecting the competitive situation of the selected products and help to compare the development and analysis of export performance and competitiveness on international market.
Keywords: Competitiveness**,** Revealed Comparative Advantages, logs.

1. INTRODUCTION

The principles of competitiveness in the economy and management are based on economic theories of Adam Smith, David Ricardo, Hunt Porter, Schumpeter, who have contributed significantly to the theory of competitiveness. Hunt (2000) is the author of the "Resource-Advantage Theory“ (RA), the theory of competitive advantage based on the sources that contributed to the development of other views on the theory of competitiveness and a new theory of competitiveness in marketing, management, business and economy. Many authors such as Mankiw (2009), Samuelson and Nordhaus (1995), Henderson et al. (1991), Varian (2010), Holman (2002), Nezval and Tuleja (2004), Frank (1995), Utkulu and Seymen (2004) dealt with the principles of competitiveness and comparative advantages.

The issue of the competitiveness is characterized by a multidisciplinary approach, competitiveness is now widely used term, still more authors are devoted to analysis of competitiveness, nevertheless there is no uniform definition of this term. This is also reflected in the understanding of competitiveness in several respects. In general terms several basic levels of competitiveness can be distinguished (Rajčániová, 2006, Vida et al., 2009) as competitiveness of a country, a region, a sector, a company and a product.

Different methods to identify and measure the comparative advantages exist. The most common method is an index of apparent (revealed) comparative advantage (RCA) and a measure of the contribution of the trade balance. These methods are used to compare the development and analyze the export performance and competitiveness in international markets. Some authors call the RCA method the specialization index because it identifies a product group which has given the country an advantage in the product specialization. There are other modified versions of RCA index to the Balassa's original concept, which was published in 1965 (Balassa, 1965). Balassa himself clarified the index in 1977 (Balassa, 1977) and 1989 (Balassa, 1989). The issue of apparent comparative advantage, its calculation or improvement was also examined by other authors such as Hinloopen and Van Marrewijk (2001), Vollrath (1991) and Yeats (1985). Accordingly to that amount of authors, there are several modified version of RCA index. In the literature (Utkulu and Seymen, 2004) we can see an overview of the various forms of RCA indices, where the authors state up to six versions of the RCA index.

At the present time significant changes in the political, social and economic areas are reflected in the use of domestic renewable resources. Wood production has a long tradition in the Slovak

Republic. Nowadays wood as a significant renewable resource is closely linked with many other sectors of the national economy. Competitiveness of each sector depends on the process of restructuralisation and modernisation of production facilities as well as the process of specialisation of production (Paluš, Šupín, 2004). Forest industry is one of the sectors in which the Slovak economy may at least partly influence European markets with maximum utilization of own resources (Paluš et al., 2009). Except natural conditions there is market which has significant impact to wood supply. In the Slovak Republic the timber market is influenced by the imbalance of demand and supply, the increased demand for coniferous logs persists. Wood logging in 2013 declined slightly and it reached 7,837,067 m^3. Logging of coniferous wood represents 52,7 % (4,131,064 m^3) and of non-coniferous 47,3 % (3,706,226 m^3). The total amount of coniferous logs export is 1,012,000 m^3 and the total import is 298,000 m^3. Regarding the non-coniferous logs, the total amount of beech logs export is 73,185 m^3, total import 208 m^3 and the total amount of oak logs export is 30,586 m^3, total import 407 m^3 (MPSR, 2014).

2. METHODOLOGY

The paper focuses on the competitiveness analysis of the coniferous and non-coniferous logs in Slovakia within the EU - 27 for the period 2009 to 2013. Material necessary for processing this paper was obtained in secondary research, based on analysis of the available scientific literature and internet sources focusing on the issue of sectors and countries competitiveness. The data necessary for the analysis and calculation of competitiveness indicators (information on production, export and import) were obtained from publicly available international statistical databases as UN COMTRADE, EUROSTAT and FAOSTAT.

Widely accepted indices of revealed comparative advantage are used in the paper to analyze the competitiveness (tab. 1). These indicators allow to detect the competitive situation in the industry, but also to compare the development and analysis of export performance and competitiveness in international markets.

Table 1. RCA indices calculation

Index	Calculation	Comparative advantage
RCA I	RCA I = Xij / Xnj	RCA I > 0
RCA II	RCA II = (Xij / Xit) / (Xnj / Xnt) = (Xij / Xnj) / (Xit / Xnt)	RCA II > 1
RCA III	RCA III = (Xij - Mij) / (Xij + Mij)	0 < RCA <1
RCA IV	RCA IV = (Xij / Xit) / (Mij / Mit) = (Xij / Mij) / (Xit / Mit)	RCA IV > 1
RCA V	RCA V = ln (Xij / Xit) / (Mij / Mit) *100 = ln (Xij / Mij) / (Xit /Mit) *100	RCA V > 0
RCA VI	RTA = RXA - RMA = (Xij/ Xit) / (Xnj/ Xnt) - (Mij/ Mit) / (Mnj/ Mnt)	RCA VI > 0
RCA VII	ln RXA = ln RCA II	RCA VII > 0
RCA VIII	RC = ln RXA - ln RMA	RCA VIII > 0

X=export, i= country (Slovakia), j=commodity/industry (coniferous and nonconiferous logs), n=set of countries (EU), M=import, t = a set of commodities (or industries).

The RCA index is used for evaluating the competitiveness of the manufacturing sector. A positive value indicates the relative competitiveness of the sector, while a negative value indicates about the loss of this competitiveness ability (Vokorokosová, 2004). RCAI is the simple measure of revealed comparative advantage. RCAI is a widely accepted and afterwards modified measure of RCA in the literature. RCAII measures a country's exports of a commodity (or industry) relative to its total exports and to the corresponding exports of a set of countries, e.g. the EU. An alternative RCAIII is computed in order to make reference to the "own" country trade performance only. This type of measurement of a country's RCA recognises the possibility of simultaneous exports and imports within a particular commodity (logs). One can derive another version of RCA from Balassa: RCA IV (indicator of comparative advantage), RCA V (logarithm of revealed comparative advantages), both might be calculated either in global or regional levels.

Vollrath (1991), on the other hand, offered mainly three alternative ways of measurement of a country's RCA. These alternative specifications of RCA are called the relative trade advantage (RTA), the logarithm of the relative export advantage (ln RXA), and the revealed competitiveness (RC). In this paper, for the sake of being systematic, we call them as RCAVI, RCAVII, and RCAVIII respectively. The relative trade advantage RTA (RCAVI) is calculated as the difference between relative export advantage RXA, which is the equivalent to the original Balassa index RCAII, and its counterpart, relative import advantage RMA.

3. THE COMPETITIVENESS ANALYSIS

By applying the indicators RCAI – RCAVIII comparative advantage of logs, as a key commodity of forest industry in foreign trade was calculated for the period 2009 – 2013 (tab. 2). Despite the different approach in accounting principles for each index, all indices (RCAI to RCA VIII) have the same objective – to determine if the Slovak Republic has a competitive advantage in the logs in foreign trade compared to the EU – 27. In particular, indices such as RCA III (pure business performance index), IV (indicator of comparative advantage), V (logarithm of revealed comparative advantages) allow us to avoid distorted results through the re-export reveal by taking into consideration the import volume.

Table 2. The development of the coniferous and non-coniferous logs competitiveness by RCA indices for the period 2009 - 2013

Indices Used		**Analysed Years**				
		2009	**2010**	**2011**	**2012**	**2013**
Coniferous logs	RCA I	0,1186	0,1670	0,1246	0,1448	0,0726
	RCA II (RXA)	3,9848	5,5637	4,2079	4,8761	2,3952
	RCA III	0,9322	0,9609	0,9756	0,5744	0,4679
	RCA IV	17,9474	31,7887	49,7399	2,1683	1,7112
	RCA V	210,8876	248,0598	269,5362	76,6763	62,9454
	RCA VI (RTA)	3,8308	5,4310	4,1419	3,2165	1,1538
	RCA VII	1,3825	1,7163	1,4370	1,5843	0,8735
	RCA VIII (RC)	3,2536	3,7360	4,1558	1,0778	0,6572
Non-coniferous logs	RCA I	0,0401	0,0427	0,0468	0,0416	0,0386
	RCA II (RXA)	1,3483	1,4228	1,5804	1,4004	1,2716
	RCA III	0,5702	0,7040	0,8340	0,8098	0,8130
	RCA IV	2,2993	3,6471	6,7723	5,5785	6,0143
	RCA V	81,5461	110,8921	147,2769	132,0702	140,9062
	RCA VI (RTA)	0,5884	0,8036	1,1071	0,8758	0,8413
	RCA VII	0,2988	0,3526	0,4577	0,3367	0,2402
	RCA VIII (RC)	0,5734	0,8312	1,2058	0,9819	1,0836

Throughout the analysed time period the index RCA I and RCA V - RCA VIII reached positive values, RCA II and RCA IV values greater than 1, RCA III in the range of 0-1, which signify a competitive advantage of the Slovakia to EU-27 countries within the logs (coniferous and non-coniferous). Only the intensity of the competitive advantage is changing.

4. CONCLUSION

The process of the wood industry competitiveness evaluation is very complex, due to that fact we applied the eight modified and widely accepted indicators of RCA in the paper. Using a larger number of indicators which have a different sensitivity and also respect particular import volume, we are able to evaluate the development of foreign trade and competitiveness of logs in a more detailed way.

Coniferous and non-coniferous logs throughout the period 2009 - 2013 reached a competitive advantage in all indicators of RCA. In general, coniferous logs achieves greater export advantage over non-coniferous. Confirmed competitive advantages of logs in turn may not be up to such advantage for Slovakia. From the perspective of the national economy just a relatively high proportion of logs exports accounts for a large export of raw material with low added value. To process logs in domestic conditions relating to products with higher added value could be for Slovakia better and cheaper, and thus there would be a greater appreciation of logs thereby timber production of Slovakia could achieve higher profits.

REFERENCES

1. Balassa, B. (1965): TRADE LIBERALIZATION AND REVEALED COMPARATIVE ADVANTAGE. The Manchester School of Economic and Social studies, 1965, 33, pp. 99 – 123.
2. Balassa, B. (1977): REVEALED COMPARATIVE ADVANTAGE REVISITED. The Manchester School, 1977, 45, pp. 327 – 344.
3. Balassa, B. (1989): COMPARATIVE ADVANTAGE, TRADE POLICY AND ECONOMIC DEVELOPMENT. New York: Harvester Wheatsheaf, 1989.
4. Frank, R. H. (1995): MIKROEKONOMIE & CHOVÁNÍ. 1995. Praha: Nakladatelství Svoboda, 1995. 765 s. ISBN 80-205-0438-9.
5. Henderson, J. V. et al. (1991): PRINCIPLES OF MICROECONOMICS. Lexington: D.C. Heath and Company, 1991. ISBN 0-601-144492-4, s. 630.
6. Hinloopen, J., Van Marrewijk, C. (2001): ON THE EMPIRICAL DISTRIBUTION OF THE BALASSA INDEX. Weltwirtschaftliches Archív, 2001, 137, s. 1 – 35.
7. Holman, R. (2002): MIKROEKONOMIE. Praha: C. H. Beck, 2002. 591 s. ISBN 80-7179-737-5.
8. Hunt, S. D. (2000): A GENERAL THEORY OF COMPETITION. California: Thousand Oaks: Sage Publications, 2000. ISBN 0-7619-1729-2.
9. Mankiw, G. N. (2009): ZÁSADY EKONOMIE. Praha: Grada Publishing, 2009. ISBN 80-7169-891-1.
10. Michaely, M. (1962): CONCENTRATION IN INTERNATIONAL TRADE. Contribution to Economic Analysis. Amsterdam: North-Holland Publishing, 1962.
11. MPSR. (2014): Správa o lesnom hospodárstve v Slovenskej republike za rok 2013. Zelená správa 2014. [online]. Bratislava: MPSR, 2014. [cit.13.03.2015] Dostupné na internete: < http://mpsr.sk/index.php?navID=123&id=8915>.
12. Nezval, P., Tuleja, P. (2004): MIKROEKONOMIE. Karviná: SU OPF, 2004. ISBN 80-7248-235-1.
13. Paluš, H., Maťová, H., Kaputa, V. (2012): CONSUMER PREFERENCES FOR JOINERY PRODUCTS AND FURNITURE IN SLOVAKIA AND POLAND. In Acta facultatis xylologiae Zvolen : vedecký časopis Drevárskej fakulty. - ISSN 1336-3824. - Roč. 54, č. 2 (2012), s. 123-132.
14. Paluš, H., Šupín, M. (2004): COMPETITIVENESS OF SELECTED CLUSTERS IN THE SLOVAK FOREST INDUSTRY. The growth and developement in forestry and wood industry. Scientific book. Zagreb, Croatia, 2004. ISBN 953-6307-73-1. p. 17-20.
15. Paluš, H., Šupín, M., Parobek, J., Kaputa, V. (2009): POSTOJE K CERTIFIKÁCII LESOV A SPOTREBITEĽSKÉHO REŤAZCA V SR. Vedecká štúdia 9/2008/B. Zvolen : Vydavateľstvo TU vo Zvolene, 2009. 56 s. ISBN 987-80-228-1997-8.
16. Rajčániová, M. (2006): KONKURENCIESCHOPNOSŤ A MOŽNOSTI JEJ MERANIA. [online]. 2006. [cit. 13. 1. 2015]. Dostupné na internete: http://www.fem.uniag.sk/mvd2006/zbornik/sekcia1/s1_rajcaniova_miroslava_175.pdf.
17. Samuelson, P. A., Nordhaus, W. D. (1995): ECONOMICS. Boston: Irwin McGraw, 1995. ISBN 0-07-054981-8. 11.

18. Triznová, M. (2014): MANAŽMENT VZŤAHOV SO ZÁKAZNÍKOM. Zvolen : Technická univerzita vo Zvolene, 2014. 86 s. ISBN 978-80-228-2640-2.
19. Utkulu, U., Seymen, D. (2004): REVEALED COMPARATIVE ADVANTAGE AND COMPETITIVENESS. European Trade Study Group 6th Annual Conference. Nottingham.
20. Varian, H. R. (2010): MICROECONOMICS. A Modern Approach. New York: W.W. Norton & Company, 2010. ISBN 978-0-393-93424-3.
21. Vida, M., Kadár, G., Kadárová, J. (2009): ANALÝZA FAKTOROV KONKURENCIESCHOPNOSTI SLOVENSKÝCH PODNIKOV. Technická univerzita v Košiciach. [online]. Transfer inovácii 13/2009. [cit.2.2.2015]. Dostupné na internete:http://www.sjf.tuke.sk/transferinovacii/pages/archiv/transfer/13-2009/pdf/133-136.pdf.
22. Vokorokosová, R. (2004): KOMPARATÍVNE A KONKURENČNÉ VÝHODY V OBDOBÍ GLOBALIZÁCIE. Bratislava, EKONÓM, 2004. ISBN 80-225-1854-9.
23. Vollrath, T. L. (1991): A THEORETICAL EVALUATION OF ALTERNATIVE TRADE INTENSITY MEASURES OF REVEALED COMPARATIVE ADVANTAGE. Veltwirtschaftliches Archiv 1991, 130, s. 265 – 279.
24. Yeats, A. J. (1985): ON THE APPROPRIATE INTERPRETATION OF THE COMPARATIVE ADVANTAGE INDEX: IMPLICATIONS OF A METHODOLOGY BASED ON INDUSTRY SECTOR ANALYSIS. Veltwirtschaftliches Archiv, 1985, 121(1), s. 61 – 73.

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A REGULATORY QUALITY ANALYSIS OF FOREST PRODUCTS TRADE IN INDIA

Joy Das, Richard Vlosky

ABSTRACT

This study examines forest products imports to India during 2009-2013, exploring the influence of Regulatory Quality on the pattern of trade from 143 partner countries. The study applies a pooled ordinary least squared (OLS) regression model of estimation with Regulatory Quality, distance between the partner country and India, total forest area of partner country, GDP and population indicators to assess the impact of partner country's regulatory quality and other trade-related factors on imports of forest products by India. The results support the notion that imports of forest products depend on Regulatory Quality, the distance between the trading countries, forest area, the size of the economy and other factors considered in the model. The study also considers the impact of regional variability on forest product imports by India in the model.
Key words: Regulatory Quality, India, import, forest products.

1. INTRODUCTION

India's forests play a significant role in the economic development of the country. There is an extensive demand for forest products in India. These include a plethora of products such as furniture, firewood, timber, materials for housing and fodder. The recent surge in demand is mainly an indication of the country's rapid economic growth, industrialization and increase in population (Malik & Dhanda, 2003). About 24 percent of India's total land area attributes to forest areas (FAOSTAT, 2013). The products produced by these resources, however, do not meet the total requirement of the country. To suffice domestic needs, importing from other countries is necessary.

During the last decade, forest products imports by India has increased by four times. The total value of forest product imports by India has reached 5.4 billion US $ during 2013 from about 1.5 billion US $ during 2003. This volume of imports by India accounts for 0.29 percent of India's GDP in 2013. There are several factors associated with this surge in forest products imports by India from exporting countries. Use of more energy efficient technology for transporting goods, trade liberalization, rapid economic growth and transition in the functioning of the governance are few factors that can influence the change in the volume of trade between countries. Operational issues of governance are currently being discussed to help define the reasons behind the changing patterns of trade. Researchers suggest that Regulatory Quality or a quantitative reflection of the overall governance of a country has significant impacts on trade patterns in different sectors across the world (Freund & Bolaky, 2006). This study examines Regulatory Quality and the effect of partner country's Regulatory Quality on forest product imports by India.

The first part of the study primarily discusses forest products trade in India. The second part defines Regulatory Quality and discusses the available literature on the effects of Regulatory Quality on trade. The third part discusses the objective of the study and, describes the methodology, research model, hypothesis, and data. The fourth part describes the results of the analysis and the last part discusses and concludes the study.

1.1 Forest products trade in India

India's forest product imports had increased by nearly four times from 1.5 billion US $ to 5.4 billion US $ during the last decade, as shown in Figure- 1 (FAOSTAT, 2013). India has only 24 percent of the total area covered by forest, and there is a large gap between the forest products demand and supply (Kumar, Viswanathan, & I, 2013). During the last decade due to a surge in the demand for wood products and the relative scarcity of timber in India, the log imports have almost doubled. Currently, India is the largest potential timber importing country after China (Flynn, 2013).

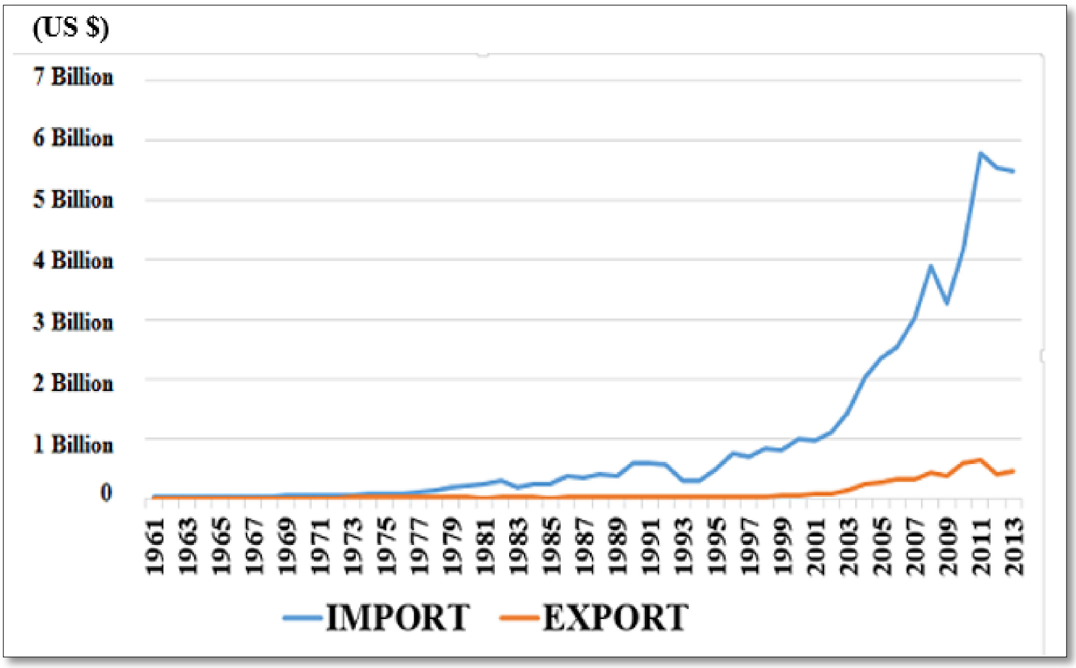

Figure 1 Trend of Forest Products Trade in India
Source: FAOSTAT, 2013

Prior to the 1980s, India's forest products trade balance was almost zero. However, during late 1980's and early 1990's, the trade balance started showing a negative trend. Due to trade liberalization in India during 1990's and an exponential growth rate of population, the demand for forest products have also increased. Since the 1990's there has been a sharp increase in India's forest products imports. The largest share of India's forest products imports comes from the United States of America followed by China, Germany, Japan and the United Kingdom. Of the top five countries, the US has exported about 1.5 billion US $ worth of forest products to India during 1961-2013.

2. LITERATURE REVIEW

2.1 Regulatory Quality

Regulatory Quality is a part of functioning of the governance that is defined as the ability of the government to form rules and regulations and properly implement them in order to promote and permit private sector development (WGI, 2013). It has an index ranging from -2.5 (weak) to 2.5 (strong) representing governance performance.

In this paper, Regulatory Quality is the main explanatory variable used, to study its effect on forest product imports in India. The value of Regulatory Quality in each country is obtained by combining around 31 different surveys and assessments from sources such as African Development Bank Country Policy and Institutional Assessments (ADB), Afrobarometer (AFR), Asian Development Bank Country Policy and Institutional Assessments (ASD), Business Enterprise Environment Survey (BPS) and European Bank for Reconstruction and Development Transition Report (EBR) etc. While constructing the index for Regulatory Quality, a diverse group of representative and non-representative sources are surveyed, and their perception regarding the quality of various aspects of governance in the country is recorded. Regulatory Quality includes assessment of a country's performance provided by different sources in regards to price control, administered prices, investment freedom, trade policies and the business regulatory environment. Each of the surveys receives a different weight, depending on the coverage and its effect on Governance. The relevant areas considered and questions asked by data sources (surveys and expert opinions) that form a part of Regulatory Quality Index are broadly categorized into two sections, representative sources and non-representative sources.

The representative sources consider the authority's performance on price controls, discriminatory tariffs, discriminatory taxes and unfair competitive practices as well as rigidity in government regulations and, the burden of taxation and excessive protection. Other aspects associated with the functioning and prevalence of the trade barriers and trade regulations, stringency of environment regulations, intensity of local competition, the effectiveness of antitrust policies, and the ease of starting a new business are considered in the survey. The extent to which there are financial freedom, investment freedom, availability of state subsidies on necessary goods for the start-up of a business such as petrol prices and the share of administered prices are considered in the process. Finally the ease of setting up a subsidiary for a foreign firm and the ease of starting a business governed by local law are considered under the non-representative sources while conducting the survey for quantifying the value of regulatory quality (WorldBank, 2014).The non-representative sources consider the effectiveness of the government in assuring less rigidity of the bureaucratic rules, check on corruption and transparency at the authoritative level. Firstly, it looks into the extent to which there are problems in tax regulations, custom and trade regulations, and labor regulations for the growth of business in the country. Secondly, it considers the extent to which price control is affecting prices of products in industries, over protectionism is affecting business, and competition legislations are preventing unfair competition in the country. Thirdly, non-representative sources consider the easy access to foreign and domestic capital markets and doing other business activities. Lastly, it considers whether or not the financial institutions' transparency is widely developed in the country, the custom authorities facilitate efficient transition of goods and services, the legal entity is harming the country's performance in competitive market, foreign investors are free to invest in the domestic market, whether the foreign bidders have sufficient access to public sector contracts, real personal taxes are non-distortionary, real corporate taxes are non-distortionary, banking regulations hinder competitiveness, and whether the labor regulations hinder business activities in the country.

Regulatory quality enhances the volume of trade between countries and helps in economic growth. It identifies smooth functioning of a business, banking and labor market flexibility (Freund & Bolaky, 2006). (Banerjee, 1997) and (Guriev, 2004) have said that there are several factors such as corruption and poor institutions that determines the level of regulation and governance of trading countries, mentioned in (Breen & Gillanders, 2010). (Iwanow & Kirkpatrick, 2007) Have studied the effect of regulatory quality on exports in the manufacturing sector and found that regulatory quality has a significant positive effect on improved export performance. They have quantified the effect of regulatory quality on the total volume of exports in the manufacturing sector. The results that they have obtained showed that a 10 percent increase in the value of regulatory quality among all the exporting countries increases the export of manufacturing sector by nearly 10 percent keeping other things constant. It is important and interesting to know the effect of regulatory quality on the volume of import of forest products by India from all the 143 partner countries that export forest products to India.

3. METHODOLOGY AND MODEL

The objective of the paper is to study the effect of Regulatory Quality on forest product imports by India. The study estimates the model with panel data of 5 years from 2009-2013 for 143 partner countries from which India imports forest products. The regression equation takes the following form:

$$Y_{ijt} = \beta_0 + \beta_1\ REGQ\_PAR_{jt} + \beta_2\ REGQ\_IND_t + \beta_3\ GDP\_IND_t + \beta_4\ GDP\_PAR_{jt} + \beta_5\ POP\_PAR_{jt} + \beta_6\ POP\_IND_t + \beta_7\ DIST_{ij} + \beta_8\ FOR\_PAR_{jt} + \beta_9\ REGION\_2_j + \beta_{10}\ REGION\_3_j + \beta_{11}\ REGION\_4_j + \beta_{12}\ REGION\_5_j + \beta_{13}\ REGION\_6_j + \beta_{14}\ REGION\_7_j + \epsilon_{ijt} \quad \ldots\ldots\ldots (2)$$

Where,
i and j are the trading partners, and t denotes time, which is (2009 – 2013). Here "i" is fixed that is India and "j" is each of the 143 partner countries that export forest products to India. All the subscripts and the other variables of equation (1) are explained including the region dummy variables used in the model to capture the effect of region specific unobserved variables on forest product imports by India. East Asia and Pacific has been taken as the base region and a POLS (Pooled Ordinary Least Squared) regression analysis is performed.

- Y_{ijt} denotes the value of total Forest Products imports to India from country j at time t.
- $REGQ\_IN_t$ and $REGQ\_PAR_{jt}$ denote the Regulatory Quality variable of India and country j respectively at time t.
- GDP_IND_t and GDP_PAR_{jt} are the real GDPs of India and country j respectively at time t.
- POP_IND_t and POP_PAR_{jt} denote the population of India and country j respectively at time t.
- $DIST_{ij}$ is the distance between the capital city of India (New Delhi) and the capital city of country j.
- FOR_PAR_{jt} is the total forest area of country j at time t.
- $REGION\_2_j$ denotes "Europe and Central Asia" is a binary 'dummy' variable which is unity if country j belongs to this region and zero otherwise.
- $REGION\_3_j$ denotes "Latin America & the Caribbean" is a binary 'dummy' variable which is unity if country j belongs to this region and zero otherwise.
- $REGION\_4_j$ denotes "Middle East & North Africa" is a binary 'dummy' variable which is unity if country j belongs to this region and zero otherwise.
- $REGION\_5_j$ denotes "North America" is a binary 'dummy' variable which is unity if country j belongs to this region and zero otherwise.
- $REGION\_6_j$ denotes "South Asia" is a binary 'dummy' variable which is unity if country j belongs to this region and zero otherwise.
- $REGION\_7_j$ denotes "Sub-Saharan Africa" is a binary 'dummy' variable which is unity if country j belongs to this region and zero otherwise.
- ϵ_{ijt} is the error term.

The dependent variable Y_{ijt} estimates the total value of forest products import by India from all the 143 partner countries during 2009-2013. The values of imports are obtained from (FAOSTAT, 2015) dataset. $REGQ\_PAR_{jt}$ that is the regulatory quality of partner country is the main variable of the study. The variable is taken from (Kaufmann, Kraay, & Mastruzzi, 2013) dataset. The values are obtained from the World Bank, 2014. Other explanatory variables such as regulatory quality of India, GDP and population (the size of the economies) of partner countries and India, distance between the trading countries and, forest area etc., are incorporated in the model as other explanatory variables in order to minimize the omitted variable bias.

All the variables are linearized by taking logarithms on both sides of the equation and in order to ensure compatibility among all the variables in the model the regulatory quality index is rescaled by shifting its mean from “0” to “10”. In this case, the value of regulatory quality ranges from 7.5 to 12.5, where 7.5 denotes weak governance and 12.5 denotes strong governance of a country. A pooled regression is used to analyze the effect of regulatory quality on forest products import by India. To make the model robust, we have incorporated the region dummy in the model and accounted for the region specific unobserved factors affecting trade.

The World Bank has classified all countries across the globe into seven groups on the basis of their respective geographical locations. They are East Asia and Pacific, Europe & Central Asia, Latin America & the Caribbean, Middle East & North Africa, North America, South Asia and, Sub-Saharan Africa. The analysis is done by including the region dummy in the model in order to give an insight on the regional variability on forest products import by India as well. This checks for the region specific unobserved variables affecting forest products import by India and makes the model more robust by reducing the omitted variable bias further (Cameron & Trivedi, 2009). Taking East Asia and Pacific as the base region the following POLS (Pooled Ordinary Least Squared) regression is performed.

4. RESULTS AND DATA ANALYSIS

Results in Table 1 indicate that partner country’s regulatory quality and the size of their economies have significant effects on trade. So, Regulatory Quality in the model, positively affects the volume of forest products imported from India. A one percent improvement in regulatory quality of the partner country would yield a 6.1 percent increase in imports of forest products by India. The scale of regulatory quality index is subtle (- 2.5 to + 2.5), while a one percent increase seems small in absolute terms, it would have a huge impact and could only be attained by drastic changes in governance and rigidity of the existing rules and regulations. Thus, it has a large effect on the volume of forest products imported by India. Also, a one percent increase in distance between India and the trading country yields a 0.6 percent decrease in total volume of imports whereas a one percent increase in forest area of a partner country yield an increase in forest products imported to India by 0.2 percent and a one percent increase in GDP of a partner country yield an increase in forest products imported to India by 0.7 percent. Most of the results are significant at the one percent level, but the variable distance is significant at a five percent level. While the regulatory quality of exporting countries and other variables have substantial positive impacts on forest products trade, the regulatory quality of India itself and the other factors do not have significant impacts on trade. However, coefficients associated with these variables are consistent with the hypothesis that was obtained from existing literature. An R-squared value of 0.4 tells that about 40 percent of the variation in the value of forest products imported by India can be explained by the regulatory quality variable and other explanatory variables in the model. Considering the statistical significance of our results, it can be inferred that an improvement in the regulatory quality, or the functioning of the governance, of partner countries, could have a significant effect on the volume of trade between countries.

From the regression result, it could also be inferred that East Asia and Pacific, Europe & Central Asia, Latin America & the Caribbean, Middle East & North Africa and, South Asia have significant effect on forest products import by India. The impact of forest products import by India from the Europe and Central Asian countries is about 2.1 percent less than the impact by the countries belonging to the East Asia and Pacific region. Latin American and the Caribbean countries and the Middle East & North African countries have 1.47 percent lesser effect of forest products import by India compared to East Asian and Pacific regional countries, Whereas the South Asian countries have 1.24 percent lesser effect on forest products import by India compared to the East Asia and Pacific region countries. However, North American countries’ impact on forest products import by India though not significant, but its direction is 0.14 percent more than that of East Asia and Pacific regional countries. Similarly Sub-

Saharan African countries do not have a significant impact on India's forest products import compared to the East Asian and Pacific regional countries. By incorporating the region dummy in the model, the estimation becomes more accurate as it reduced the omitted variable bias further by considering the effect of region specific unobserved variables on forest products imports by India.

Table 1 Pooled Ordinary Least Squares (OLS) Regression Using Regional Variability

	Import of Forest Products	Std. Err	Directionality
Regulatory Quality of Partner country	6.1***	2.2	Consistent With the Hypothesis
Regulatory Quality of India	22.9	27.2	Consistent With the Hypothesis
Distance	-0.6**	0.3	Consistent With the Hypothesis
Forest Area of Partner Country	0.2***	0.06	Consistent With the Hypothesis
GDP of India	1.9	1.8	Consistent With the Hypothesis
GDP of Partner Country	0.7***	0.1	Consistent With the Hypothesis
Population of India	10.08	19.9	Consistent With the Hypothesis
Population of Partner Country	-0.4***	0.1	Consistent With the Hypothesis
Europe & Central Asia	-2.1***	0.3	
Latin America & the Caribbean	-1.4***	0.5	
Middle East & North Africa	-1.4***	0.4	
North America	0.1	0.4	
South Asia	-1.2**	0.6	
Sub-Saharan Africa	-0.2	0.4	
Constant	-333.2	426.08	
N	456		
R-squared	0.4		

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

5. CONCLUSION

The purpose of this study has been to provide a quantitative assessment of the effect of regulatory quality on the import volume of forest products by India. The study suggests, using a pooled OLS regression model that improvements in regulatory quality by partner countries could indeed play a significant role in increasing India's forest products imports. Changes in the functioning of governance in

India and trade liberalization influence the demand for forest products by India. Due to large shifts in the growth rates of the economy and the population, India demands more forest products. Also, there are changes in partner countries' levels of Regulatory Quality over the years. Improvements in Regulatory Quality help reduce transaction costs and thus result in more trade between countries.

The regional effect on imports of forest products by India gives an insight into the region specific contribution on forest products import by India. It supports the existing literature by characterizing the countries in terms of proximity to India, where the distant countries participate in relatively lesser volumes of trade with India than the nearer ones. Compared to East Asia and Pacific region, the Europe & Central Asia, Latin America & the Caribbean, Middle East & North Africa, South Asia and, Sub-Saharan Africa have relatively lower effects on forest products import by India. This can be explained by the fact that East Asia and Pacific region countries are nearby with India geographically. As our results suggest that distance has a significant effect on trade as it affects the transaction costs to a large extend, the effects of distance on India's import by other countries belonging to the above-mentioned regions are relatively less than East Asia and Pacific regional countries. Latin America and Caribbean countries though have a significant effect on India's forest products import, but their impact is about 1.48 percent less than the impact on East Asia and Pacific region countries. Similarly Europe and Central Asia has 2.1 percent less, the Sub-Saharan African countries have 0.27 percent less and, the Middle East and North African countries have1.47 percent lesser impact than East Asia and Pacific regional countries on India's forest products import.

South Asian countries though are in close proximity to India, trades lesser forest products to India as compared to countries of the East Asia and Pacific region because the major components of forest products like lumber and wood products are abundant in the later. Three of the major partner countries Myanmar, Malaysia and China from which India imports forest products in bulk, lies in the East Asia and Pacific region. Thus our conclusion being consistent with the literature that distance between the trading countries, their regulatory environments and abundance of forest resources in the exporting countries, all play a significant cumulative role in the trade of forest products between India and rest of the world.

The volume of forest products imported by India is affected by the size of the economies of partner countries and the distance between the two countries also to governance or institutional quality of India. More distant countries trade lower volumes of goods than the neighboring countries. However, larger economies and higher levels of forest cover in the partner countries, the latter of which would be expected to produce larger volumes of forest products, are associated with more trade with India. Countries with these characteristics are thus in more advantageous competitive positions than other countries, in terms of trade. Our results thus contributes to the existing literature on the factors affecting international trade of forest products in complementing the research by studying the impact of regulatory environment of the trading partners, Size of their economies and available forest resources and distance between them on enhancement of economic interactions.

5.1 Limitations of the study

This study considers only India's forest products imports value. However, a descriptive study could be done on forest products, considering all the importing and exporting countries across the globe. More years could have been included to get a reflection of the trends in forest products trade over a longer time periods. More explanatory variables could be included to reduce the omitted variable bias from the model. The study considers aggregate forest products, so it fails to explain the sector-specific impacts of the factors affecting trade, which could be developed in further studies.

REFERENCES

Banerjee, A. V. (1997). A Theory of Misgovernance The Quarterly Journal of Economics, 112(4).
Breen, M., & Gillanders, R. (2010). Corruption, Institutions and Regulation. Irish Society of New Economists conference 2010.
Cameron, A. C., & Trivedi, P. K. (2009). Microeconometrics Using Stata
FAOSTAT. (2013). FAOSTAT.
FAOSTAT. (2015).
Flynn, R. (2013). India's Forest Products Industry Outlook. from http://www.risiinfo.com/risi-store/do/product/detail/2013indias-forest-products-industry.html
Freund, C., & Bolaky, B. (2006). TRADE, REGULATIONS, AND GROWTH. Paper presented at the Trade and Growth Conference, Research Department, Hosted by the International Monetary Fund.
Guriev, S. (2004). Red tape and corruption. Journal of Development Economics, 73(2), 489-504.
Iwanow, T., & Kirkpatrick, C. (2007). Trade Facilitation, Regulatory Quality and Export Performance. Journal of International Development, 19, 735-753.
Kaufmann, D., Kraay, A., & Mastruzzi, M. (2013). Governance Matters V: Aggregate and Individual Governance Indicators for 1996-2005
Kumar, K. S. K., Viswanathan, B., & I, Z. B. (2013). ESTIMATION AND FORECAST OF WOOD DEMAND AND SUPPLY IN TAMILANDU.
Malik, D. P., & Dhanda, S. (2003). Status, Trends and Demand For Forest Products In India. Retrieved from http://www.fao.org/docrep/ARTICLE/WFC/XII/0228-B1.HTM
WGI. (2013). World Governance Indicators Report. World Bank.
WorldBank. (2014). World Bank Report. World Bank.

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WHAT SHARE OF THE WOOD IMPORTS INTO EU IS COVERED BY THE EUTR?

Niels Janzen, Holger Weimar

ABSTRACT

In 2003 the EU proposed the Action Plan on Forest Law Enforcement, Governance and Trade (FLEGT) to combat illegal logging. In March 2013 the European Timber Regulation (EUTR) came into effect as a main mechanism of FLEGT. The objective of this study is to quantify the share of all wood and wood-based product imports into the EU to which the EUTR applies. We defined the scope of the wood-based products based on the definition of the forest-based sector and aggregated them to twelve product groups. We then calculated EUTR coverage ratios for three different reference units: import value (Euro), roundwood eq. and wood fibre eq.

Our results show that approximately 90% of total imported wood quantities are covered by the EUTR. This means that 6 million m³ wood fibre eq. (17 million m³ roundwood-eq.) not covered by the EUTR were imported into the EU in 2013. Coverage ratios for product groups differ. Typically raw materials have a higher coverage ratio and finished products a lower coverage ratio. The wood not covered by EUTR is highly concentrated on a few commodities like wood charcoal, articles of wood, n.e.s. and printed books and brochures. The regional import structure of the EU differs between total imports and imports that are not covered by the EUTR. Eastern and South-Eastern Asia and Africa are gaining importance when looking at imports not covered by the EUTR.

Keywords: EUTR, coverage ratio, wood-based products, illegal logging, international trade

1.INTRODUCTION

Illegal logging is one of the major causes for deforestation and the degradation of forests. The further manufacturing of illegally logged wood and products made thereof, as well as the associated trade, negatively affects social and economic interests. The adoption of the EU Action Plan on Forest Law Enforcement, Governance and Trade (FLEGT) in 2003 was a major milestone in combating illegal logging. Since then, two main mechanisms have been implemented in order to achieve the goals of the FLEGT Action Plan: Voluntary Partnership Agreements (VPAs) and the EU Timber Regulation (EUTR).

Our focus is on the EUTR [1]. It came into effect on March 1, 2013 and prohibits the placing of “timber and timber products” on the EU internal market. In this article, we examine the import quantities of wood and wood-based products into the EU from outside the EU with regard to EUTR. We want to quantify the share of imports of all wood and wood-based products into EU to which the EUTR applies.

Our report on this topic [2] is the basis for this article, which is structured as follows: Chapter 2 deals with methodology and data; Chapter 3 presents the results, and finally, in Chapter 4, a discussion and conclusion are provided.

2.METHODOLOGY AND DATA

2.1.Scope of wood and wood based products

Wood and wood-based products cover a wide variety of different goods and commodities. These include, for example, wood products such as firewood, sawnwood, pellets or window frames or paper products such as newsprint, sanitary paper, and paper for packaging or printed articles. Other products beyond the scope of these traditional goods are also manufactured and have to be considered. Regenerated cellulose or cellulose nitrate can be listed as examples. Additionally, there are a lot of products which also can be made of or contain parts of wood (e.g., toys, chewing gum). Hence, it is essential to define the scope of wood-based products for our analysis.

Most of the wood-based products can be attributed to the forest-based sector, which was already described by the European Union in 1999 [3]. In this definition the forest based sector consists of the wood working industry, the wood processing industry, the construction industry, the pulp and paper industry and the printing and publishing industry. Based on this definition of the forest-based sector, the scope of wood and wood-based products of our analysis can be derived. Table 2 gives an overview and structures the wood-based products in categories and products groups.

Table 2. Scope of wood and wood based products

	wood products	paper products	other wood-based products
raw material	(1) roundwood (2) wood processing residues	(8) wood pulp and recovered paper	
semi-finished products	(3) sawnwood (4) wood-based panels (5) other semi-finished wood products	(9) paper and paperboard	(12) regenerated cellulose, artificial fibres a.o.
finished products	(6) finished wood products (7) furniture	(10) articles of paper or paperboard (11) printed matter	

Wood-based products can be categorized into raw materials, semi-finished products and finished products, and between the categories wood products, paper products and other wood-based products. Based on this structure we aggregated the products into twelve product groups for further analysis. The above matrix contains all products for which the EUTR applies. However, as already mentioned, the EUTR does not cover all commodities which have been defined as wood-based products. The EUTR focuses on timber and timber products “with the exception of timber products that have completed their lifecycle and would be disposed as a waste” [1, No. 2(a)]. For a further definition of timber and timber products, the regulation refers to its Annex where a list is provided with respective commodities. The products are structured according to the trade classification of the Combined Nomenclature (CN). The main focus is laid on wood and articles of wood (Chapter 44 of the CN), on pulp of wood (Chapter 47) and on paper and paperboard and articles made thereof (Chapter 48). Additionally some commodity codes for furniture and one code for prefabricated buildings are listed. Especially further processed wood-based products are not included in the EUTR, e.g., wood charcoal, wood marquetry, printed matter or regenerated cellulose.[1]

2.2.Data and reference units

For our analysis we use bilateral trade data of Eurostat (Eurostat 2015). We focus on the year 2013, the year when the EUTR came into force. In this paper the term EU refers to the status of the EU at the end of the year 2013, i.e. it consist of 28 member states. The trade data are provided on the 8-digit level of the Combined Nomenclature (CN) and are basically measured in the net mass of the traded volumes and in monetary values. For calculations of physical coverage ratios, meaningful

[1] For a complete list of the wood-based commodities, the classification into product groups and its coverage status of the EUTR see [2]. Also another aspect should be mentioned. The EUTR and our scope of wood-based products only focuses on manufactured goods as classified in the Combined Nomenclature. Hence, wood and paper products for packaging which are already in use are not covered within the scope of either classification. Also products which consist only partly of wood, products which only partly contain wood or products which are manufactured in an industry branch outside of the forest based sector are not in the scope of our analysis. Examples for the products are wooden toys, chewing gum, caravans or musical instruments.

reference units are needed. The units provided in the database inadequately specify the associate wood quantity. Many wood-based products also consist of other materials such as adhesives in panels or minerals and additives in paper and paperboard. We therefore converted all physical trade data into suitable reference units.

In the scope of this analysis we used three different reference units for our analysis: import value as a monetary unit denoted in Euro, and two physical reference units, the roundwood equivalent and the wood fibre equivalent. Both physical reference units are units of volume and measured in cubic meters. The roundwood equivalent (m^3 (r)) expresses the amount of roundwood which is needed for the production of one unit of a product. As such it indicates the required resource input of roundwood for manufacturing of a product.[2] The wood fibre equivalent as the second physical reference unit is also measured in cubic meter (m^3 (f)). The wood fibre equivalent is defined as the equivalent volume of the wood fibres or wood-based fibres that are contained in the product (Weimar 2011).[3] Hence, it can be interpreted as an output based unit and the calculated volumes in m^3 (f) indicate how much wood fibres have effectively been traded with a given product.

3.RESULTS
3.1.Analysis of global imports to the European Union

Table 3 presents the import quantities to EU for product groups and product categories expressed in the three reference units. Furthermore, the import quantities are differentiated by EUTR coverage. In the year 2013, wood and wood-based products were imported to the EU by an import value of 29 billion Euros. This is almost equally distributed between wood and paper products. Imports of other wood-based products amount to 1.2 billion Euros. In terms of import value, finished wood products and furniture are the most important product groups in the wood product category. Roundwood imports contribute to only 3% of the total value of imports. In the paper product category all product groups contribute between 10% and 15% to the total import value. About one quarter of the imports, measured by their import value, are not covered by the EUTR. The most important product group in this respect is printed matter. Commodities in the product groups furniture and finished wood products also account for a high share of the import value not covered by EUTR. The products of wood pulp & recovered paper, which are not covered by EUTR, account for 0.2 billion Euros which equals less than 1% of total import value.

This structure changes when looking at physical import quantities of the EU. We calculated the actual wood imports by using the reference units roundwood equivalent and wood fibre equivalent. Naturally, by using completely different reference units the structure of import, as well as the coverage ratios will be different. Still, it is useful to compare these structures to emphasize the more suitable physical reference units, to get a better understanding of the different reference units and hence of resulting product structures of imports as well as coverage ratios.

Measured in cubic meter of roundwood equivalents (m^3 (r)) the EU imported a total of 136 million m^3 (r) in 2013, of which 73 million m^3 (r) are wood products and 61 million m^3 (r) are paper products. Further processed products like furniture or printed matter, which typically have a higher price per m^3 (r), contribute less to total import volumes than in the case of import value. Vice versa, product groups that can be classified as raw material like roundwood or wood processing residues as well as wood pulp and recovered paper are more important when using roundwood (or wood fibre) equivalents. These product groups contribute, with 60 million m^3 (r) ($\widehat{=}$ 44%), to total imports of roundwood equivalents (see Table 3), which is much more than its share of 20% of total import value.

[2] It has been used in various studies for balancing and analysing material flows of wood-based products, e.g. [4-9].
[3] The wood fibre equivalent has been used for material flow analysis [10, 11]. The volume of the wood fibres is calculated above the fibre saturation point to take into account the swelling and shrinking of the wood fibres below this threshold. For the purposes of this study we first calculated the mass of the wood fibres of the different commodities based on the study by Diestel and Weimar [8]. We then calculated the volume by using the density by volume of the respective commodity code.

Also, by using the reference unit of wood fibre equivalents (m³ (f)) the product structure of imports changes compared to the structure when using import value. This is also true for a comparison between m³ (f) and m³ (r) structures. As mentioned above, roundwood equivalents express the amount of roundwood which is needed for the production of one unit of product. The wood fibre equivalent quantifies the amount of wood fibres that one unit of product actually contains. In 2013, the EU imported in total 77 million m³ (f) - of which 53 million m³ (f) were wood products (≙ 68%) - and 24 million m³ (f) are classified as paper products. Roundwood and wood processing residues account with about 30% of total wood fibre imports for an even bigger share than measured in roundwood equivalents (18%).

Coverage ratios of the EUTR for all wood and wood-based products are about 90% based on m³ (r) and m³ (f) (88% and 92%). Calculations based on the import value are considerably lower at 74%. For the category wood products, 94% of imported m³ (f)) are covered by the EUTR. Coverage ratios based on m³ (r) and import value amount to 89%, and 77% respectively, in this category. Coincidentally the same coverage ratios as for wood products were calculated for paper products based on m³ (r) (89%) and import value data (77%). Measured in m³ (f) 88% of all imported wood fibres in paper products are covered by the EUTR.

The coverage ratios for wood products significantly vary between the product groups. A full coverage of 100% can be identified for roundwood, wood processing residues, sawnwood and wood-based panels. In the product groups other semi-finished wood products, finished wood products and furniture, not all commodities are covered by the EUTR. Hence, the coverage ratios are less than 100% (between 74% and 92%). The spread of coverage ratios in the wood product category is even wider by using roundwood equivalent (67%-100%) or import value (59%-100%).

Table 3. Imports to EU28 by product groups and by EUTR coverage for three reference units

		1,000,000 Euro				1,000 m³ (r)				1,000 m³ (f)			
		covered by EUTR		total	coverage ratio	covered by EUTR		total	coverage ratio	covered by EUTR		total	coverage ratio
		no	yes			no	yes			no	yes		
1	roundwood	0	956	956	100%	0	16,613	16,613	100%	0	15,406	15,406	100%
2	wood processing residues	0	309	309	100%	0	7,995	7,995	100%	0	6,655	6,655	100%
3	sawnwood	0	2,042	2,042	100%	0	10,801	10,801	100%	0	8,267	8,267	100%
4	wood based panels	0	1,583	1,583	100%	0	8,722	8,722	100%	0	4,268	4,268	100%
5	other semi-finished WP	16	822	838	98%	122	2,350	2,472	95%	91	1,061	1,151	92%
6	finished WP	1,464	2,116	3,581	59%	6,686	13,385	20,071	67%	2,373	12,518	14,891	84%
7	furniture	1,668	2,914	4,581	64%	1,427	4,864	6,291	77%	488	1,374	1,862	74%
8	woodpulp & recov. paper	214	4,317	4,531	95%	4,738	30,011	34,750	86%	1,960	12,067	14,027	86%
9	paper and paperboard	0	3,672	3,672	100%	0	20,051	20,051	100%	0	7,985	7,985	100%
10	articles of paper & paperboard	0	3,026	3,026	100%	0	4,358	4,358	100%	0	1,537	1,537	100%
11	printed matter	2,985	0	2,985	0%	2,013	0	2,013	0%	893	0	893	0%
12	reg. cellulose, art. fibres a.o.	1,182	0	1,182	0%	1,520	0	1,520	0%	212	0	212	0%
13 : 1 to 7	**total wood p.**	3,148	10,742	13,890	77%	8,235	64,730	72,965	89%	2,952	49,548	52,500	94%
14 : 8 to 11	**total paper p.**	3,199	11,015	14,214	77%	6,752	54,420	61,172	89%	2,853	21,590	24,443	88%
15 : 12	**total other wood based p.**	1,182	0	1,182	0%	1,520	0	1,520	0%	212	0	212	0%
16 : 13, 14, 15	**total imports**	7,528	21,757	29,286	74%	16,507	119,150	135,656	88%	6,017	71,138	77,155	92%

Source: own calculation

In the category of paper products all commodities in the product groups paper and paperboard and articles of paper and paperboard are covered by the EUTR. Since printed matter is not listed in the EUTR, the coverage ratio is 0% for all reference units. The coverage ratio in the product group wood pulp and recovered paper amounts to 86% of total imported m³ (f) quantities. Based on m³ (r) quantities the coverage ratio is also 86%, but 95% when calculating the import value. Recovered paper commodities are excluded by EUTR; hence there is only a partial coverage in this product group. Because of the comparatively low price of recovered paper, the coverage ratio based on import value is higher than the coverage ratio calculated by the reference unit wood fibre equivalent. Coverage ratio of the product category "other wood-based products" is zero as commodities related to regenerated cellulose, artificial fibres a.o. are not listed in the annex of EUTR.

3.2.Analysis of commodities not listed in the EUTR

In the above section we described the coverage ratios for different product groups. In this section we will focus on commodities that are not covered by EUTR. Table 4 lists the respective top ten commodities, ranked by their import volume in 2013 m³ (f). These ten commodities already account for about three quarters of the imported wood quantity which is not covered by EUTR.

Wood charcoal can be identified as the main product which is not covered by the EUTR. Its import volume sums up to 1.4 million m³ (f) or 23% of all imported wood quantities that are not covered by EUTR. Placed second are "Articles of wood, n.e.s."[4] which account for another 0.7 million m³ (f) (≙ 11%). Additionally, there are three other products and their related commodities of importance: Firstly, commodities related to recovered (waste and scrap) paper and paperboard (1.8 million m³ (f), 31% share of total imports "not covered by EUTR"). Secondly, commodities related to printed books, brochures, etc. (0.6 million m³ (f)). And thirdly, commodities related to seats with wooden frames.[5]

Table 4. Top 10 of products "not covered by EUTR", measured in m³ (f)

Rank	m³ (f)	share of imports "not covered by EUTR"	CN Code	Description	Product Group	Product Category
1	1,393,634	23%	44029000	WOOD CHARCOAL, INCL. SHELL OR NUT CHARCOAL, WHETHER OR NOT AGGLOMERATED (EXCL. BAMBOO CHARCOAL, WOOD CHARCOAL USED AS A MEDICAMENT, CHARCOAL MIXED WITH INCENSE, ACTIVATED CHARCOAL AND CHARCOAL IN THE FORM OF CRAYONS)	finished WP	wood p.
2	674,285	11%	44219098	ARTICLES OF WOOD, N.E.S.	finished WP	wood p.
3	566,492	9%	47071000	RECOVERED "WASTE AND SCRAP" PAPER OR PAPERBOARD OF UNBLEACHED KRAFT PAPER, CORRUGATED PAPER OR CORRUGATED PAPERBOARD	woodpulp & recov. paper	paper p.
4	496,678	8%	49019900	PRINTED BOOKS, BROCHURES AND SIMILAR PRINTED MATTER (EXCL. THOSE IN SINGLE SHEETS; DICTIONARIES, ENCYCLOPAEDIAS, PERIODICALS AND PUBLICATIONS WHICH ARE ESSENTIALLY DEVOTED TO ADVERTISING)	printed matter	paper p.
5	384,405	6%	47079010	UNSORTED, RECOVERED "WASTE AND SCRAP" PAPER OR PAPERBOARD (EXCL. PAPER WOOL)	woodpulp & recov. paper	paper p.
6	348,500	6%	94016100	UPHOLSTERED SEATS, WITH WOODEN FRAMES (EXCL. CONVERTIBLE INTO BEDS)	furniture	wood p.
7	254,402	4%	47079090	SORTED, RECOVERED "WASTE AND SCRAP" PAPER OR PAPERBOARD (EXCL. WASTE AND SCRAP OF UNBLEACHED KRAFT PAPER OR KRAFT PAPERBOARD, OR OF CORRUGATED PAPER OR CORRUGATED PAPERBOARD, THAT OF PAPER OR PAPERBOARD MADE MAINLY OF BLEACHED CHEMICAL PULP NOT COLURED IN THE MASS, THAT OF PAPER OR PAPERBOARD MADE MAINLY OF MECHANICAL PULP, AND PAPER WOOL)	woodpulp & recov. paper	paper p.
8	248,337	4%	47073010	OLD AND UNSOLD NEWSPAPERS AND MAGAZINES, TELEPHONE DIRECTORIES, BROCHURES AND PRINTED ADVERTISING MATERIAL	woodpulp & recov. paper	paper p.
9	224,175	4%	47073090	WASTE AND SCRAP" OF PAPER OR PAPERBOARD MADE MAINLY OF MECHANICAL PULP (EXCL. OLD AND UNSOLD NEWSPAPERS AND MAGAZINES, TELEPHONE DIRECTORIES, BROCHURES AND PRINTED ADVERTISING MATERIAL)	woodpulp & recov. paper	paper p.
10	169,633	3%	47072000	RECOVERED "WASTE AND SCRAP" PAPER OR PAPERBOARD MADE MAINLY OF BLEACHED CHEMICAL PULP, NOT COLOURED IN THE MASS	woodpulp & recov. paper	paper p.
	4,760,541	79%		**total Top 10**		
	6,017,444	100%		**total "not covered by EUTR"**		

Source: own calculation

3.3.Regional analysis

In this section we focus with our analysis on the geographical origin of imports of wood and wood-based products. For this purpose we defined nine regions.[6] We generated our regional classification by using UN-regional classification (UN Stats) and aggregated the sub-regions. Table 5 presents the trade flows of wood and wood-based products in wood fibre equivalents into EU.

[4] It is noteworthy that it could be tempting to classify wood products as those "Articles of wood, not elsewhere specified" to avoid due diligence effort.

[5] Import quantities only added out of the commodities of the Top 10. Outside the Top 10 there can be even more commodities related to the mentioned commodity clusters.

[6] (1) European Union, with 28 member states (EU28), (2) Western, Northern and Southern Europe, excluding EU-28 member states" (WNS Europe (Non-EU-28)), (3) "Russia and Eastern Europe, excluding EU-28 member states" (Russia & EE (Non-EU28)), (4) "Western, Central and Southern Asia" (WCS Asia), (5) "Eastern and South-Eastern Asia" (ESE Asia), (6) North America (North Am.) (7) Latin America (Latin Am.), (8) Africa and (9) Oceania.

The largest exporter of wood and wood-based products into the EU in the year 2013 was the region Russia and Eastern Europe (Non-EU-28). The EU imported 25 million m³ wood fibre equivalents from this region, which equals a third of total imports of wood and wood-based products into the EU. The second biggest exporter to the EU is North America, followed by the region WNS Europe (Non-EU-28). These three regions account together, with 55 million m³ (f), for about 70% of total imports. Least important in terms of total wood fibre imports are the regions WCS Asia, Africa and Oceania. Imports into the EU from these regions add up to only 4 million m³ (f), which is less than 5% of total wood fibre equivalent imports.

On average, the coverage ratio for all wood and wood-based products is 92% based on m³ (f) calculations. Coverage ratios vary between regions according to export composition of commodities and product groups. Imports from Oceania and Russia & EE (Non-EU28) are almost completely covered by EUTR (99% and 98%). But one has to be mindful of the associated volumes. A third of total imports in wood fibre equivalents originate from Russia & EE (Non-EU-28). Compared to that, the high coverage ratio for Oceania is less important, because the associated trade flows are negligible (0.3%). Eastern and South-Eastern Asia has the lowest coverage ratio with 74%. This should be mentioned as with 7 million m³ (f) about one tenth of all imports in wood fibre equivalent are imported from this region

The regional structure of the products not covered by the EUTR is much different than the regional structure for total wood and wood-based product imports based on m³ (f). The major export regions Russia & EE (Non-EU-28) and North America each contribute significantly less (≈10%). WNS Europe is almost twice as important, as it is the origin of 30% of all imported wood fibre eq. which are not covered by EUTR. The reason is high imports of recovered paper commodities. Two other regions triple their shares: ESE Asia with 30% and Africa 9% (shares for total imports: 9% and 3.3%, respectively). The reason for the increase in ESE Asia is on the one hand the relatively high amount of printed matter that is exported from ESE Asia. In fact, 69% of all imported printed matter into the EU is exported from ESE Asia. On the other hand, relatively high shares of furniture and finished WP can be seen in their export product structure in combination with a low coverage ratio in the product group finished wood products. The imports of the EU from Africa which are not covered by EUTR amount to 9% of all imports not covered by EUTR. This is mainly due to the import of wood charcoal.

Table 5. Wood imports to EU28 by export region and by EUTR coverage, measured in 1.000 m³ (f)

	WNS Europe (Non-EU28)	Russia & EE (Non-EU28)	North Am.	Latin Am.	WCS Asia	ESE Asia	Africa	Oceania	All Regions
imports in 1,000 m³ (f)									
not covered by EUTR	1,817	579	571	515	155	1,825	542	3	6,017
covered by EUTR	12,019	24,628	15,696	10,590	683	5,119	2,017	263	71,138
total imports	13,837	25,207	16,267	11,105	838	6,944	2,559	265	77,155
regional share on imports									
not covered by EUTR	30%	10%	9%	9%	3%	30%	9%	0.0%	100%
covered by EUTR	17%	35%	22%	15%	1%	7%	3%	0.4%	100%
total imports	18%	33%	21%	14%	1%	9%	3%	0.3%	100%
regional coverage ratio	87%	98%	96%	95%	81%	74%	79%	99%	92%

Source: own calculation

4.DISCUSSION AND CONCLUSION

The objective of the present analysis was to identify to which extent the EUTR applies for wood and wood-based products. We first defined the scope of the wood-based products based on the definition of the forest-based sector. We then analysed the imports to the countries of the EU from other countries of the world by using different reference units. As the monetary reference unit we used the mandatory trade values denoted in Euro. Additionally we used two different physical units, the roundwood equivalent and the wood fibre equivalent.

Our results show that approximately 90% of the imported quantities are covered by the EUTR. This means, the EU imported in 2013 a wood quantity of 6 million m³ wood fibre equivalents (17 million m³ roundwood equivalents) that is not covered by the EUTR. This quantity is almost equally distributed between wood products and paper products. For the twelve wood and wood-based product groups we quantified the wood imports and coverage ratios of EUTR. Coverage ratios for product groups differ. Typically raw materials have a higher coverage ratio and finished products have a lower coverage ratio. The wood quantities that are not covered by EUTR are highly concentrated on a few commodities like wood charcoal, articles of wood, n.e.s. and printed books and brochures. The regional import structure of EU for all wood and wood-based imports is much different than structure of imports not covered by EUTR. When looking at the regional import structure of products that are not covered by EUTR, Russia and Eastern Europe (Non–EU28) are less important, while Eastern and South-Eastern Asia is now the most important region.

If measured in monetary terms, the overall coverage ratio only accounts for 74% of all wood-based imports. This significant drop is mainly due to the fact that further processed wood-based products typically show an increasing value per unit. The coverage ratio of the EUTR tends to decrease with increasing stage of processing. This leads to the discrepancy of physical and monetary reference units.

It is obvious that the coverage ratio we calculate in this study mainly depends on the definition and scope of the wood-based products in total. The chosen scope is clearly defined, it comprises all products which can be classified as "wood-based". A lot of other commodity codes contain wood or products made of wood. Either products with a minor share of wood in the given commodity code (e.g., caravans) or products with a high content of wood which are commingled in a commodity code with products made of other materials (e.g., toys). In this respect also wood-based packaging material can be mentioned for imported products (e.g., cardboard boxes). Conversion factors to wood fibre equivalents (or roundwood eq.) are almost impossible to calculate for all these products. Also, for these products, EUTR might not serve as an appropriate measure for combating illegal logging due to limits of practical implementation. Costs for acquisition of necessary information, legal uncertainty and administrative workload come to mind.

According to the regional analysis, an extension of the commodities listed in the EUTR would affect imports from regions differently. For example, (1) an inclusion of printed matter would affect trade relations of EU and ESE Asia the most, as 69% of imported printed matter is of this origin. (2) A complete expansion of the EUTR to the same product scope as in this analysis would affect the trade with Russia & EE (Non-EU28) only marginally. 98% of all wood and wood-based products are already covered by the EUTR as of now. (3) An inclusion of recovered paper commodities or generally, a complete coverage in the product group wood pulp & recovered paper would affect WNS Europe (Non-EU28) the most as it has a very low coverage ratio (22%) in this product group and a significant percentage of exports to EU are in this product group (see Table 5). (4) Finally, an entry of wood charcoal in the Annex of EUTR would affect Africa and Latin America the most. They are the biggest exporters to the EU with around 500 million m³ (f) each.[7]

A deeper analysis of consequences (if any) on trade relations and import structures, due to an expansion of the commodity list in EUTR, is not in the scope of this study. However, it is worth mentioning that at least importers of newly covered commodities have to engage with their trade partners, so these will provide the necessary information for due diligence actions according to EUTR. This raises awareness and might positively influence behaviour along the production chain as the continuation of trade relations gives financial incentives. The EUTR can basically be a suitable measure for all wood-based products as classified in this paper , even if proposed positive effects of EUTR (in combination with VPAs) on the forest sector in the wood producing and the wood manufacturing countries have just begun to evolve [12].

[7] Around 90% of all finished wood products imported from Africa are wood charcoal. Hence, we derive a very low coverage ratio of 9% for Africa in this product group.

In contrast, measures like the EUTR can have ambiguous effects: For example Prestemon [13] analysed the effect of the U.S. Lacey Act Amendment on prices and quantities of imported hardwood lumber and hardwood plywood imports to the U.S. and described negative results for consumers and further processing industries as import quantities decrease and prices increase. Also in this context, Giurca et al. [14] described two possible consequences especially for tropical timber: substitution by temperate hardwood species and trade diversion from more strictly regulated regions to less regulated markets. Generally, if the EUTR acts as a non-tariff-barrier, a higher level of domestic wood processing and/or consumption in exporting countries or shifts in regional structure of imports in EU are possible effects.

As these examples as well as the results of our analysis show, there is still the necessity for improvement. For example, following the concept of EUTR it seems logical to include more products and especially further processed wood-based products in the annex of the EUTR in order to avoid possible leakages in trade.

Typically exports are rather small compared to domestic consumption. Hence, EUTR alone is unlikely to solve the problem of illegal logging. Also other measures, such as VPAs, by Europe (and other countries) with partners in the producing regions have to be applied in order to achieve the ambitious goals of the fight against illegal logging of the international community.

REFERENCES

1. EUTR (2010): Regulation (EU) No 995/2010 of the European Parliament and of the Council of 20 October 2010 laying down the obligations of operators who place timber and timber products on the market (Text with EEA relevance), Official Journal of the European Union, 53, 12 November 2010, L 295, p. 23-34.
2. Weimar, H., N. Janzen, and M. Dieter (2015): How many imports of wood based products are covered by the EU timber regulation? Thünen Working Paper, forthcoming, Thünen Institute, Hamburg.
3. EC (1999): The state of the competitiveness of the EU forest-based and related industries, Communication from the commission, 457, Commission of the European Communities, Luxembourg.
4. Dieter, M. (2009): Analysis of trade in illegally harvested timber: Accounting for trade via third party countries, Forest Policy and Economics, 11 (8), p. 600-607.
5. Ollmann, H. (2001): Holzbilanzen für die EU und ihre Mitgliedsländer, Bundesforschungsanstalt für Forst- und Holzwirtschaft, Institut für Ökonomie, Hamburg.
6. UN (2005): European forest sector outlook study, 1960 - 2000 - 2020, Main Report. Geneva timber and forest study paper, United Nations, Geneva.
7. UN (2011): The European Forest Sector Outlook Study II, 2010 - 2030, United Nations, Geneva.
8. Diestel, S. and H. Weimar (2014): Der Kohlenstoffgehalt in Holz- und Papierprodukten – Herleitung und Umrechnungsfaktoren, Thünen Working Paper, 38, Thünen-Institut, Hamburg.
9. WWF (2008): Illegal wood for the European market - An analysis of the EU import and export of illegal wood and related products, WWF-Germany, Frankfurt a. M.
10. Weimar, H. (2011): Der Holzfluss in der Bundesrepublik Deutschland 2009. Methode und Ergebnis der Modellierung des Stoffflusses von Holz, Johann Heinrich von Thünen-Institut, Institut für Ökonomie der Forst- und Holzwirtschaft, Hamburg.
11. Bösch, M., et al. (2015): Physical input-output accounting of the wood and paper flow in Germany, Resources, Conservation and Recycling, 94, p. 99-109.
12. Jonsson, R., et al. (2015): Assessment of the EU Timber Regulation and FLEGT Action Plan, From Science to Policy, 1, European Forest Institute.
13. Prestemon, J.P. (2015): The impacts of the Lacey Act Amendment of 2008 on U.S. hardwood lumber and hardwood plywood imports, Forest Policy and Economics, 50, p. 31-44.
14. Giurca, A., et al. (2013): Ambiguity in Timber Trade Regarding Efforts to Combat Illegal Logging: Potential Impacts on Trade between South-East Asia and Europe, Forests 4 (4), p. 730-750.

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FORECASTING OF INDUSTRIAL ROUNDWOOD PRODUCTION FOR THE PART OF SOUTH-EAST EUROPE

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ABSTRACT

On the basis of established values for period 1993-2013, in this paper we discuss a possibility to forecast trends in production of industrial round wood in the part of South-East Europe. The data of production values of industrial round wood through analyzed period are gathered from Croatian Bureau of Statistics and Food and Agriculture Organization of the United Nations Statistics Division (FAO base). In order to predict the future trends of industrial round wood production for some countries from SEE region, dynamic economic analysis of time series data was performed. Because of turbulences in this region of South-East Europe and the length of analyzed time series, prediction is limited to year 2020.
Key words: industrial round wood, production, time series models, forecasting

1. INTRODUCTION

The South-East Europe area is the most diverse, heterogeneous and complex transnational cooperation area in Europe, made up of a broad mix of countries. The emergence of new countries and with it the establishment of new frontiers has changed the patterns of political, economic, social and cultural relationships. The 16 participating countries of South-East Europe (SSE) are: Albania, Austria, Bosnia and Herzegovina, Bulgaria, Croatia, The former Yugoslav Republic of Macedonia, Greece, Hungary, Italy (only some of its regions), Republic of Moldova, Montenegro, Romania, Serbia, Slovakia, Slovenia and Ukraine (only some of its regions). The area has been undergoing a fundamental change in economic and production patterns following the 1990 changes. While some regions, especially the capital cities, are adapting well to the new challenges, others are trying to re-orientate themselves. Significant for the programme area are regional disparities in terms of economic power, innovation, competitiveness and accessibility between urban areas and rural areas. The South East Europe Programme helps to promote better integration between the Member States, candidate and potential candidate countries and neighbouring countries. Regional cooperation in South East Europe is essential, regardless of the different stage of integration of the various countries. The security, stability and prosperity of the region are of significant interest to the European Union (EUROPA/EU, 2015).

According to Samuelson and Nordhaus (2003), economic theories are dynamic by nature and now we are witnessing almost everydays changes that are caused by the penetration of IT and computer science revolution. In this new and dynamic conditions it is necessary to strive for a new standards using economic theory for the qualitative and quantitative analysis of markets. The key to survival and growth of an organization is in ability to adapt its strategy to rapidly changing enviroment (Kotler, 2001). Interpreting economic data and forecasting the future economic values are under the influence of environment and government policies, starting from the basic economic theories that operate in the market (Fair and Case, 1989). According to Lovrinčević (2001), specific developments in some key macroeconomic variables, such as employment, production, imports, exports, the exchange rate of national currency, etc., characterize different turbulent periods of Croatian history.

In this paper we narrowed the field of research on Croatia and surrounding countries. The participating countries include Bosnia and Herzegovina, Croatia, Macedonia, Montenegro, Serbia and Slovenia (SEE*). On the basis of established values for period 1993-2013, we performed the dynamic economic analysis of time series data and discuss a possibility to predict trends in production of industrial round wood in SEE* (Croatia and surrounding countries). Because of a turbulences in this market, as well as a length of the analyzed time series, prediction is limited to the year 2020.

2. MATERIAL AND METHODS

The data of production values of Industrial Round Wood (IRW) through analyzed period 1993-2013 are gathered from Croatian Bureau of Statistics (CBS/DSZ, different years), Ministry of Finance and Financial Agency (FINA) and FAO base (FAOSTAT, different years). The data of population, land area and forested area in Bosnia and Herzegovina, Croatia, Macedonia, Montenegro, Serbia and Slovenia (SEE*) are gathered from official websites of the participating countries.

For the purposes of forecasting future trends in IRW Production in SEE* (in mil. m^3) and IRW Per Capita (IRW/PC) Production in SEE* (in m^3/year per 1000 people), the dynamic economic analysis of time series data was performed. Two types of time series models were built: models A - based on average rates of change and models B - linear trend models.

According to Rozga and Grčić (2000), by using models we got a picture of what happened in the (near) past, what is the current situation, and planned and future course of events, i.e. the movement of each indicator in the near future. It is known that future projections of development can not predict the detail movement of market indicators, they are only a rough indication of the future course, assuming that the macroeconomic policies won't change significanty (Hanke and Reitsch, 2001).

3. RESULTS AND DISCUSSION

The SEE* area is made up of 6 different countries which cover 245,1 thousand km^2, range in size from 13,8 thousand km^2 (Montenegro) to 77,5 thousand km^2 (Serbia). A total resident population of SEE* countries is almost 20 million people, range in size from 0,6 million people (Macedonia) to 7,1 million people (Serbia). Shares of population and shares of land area according to total population and total land area of countries in SEE* region are shown in Figure 1.

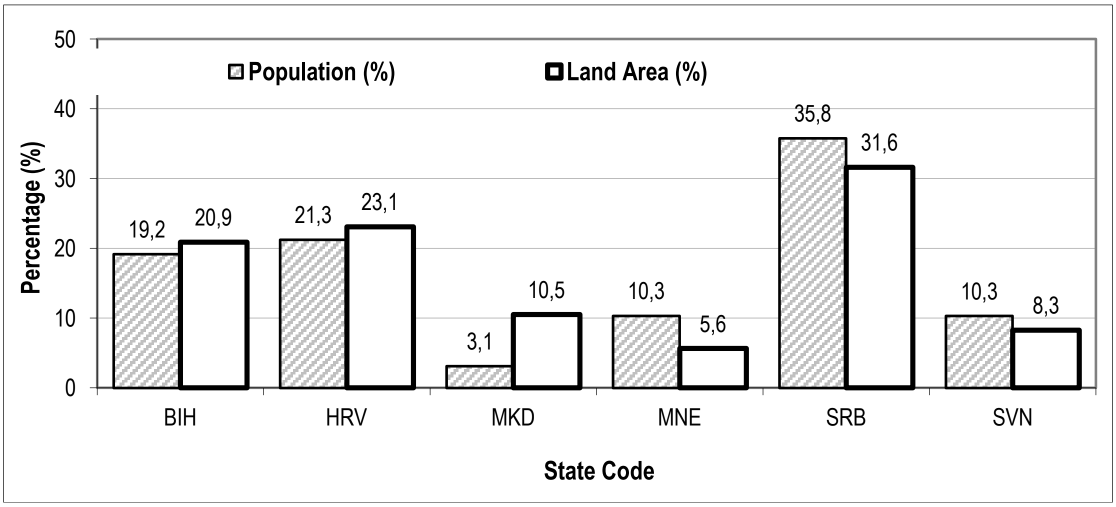

Figure 1. Shares of population and land area in SEE* region

Average population density (population divided by total land area) in SEE* region is 86 people per km^2 with standard deviation of 41 people per km^2. The greatest population density is in Montenegro with 150 people per km^2, followed by Slovenia (102 people/km^2), Serbia (92 people/km^2), Croatia (75 people/km^2), BIH (75 people/km^2) and smallest population density in Macedonia with 24 people per km^2.

The EU currently contains 5 % of the world's forests and more than 42 % of EU land area is covered with forest and other wooded land (EUROPA/EU, 2015). Area covered by forests in SEE* region is 99 thousand km^2, range in size from 6,3 thousand km^2 (Montenegro) to 27,1 thousand km^2 (Bosnia and Herzegovina). Shares of forested area in total land area for countries in SEE* region are shown in Figure 2.

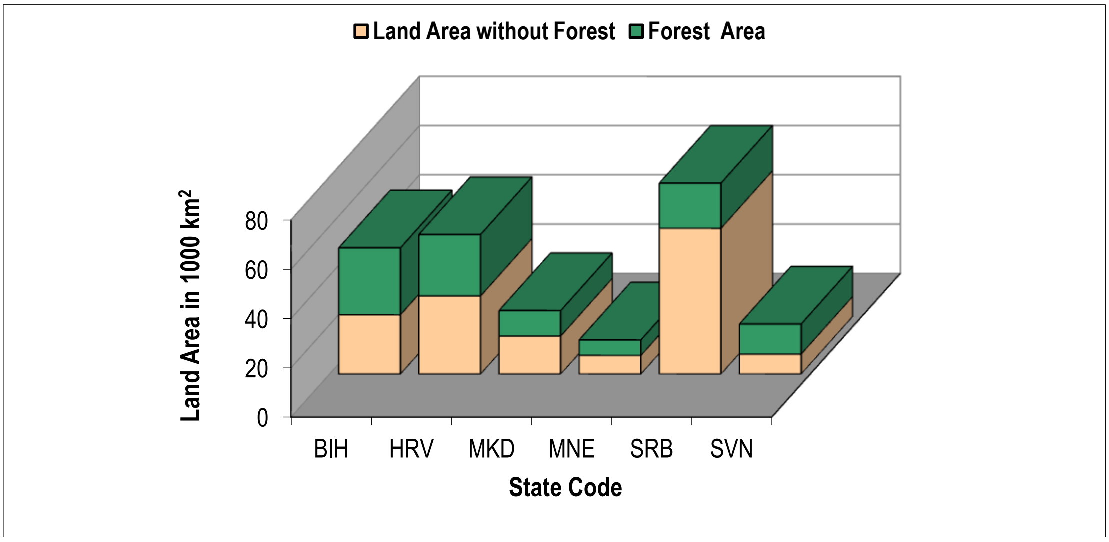

Figure 2. Shares of forested area in total land area for SEE* region

Looking at the SEE* countries individually, the greatest share of forested area in total land area is in Slovenia (60%), followed by BIH (53%), Montenegro (45%), Croatia (44%), Macedonia (40%) and smallest share in Serbia with only 24% of forested area.

3.1. Industrial round wood (IRW) production in SEE* countries

Descriptive statistics were determined for annual values of Industrial Round Wood (IRW) production according to countries in SEE* region on the basis of established values in the period 1993-2013. All results of descriptive analysis are given in Table 1.

Table 1. Descriptive Statistics for IRW Production in m^3

State Code	Valid N	Mean m^3	Std.Dev. m^3	Coef.Var. %	Minimum m^3	Median m^3	Maximum m^3	Conf. -95% m^3	Conf.+95% m^3
BIH	17	2.749.436	353.077	12,8	2.099.530	2.683.000	3.332.000	2.567.901	2.930.972
HRV	21	2.882.571	795.847	27,6	1.710.000	2.886.000	4.157.000	2.520.306	3.244.837
MKD	21	142.833	24.846	17,4	101.000	151.000	193.000	131.523	154.143
MNE	8	219.126	44.981	20,5	192.000	208.001	329.000	181.521	256.730
SRB	8	1.382.875	109.289	7,9	1.250.000	1.360.000	1.615.000	1.291.507	1.474.243
SVN	21	1.856.532	307.957	16,6	958.000	1.841.404	2.288.160	1.716.351	1.996.712

According to results of IRW production SEE* countries can be categorized into three groups:

1. Croatia with an average IRW production of 2,9 million m^3 and BIH with 2,7 million m^3;
2. Slovenia with 1,9 million m^3 and Serbia with an average IRW production of 1,4 million m^3;
3. Montenegro with 0,2 mil. m^3 and Macedonia with an average IRW production of 0,14 mil. m^3.

Group categories aggrading to an average IRW production seen in Table 1 can be affirm by analysis of IRW production in 2013 (Figure 3) in which shares of IRW production for individual SEE* countries were categorized in the same groups, HRV and BIH together with 63,5%, followed by SVN and SRB with 33,5% and only 3% of total IRW production in 2013 were produced in MNE and MKD.

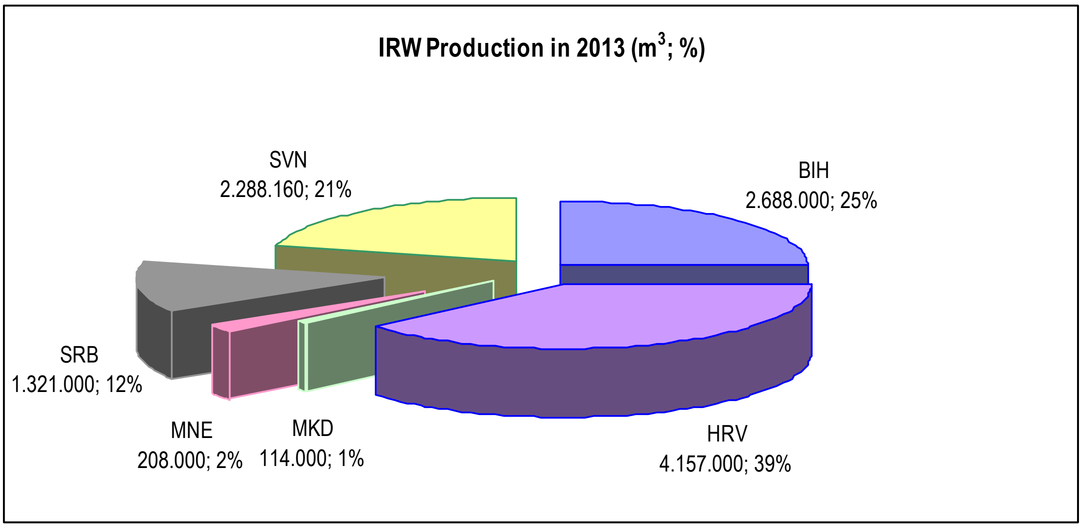

Figure 3. IRW Production in 2013 for SEE* region

3.2. Industrial round wood production per capita (IRW/PC) in SEE* countries

Descriptive statistics were determined for annual values of Industrial Round Wood production per capita (IRW/PC) according to countries in SEE* region on the basis of established values in the period 1993-2013 and available data on the population of individual Member States. All results of descriptive analysis are given in Table 2.

Table 2. Descriptive Statistics for IRW/PC Production in m^3/year per 1000 people

State Code	Valid N	Mean m^3/year per 1000 people	Std.Dev. m^3/year per 1000 people	Coef.Var. %	Minimum m^3/year per 1000 people	Median m^3/year per 1000 people	Maximum m^3/year per 1000 people	Conf. -95% m^3/year per 1000 people	Conf.+95% m^3/year per 1000 people
BIH	17	717,7	92,2	12,8	548,0	700,4	869,8	670,3	765,1
HRV	21	678,8	187,4	27,6	402,7	679,6	978,9	593,5	764,1
MKD	21	229,8	40,0	17,4	162,5	243,0	310,5	211,6	248,0
MNE	8	106,1	21,8	20,5	92,9	100,7	159,3	87,9	124,3
SRB	8	193,5	15,3	7,9	174,9	190,3	226,0	180,7	206,3
SVN	21	900,8	149,4	16,6	464,8	893,4	1.110,2	832,7	968,8

According to results of IRW/PC production SEE* countries can be categorized into two groups:

1. Slovenia with an average IRW/PC production of 901 m^3/year per 1000 people, Bosnia and Herzegovina with 718 m^3/year per 1000 people and Croatia with 679 m^3/year per 1000 people;
2. Macedonia with with 230 m^3/year per 1000 people, Serbia with 194 m^3/year per 1000 people and Montenegro with an average IRW/PC production of 106 m^3/year per 1000 people.

Group categories aggrading to an average IRW/PC production seen in Table 2 can be affirm by analysis of IRW/PC production in 2013 (Figure 4) in which shares of IRW/PC production for individual SEE* countries were categorized in the same groups; SVN, HRV and BIH together with 85,5%, followed by SRB, MKD and MNE with only 14,5% of total IRW/PC production in 2013.

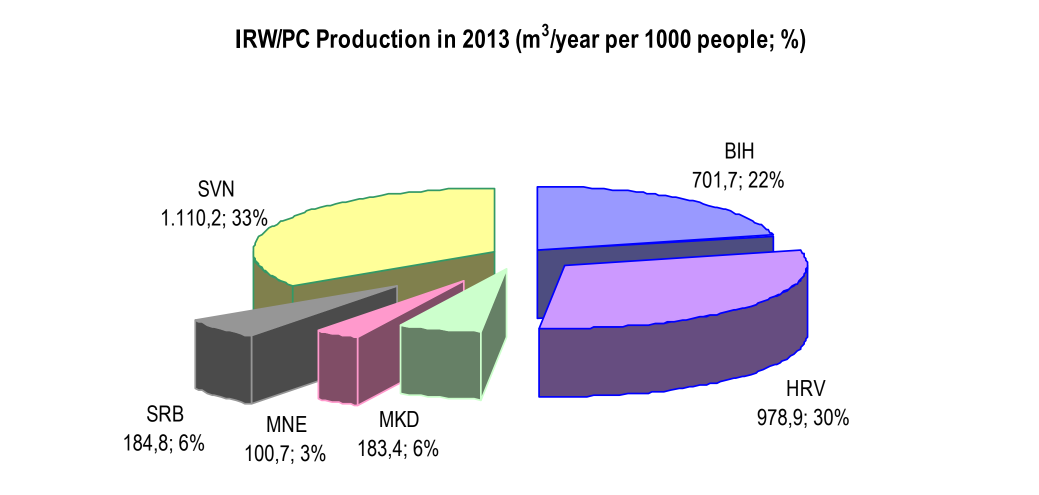

Figure 4. IRW/PC Production in 2013 for SEE* region

3.3. Projections for Industrial round wood production in SEE* countries

For the purpose of projection for IRW Production in SEE* first we interpolate the missing data for Bosnia and Herzegovina (1993-1996) and for Montenegro and Serbia (1993-2005) with an average values that they gained in origanal base.

According to Blažević (2007), when the rates of change in successive time periods are approximately equal, and assuming that the average rate of change will not change, with the average rate of change can be predict variable values in future period. Based on the average rate of change for IRW Production in SEE* (in mil. m^3) and IRW/PC Production in SEE* (in m^3/year per 1000 people) in the observed period ($\overline{S} = 2,027\%$), models A for prediction of future values were developed.

Correlation analysis to determine the degree of correlation between the values of IRW Production as dependent variables and time (*t*) as independent variable was used. We found that the direction and strength of the correlation relationship was positive and high (*r*=0,8673), so we developed linear trend models (models B) for prediction of future values of IRW Production. According to models B, the expected linear increase in the annual IRW Production values for SEE* countries is 0,132 million m^3 and the expected linear increase in the annual IRW/PC Production for SEE* countries is 6,6 m^3/year per 1000 people.

In all models, *t* is mark for the *time*, where *t* = 0 compared to year 1993, *t* = 1 for year 1994; ... , *t* = 15 to year 2008, etc. Unit for predict values of IRW Production in SEE* is mil. m^3. Unit for predict values of IRW/PC Production in SEE* is m^3/year per 1000 people. Constructed models A and B for predicting the future values of IRW Production are shown in Table 4.

Table 3. Models A and B for calculating the future IRW Production values for SEE* countries

Production	Model A	Model B
IRW	$\hat{P}_A(t) = 7,215 \cdot 1,02^{(t-1)}$	$\hat{P}_B(t) = 0,1319 \cdot t + 7,916$
IRW/PC	$\hat{P}_A^{PC}(t) = 361,3 \cdot 1,02^{(t-1)}$	$\hat{P}_B^{PC}(t) = 6,605 \cdot t + 396,35$

Comparison of existing values and calculated predicted values by models A and models B for IRW Production in SEE* in mil. m^3 are shown in Figure 5, while the comparison of existing and calculated predicted values by models A and B for IRW/PC Production in SEE* in m^3/year per 1000 people are shown in Figure 6. Calculated predicted values by models A and models B for IRW and IRW/PC Production in SEE* countries for period 2014-2020 are shown in Table 4.

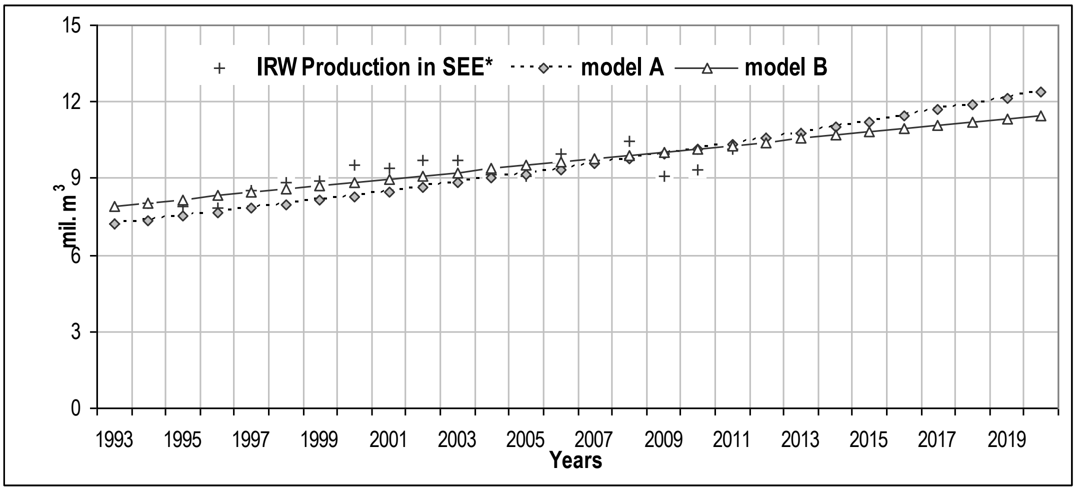

Figure 5. Existing and projected IRW Production values for SEE* countries

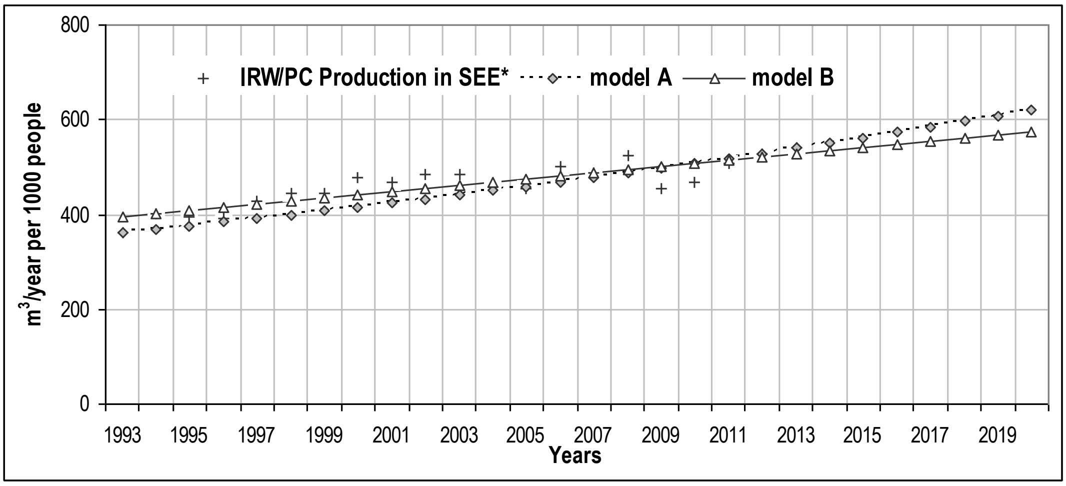

Figure 6. Existing and projected IRW/PC Production values for SEE* countries

Table 4. Predicted IRW and IRW/PC Production values for SEE* region by models A and B

SEE*	IRW Production (mil. m^3)		IRW/PC Production (m^3/year per 1000 people)	
Year	model A	model B	model A	model B
2014	11,0	10,7	550,6	535,0
2015	11,2	10,8	561,7	541,7
2016	11,4	11,0	573,1	548,3
2017	11,7	11,1	584,7	554,9
2018	11,9	11,2	596,6	561,5
2019	12,2	11,3	608,7	568,1
2020	12,4	11,5	621,0	574,7

4. CONCLUSION

Regional cooperation in SEE* region is essential, regardless of the different stage of integration of the various countries. The security, stability and prosperity of the region are of significant interest to the all participants.

Applying methods that have not been traditionally used could be help at the strategic, tactical and/or operational planning level and decision making in the managing of a wood sector, and businesses entities of our common timber industry. Assuming that the macroeconomic policies of each SEE* country will not be altered, and assuming that the models for predicting future values of IRW production satisfy all statistical and theoretical terms, constructed models A and models B could become a great help for a future actions in this region.

By applying models companies in Croatia and surrounding countries that deals with primary and secondary wood products and depend on production of industrial round wood will be able to define the future business strategy. The paper could also help to research institutions for decision-making and strategy development.

REFERENCES

1. Blažević, S. (2007): EKONOMETRIJA, Sveučilište Jurja Dobrile u Puli, Odjel za ekonomiju i turizam, Pula, http://oliver.efpu.hr/~sblazev/Ekonometrija.pdf, 2007.
2. CBS/DSZ (different years): YEARBOOKS, Official website of the Croatian Bureau of Statistics, http://www.dzs.hr.
3. EUROPA/EU, Official website of the European Union, http://europa.eu/index_en.htm.
4. Fair, R.C., Case, K.E. (1989): PRINCIPLES OF ECONOMICS, Prentice-Hall.
5. FAOSTAT (different years): YEARBOOKS, Official website of the Food and Agriculture Organization of the United Nations Statistics Division, http://faostat3.fao.org.
6. FINA - Financijska agencija Republike Hrvatske (different years): http://www.fina.hr.
7. Hanke, J.E., Reitsch, A.G. (2001): BUSINESS FORECASTING, 4th Edition, Allyn&Bacon, Boston.
8. Kotler, P. (2001): UPRAVLJANJE MARKETINGOM: ANALIZA, PLANIRANJE, PRIMJENA I KONTROLA, Mate, Zagreb.
9. Lovrinčević, Ž. (2001): MAKROEKONOMIJA: HRVATSKA U 21. STOLJEĆU, Ured za strategiju razvitka Republike Hrvatske, Zagreb.
10. Rozga, A., Grčić, B. (2000): POSLOVNA STATISTIKA, Veleučilište u Splitu, Split.
11. Samuelson, P., Nordhaus, W.D. (2003): ECONOMICS, McGraw-Hill, 17th edition.

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PRODUCTION OF SOLID WOOD PANELS WITH FOAMED ADHESIVES

Gabriel Giertl, Marek Potkány, Jarmila Schmidtová, Lucia Krajčírová

ABSTRACT

Adhesives play important role in the production of solid wood panels and they are important secondary materials in furniture industry. Adhesives significantly contribute to improving the products quality and they are also the basis for the development of new improved wood products. Through the increasing of adhesive volume by foaming technology, adhesive can be applied to the bonding area more efficiently, better and more uniform. It creates opportunities for applying of less volume of adhesive in bonded joints and on the other hand for obtaining the comparable strength requirements as the conventional volume of un-foamed adhesive. Adhesives foaming is a technology that allows achieving the desired bonding strength at significantly reduced spread rate of adhesives and has also positive economic aspects in the production in solid wood panels.
Key words: solid wood panels, foamed adhesives, wood bonding, consumption, cost

1. INTRODUCTION

The technology of wood bonding is one of the essential technological operations changing wood shape and dimensions. Wood bonding significantly participates in improving the quality of products and it is also one of the cornerstones in the development of new wood products. This complex process should result in the creation of good and strong adhesive bond (Hass P., et al., 2011). As it is written, adhesives play an important role in the production of solid wood panels. The wide range of factors affects the quality of adhesive bond. Several types of adhesives are used for wood bonding. However, nowadays dispersion adhesives are the most used for wood bonding. The importance of dispersion adhesives is increasing continually (Kurt, R. 2006).

With adhesives foaming, resp. urea-formaldehyde adhesives (UF) for bonding process of plywood and chipboard have many authors dealt since the 80´s of the 20th century, as evidenced by the scientific works of Watters and Wellons, published in Forest Products Journal in year 1978 as well professional articles from Sellers, which have also been published in Forest Products Journal in 1988. In 1994 a group of American scientists gave invention of foaming urea-formaldehyde adhesives for the production of chipboard patented.

Foaming of dispersion adhesives with air enable to increase its total volume, the adhesive may be applied into a glue-line more efficient and more uniform. Foaming PVAc dispersion adhesives is a relatively new field of research. Currently, the technology of foaming dispersion adhesives proved far especially in the lamination and gluing cartons. The adhesive foaming is the focal point of scientific debates in the wood industry and the furniture manufacturing because of rapidly increasing customer requirements for product quality and necessity of the manufacturing cost reduction (Sedliačik J., Schmidtová J., Šmirdiaková M. 2014). Adhesive foaming creates the conditions for achieving cost-efficient coatings of adhesive applied into the glued joints while achieving comparable strength of the bond in comparison with un-foamed conventional adhesive bonded joints. Foaming of adhesive is a technology that provides the ability to achieve the required bonding strength at reduced adhesive spread and thereby can bring positive economic aspects in the production of solid wood panels.

Advantages of using foamed dispersion PVAc adhesive in the gluing process can be summarized as follows:

- good wetting of the adherent surface – due to better and more uniform adhesive spread;
- weaker, resp. slower penetration of water from glue into the cells of wood – due to lower adhesive spread and cohesive bonds between air micro-bubbles resulting in better ensuring the flat stability of the panel and increase the quality at the interface wood – adhesive;
- cost savings – in the bonding process, there is a reduction of direct used material by reducing the amount of applied glue;
- no formaldehyde emissions.

2. MATERIAL AND METHODS

The conventional spread of dispersion in the production of solid wood panels is at the level 180 g/m^2. In our research the adhesive bonds strengths were evaluated in order to ***7 levels of foamed adhesive amount*** in glue line (100 g/m^2, 110 g/m^2, 115 g/m^2, 125 g/m^2, 140 g/m^2, 160 g/m^2, 180 g/m^2). Adhesive - one component PVAc dispersion, type RAKOLL® 4340, with perfect water resistance (class D4 according to EN 204) were tested with the aim to find optimal amount of applied adhesive. This type of adhesive was specially developed for application in the micro-foam state. In our research was used adhesive foamed at 30% of its volume.

According to the standard EN 13354: 2009 Solid wood panels (SWP). Bonding quality. Test method. there was tested quality of gluing. Based on the standard requirements, it was necessary from each tested batch, resp. from each panel to prepare testing samples for minimally 10 valid values from different adhesive amount (70 testing samples together).
Preparing of testing samples, the shape and dimension, is illustrated in the following Figure 1:

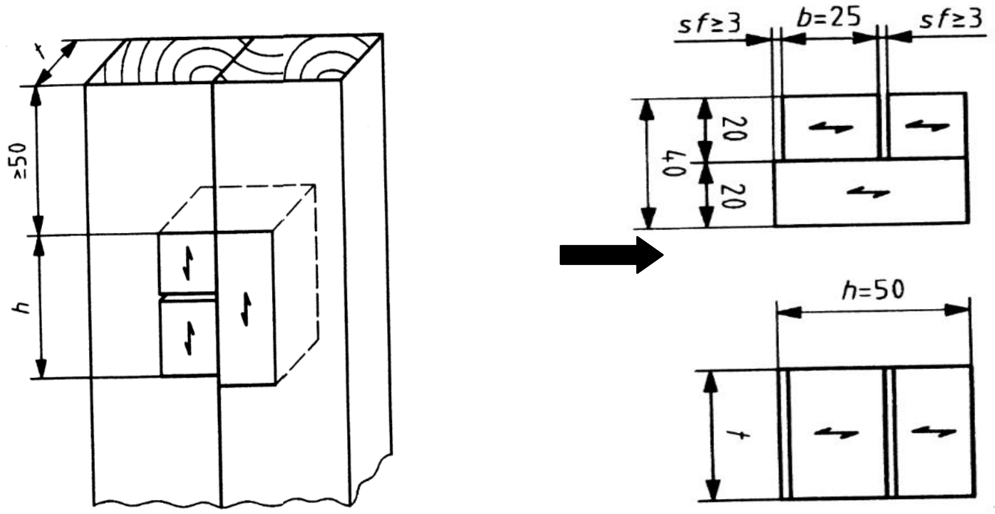

Figure 1. Preparing of testing sample

The requirements of standard STN EN 13 354 have specified, that the principle of shear test is based on the pre-treatment of the testing samples in the thermostatic bath. All 70 testing samples were dipped in a water bath for 24 hours at the water temperature T = (20 ± 3)°C. Based on STN EN 13 353: 2009, the required strength of the glued joint is expressed by lower 5% percentile from measured values on the level over 2,5 MPa.

Information obtained by measuring of all test pieces was evaluated by selected tool of mathematical statistics. The results of all our measurements were summarized and statistically evaluated by using the program STATISTICA 12 and mathematical software Wolfram Mathematica 7.0. Based on the estimated savings of used adhesive it was made a brief calculation of cost savings.

3. RESULTS AND DISCUSSION

The results of our measurements were aimed at the verification of the assumption, that increasing of the dispersion volume by foaming enables to spread the adhesive on the surface more uniform with a better quality, but also the effect of saving is achieved.

Based on obtained results (7 different adhesive spreads x 10 testing samples in each spread), we counted the dependence of the shear strength (Y) on the glue spread (X) within the interval <100 g/m^2; 180 g/m^2> by the mathematic function as is illustrated in the following Figure 2:

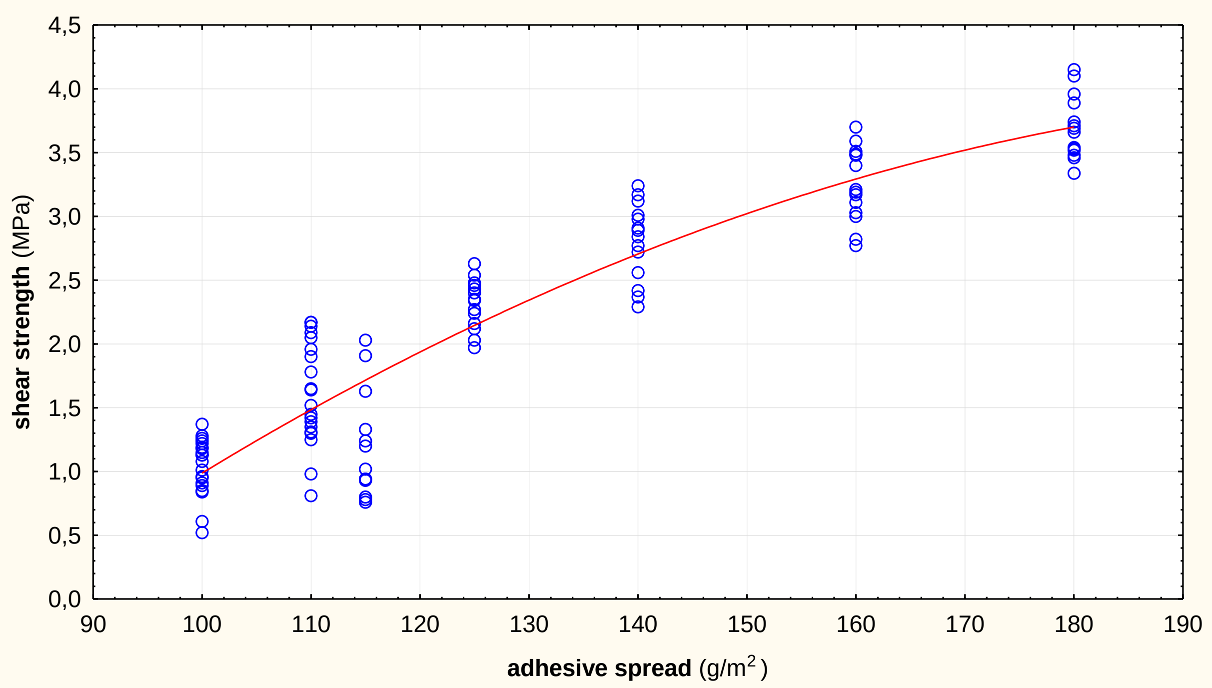

Figure 2. Regression analysis

The statistical significance of parameters and model as a whole, as well as the adequacy of the model was verified. The results showed that all of the parameters are statistically significant and adequate. The equation of the regression line had the form:

$$y = - 6,7262 + 0,0972*x - 0,0002*x^2 \qquad [1]$$

On the basis of homogeneity of the variance in the residual component we have calculated and converted mentioned above quadratic equation by using mathematical program Wolfram Mathematica 7.0. Based on the obtained results, we can assume that the samples with application of 30 % of foamed adhesive RAKOLL® 4340 with the ***adhesive spread of 140,51 g/m² can be achieved such shear strength where the lower 5 % percentile is on the level of 2,5 MPa.***

From the evaluation of the results, we can conclude, that the adhesive spread oscillating around 140 g/m^2 of used dispersion adhesive, which is foamed up to 30 % of its volume. In this adhesive spread should be achieved such shear strength of samples which meets the requirements of the EN 13 353: 2009 Solid Wood Panels (SWP). Requirements. The average consumption in the conventional dispersion adhesive spread is 180 g/m^2. Through our research we can conclude that if we use dispersion adhesive foamed at 30% of its volume (with the level of water resistance D4) there can be achieved the adhesives savings at the level of 40 g/m^2. It is approx. 22% of total used adhesive volume. This fact brings the positive economic aspect in the production of solid wood panels. There is a reduction of direct material by reducing the amount of applied adhesive (lower direct costs) and it can has also positive impact to the reduction of indirect costs (costs for storage, transportation…). However, the question is what should be the minimum volume of company´s production, if we want to return the initial investment of 35 000 EUR for the acquisition of such technological equipment, which is capable of adhesives foaming.

4. CONCLUSION

The foaming of dispersion adhesives can optimize the amount of applied adhesive in gluing process in the production of solid wood panels. Our results are reflected in the finding that foaming of PVAc dispersions leads to the reducing its consumption. The practical benefit of the research from the technological point can be expected within the optimisation of wood gluing processes, with the aim to ensure such production assumptions, which will bring effective minimisation of the production costs at required quality level. Researched dispersion adhesive (water resistance D4) was foamed at 30% of its volume by air. The adhesive consumption saving was approx. 22% of used PVAc adhesive. Final effect from the economic view can be expected in an effort to at least partially manage the production costs and maintaining a strong link between the quality characteristics of the final product, technology, production costs and the final price of the product, which can create a strong competitive advantage for the companies with the higher production volumes, mainly in the wholesale.

REFERENCES

1. Sedliačik, J., Šmidriaková, M. (2012): HEAT RESISTANCE OF ADHESIVE JOINTS FOR WOOD CONSTRUCTIONS, Acta Facultatis Xylologiae Zvolen. Vol. 54 (2), 79-94 p. ISSN 1336-3824.
2. Sedliačik, J., Schmidtová, J., Šmidriaková, M. (2014): Foaming of polyvinylacetate adhesives – improved technologic parameters for a solid wood gluing process. Annals of Warsaw University of Life Sciences – SGGW. Forestry and Wood Technology No. 87, 224 – 228 p., ISSN 1989 – 5912.
3. Gereke T., Gustafsson P.J., Person K., Niemz P. (2007): EXPERIMENTAL AND NUMERICAL DETERMINATION OF THE HYGROSCOPIS WARPING OF CROSS LAMINATED SOLID WOOD PANELS. Holzforschung, Vol. 66, 340 – 347 p., 2007. ISSN 0018-3830.
4. Kurt, R. (2006): EFFECT OF GLUE LINE THICKNESS ON SHEAR STRENGTH OF WOOD TO WOOD JOINTS. Wood Research. Vol. 51 (1). 59-66 p. ISSN: 1336-4561.
5. Hass P., Wittel F.K., Mendoza M., Herrmann H.J., Niemz P. (2011): ADHESIVE PENETRATION IN BEECH WOOD. Part I: Experiments. Zurich: Institute for Building Materials, 22 p.

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FURNITURE MANUFACTURING CHALLENGES ON THE WORLD MARKET: THE BULGARIA'S CASE

Rossitsa Chobanova, Radostina Popova

ABSTRACT

The paper attempts to identify the trends and challenges before the innovation policy activities in the furniture manufacturing, resulting from the furniture challenges on the world market. In this respect on the base of a documents survey it characterises the state of the art and trends in the manufacture of the furniture, consumption, import/export, cost structure of furniture production, availability of raw materials and components, labour cost, investment in technology machinery, R&D, innovation and design. The paper draws some conclusions and recommendations how a country (the case of Bulgaria) could respond to the contemporary challenges of the furniture manufacturing on the world market.
Key words: Bulgaria, challenges, innovation, world market, furniture manufacturing

1. INTRODUCTION

The furniture sector has traditionally been a resource and labour-intensive industry characterized by the co-existence of both local craft-based firms and large volume producers. Following the crisis, the global furniture market is now backing to a growth path. Market opportunities are developing in different areas of the world, with emerging markets, where disposable income is increasing fast, playing an important role alongside the large traditional markets. As it is unlined in the 2008 Commission Communication on innovative and sustainable forest-based industries in the EU these industries are competitive at the global level, but are currently facing several **challenges**. These include – among others – **growing global competition, the availability of energy and wood supplies, and the role of the sector in limiting climate change.** Based on the analysis of recent data from official resources of the European Commission the paper attempts to indentify the challenges Bulgarian policy has to responds to.

2. MANUFACTURE OF FURNITURE - FRAGMENTED VALUE CHAIN

Firms designing, manufacturing and shipping products in large quantities (particularly, but not only, in the low and middle-price ranges) are leading players and took advantage of their large scale and the availability of huge capital resources to invest in organizing their production and logistics in order to penetrate foreign markets.

On the other hand, larger firms find it convenient and profitable to outsource and fragment their activities into many functions carried out by different actors in different locations, and small and medium-sized enterprises are increasingly relying on them for their access to markets.

The importance of SMEs is relatively high in niche market segments, primarily for high- end, custom made and design-led products. Overcoming difficulties related to small company size was one of the factors underlying the development of cluster experiences in the furniture sector.

The EU furniture sector is predominantly made of SMEs, with around 85% being micro enterprises (fewer than 10 employees) and another 12% of companies being small (10 to 49). Medium-sized companies account for 2%.

The Bulgarian furniture manufacturing is performing better than other traditional manufacturing areas. The Bulgaria's furniture production has constantly contracted over the last decade and the value of furniture production in 2012 was almost at the same level as ten years before. Furniture production in Bulgaria in 2012 is 266 €million, 0.% of EU total with 2.6 percentage of average growth rate (2003-2012). In 2011, about 21,000 workers were employed in approximately 2,200 firms belonging to the manufacture of furniture in Bulgaria. For the last decade the number of employed is still decreasing after 2007, when they are 27,352, while the number of enterprises is increasing and becoming 2,407 in 2009 and then they are decreasing. In 2011, the sector's production amounted to more than €240 million with a value added of nearly €100 million, while in 2003 the respective indicators amount respectively – 212 and 45. A tendency of further fragmentation has been occurred in the case of Bulgaria during the last 10 years when the number of enterprises is almost doubled, while the workers in the sector are increased about 10%.

The semi-finished wooden products represent the upstream segment of the value chain. In 2010, this forest-based manufacturing industry in EU included 184,000 enterprises and employed 1.05 million people, i.e. 0.8% of total non-financial employment. The wood manufacturing sector is characterized by a vast majority of SMEs which in 2010 were responsible for 85% of the employment and 77% of value added.

3. THE ROLE OF FURNITURE MANUFACTURING WITHIN THE ECONOMY

As a matter of fact, the role of the furniture manufacturing sector within the economy varies across the EU countries and in the time span considered. In order to capture these effects we calculate here a basic indicator, the concentration index[8] . Despite being a very simplified index, it provides a first overview of the relative contribution of a specific sector to the national economy of each country compared to the EU average, thus measuring a sort of comparative advantage of the sector within the country.

According to this index the furniture sector in Bulgaria is relatively not important like in the Italian, Danish and Portuguese. The furniture sector as a whole has lost importance within the EU economy in the last decade[9]. The number of active companies fell from 135,000 in 2003 to 126,000 in 2011 and the number of employees from around 1,200,000 in 2003 to 920,027 in 2011. The share of furniture production over the total manufacturing sector is in the range of 1.4%, decreasing over the last decade.

In addition, EU furniture production saw a sharp contraction during the crisis, with some recovery in 2010 and 2011 and a slight reversal of trend again in 2012. As a result, the value of furniture production is almost the same as it was ten years ago. However, within the EU, some countries are growing rapidly in terms of production value and others are lagging behind because of structural factors or as the result of the recent economic slump.

Access to sustainably-sourced raw materials, the cost and complications of harvesting wood in the EU, price increases driven by competing demand (e.g., from the bio-energy sector), comparatively higher energy costs in the EU and a more complex and demanding policy environment affect all segments of the value chain, including the furniture sector.

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[8] If furniture production accounts for a 5% share of country X's GDP and a 5% share of the EU GDP, the concentration index of the furniture sector for country X equals to 100. If furniture production represents 5% of country X's GDP, but 10% of the EU GDP, the concentration index of the furniture sector for country X is 50. If furniture production represents 10% of country X's GDP and 5% of the EU GDP, the concentration index is 200.

[9] At EU level, furniture production/GDP ratio was 0.8% in 2003 and 0.6% in 2012.

The increasing competition that global furniture producers are facing has drawn the attention of policy-makers to the possible absence of a level-playing field at the global level, to the detriment of EU producers. While these considerations apply to several sectors, they are even more pertinent for those that are highly dependent on a global and fragmented value chain.

4. CONSUMPTION – STILL LOW

Total world furniture consumption grew from €226 billion in 2003 to a peak of €281 billion in 2007, before decreasing as a consequence of the recession. Growth resumed in 2010.

The Bulgarian furniture market is slowly recovering and constantly opening up. Bulgaria takes 0.2% of the EU market. Average growth rate 2003-2012 is 0.5% (0.0% for EU 28). Consumption per capita is the lowest in EU28. Consumption in Bulgaria in 2012 (154 €million) was still below the pre-crisis level (284€million), while the production has reached it (268 €million) . Furniture consumption in 2012 is 54% of its volume in 2008 and respective furniture imports -59%. For EU28 countries those share are 84% and 93%. Consumption reached €347 billion in 2012, well above pre-recession levels.

In Bulgaria there is no clear tendency of increasing consumption after the crisis. The level of €286 in 2008 is not reached (€154 in 2012).In other words Bulgaria recovers slower than EU28.

The advent of the Internet and e-commerce has also added another dimension of understanding the consumption. According to Eurostat data, more than four out of ten EU consumers (44%) have purchased goods and services over the Internet in the past year. Since 2004 the proportion of Internet shoppers has risen to 44% from 20%. Online shopping remains largely domestic, i.e. consumers are more likely to purchase online from national sellers/providers (41%) than from sellers located in other EU countries (11%). However, e-commerce is the most common form of distance shopping and has been growing steadily since it was first measured in 2004. The results at country level reveal that consumers are most likely to buy online in Sweden (74%), the UK (73%) and Denmark. The lowest levels of online shopping are recorded in Romania (5%) and Bulgaria (9%).

5. BULGARIAN IMPORT AND EXPORT – WELL INTEGRATED IN EU MARKET

Bulgaria operates in the global context and purchases furniture items for the domestic market and sells its production to other countries. Ten years ago, furniture exports to exceeded furniture imports almost 3 times. Similar is situation in 2012 when the ratio is 2 times.

Market sources for Bulgaria are dominated by foreign, mainly of European origin ones. Share of national production out of total consumption is 25%. Share of imports out of total consumption is 75%, which means Bulgaria depend on imports more than EU28 average -47%.

Bulgaria is well integrated in EU furniture market. Imports from intra-EU countries' share of consumption is 54% (32% for EU 28). Imports from extra-EU countries' share of consumption is 21% (15% for EU 28).

Furniture manufacturing is a dynamic industry, with its success factors lying in the creative capacity of combining raw materials and technology in order to meet the demand emerging from the markets and to satisfy consumers' needs.

The Bulgaria's comparative advantage relates to the low cost of labour. A long tradition in furniture making is another factor, but even if craftsmanship still plays a role in the productive system, furniture production has become an assembly industry and adequate and performing production systems are more important.

The furniture export in Bulgaria performs a half of its production in 2003, and is almost the same in 2012.

6. KEY FACTORS AFFECTING COMPETITIVENESS IN THE FURNITURE INDUSTRY

The key factors affecting competitiveness in the furniture industry **are the upstream section of the value chain and the role of raw materials and components, labour costs and the availability of skilled labour, of investment in technology, R&D, innovation and design, relevant policies affecting the industry**.

6.1. Upstream section of the value chain

The main factors affecting the upstream portion of the value chain include the availability of raw materials and skilled labour and investment in tangible goods such as machinery and equipment. Intangible investments in innovation and design also play a decisive role. The combination of these factors for the production of items at competitive prices is another key element. First of all, the weight of raw materials and other production inputs on the total production value can be approximated by the share of the production value taken up by total purchases of goods and services. According to Eurostat Structural Business Statistics, the total purchases of goods and services include the value of all goods and services purchased during the accounting period for resale or consumption in the production process (excluding capital goods) . In 2011, purchases of goods and services accounted for 73% of the total production value in the EU28 furniture industry. In particular, the share was higher in EU13 (81%) than in EU15 (72%). Nonetheless, over the period 2008- 2011, in absolute value, the average purchases of goods and services per enterprise were steadily higher in EU15. For instance, in 2011 for each €100 spent by an average EU furniture manufacturer, a company based in EU15 spent more than €120 against €52 spent by companies based in EU13.

6.2. Cost structure of furniture production

The country cost structure of furniture production needs to be improved. In 2011 in Bulgaria purchases of goods and services including energy products are 82.1% over total production value while in EU28 they are 73.3%. A purchase of energy products is 2.5%, while in EU is 1.4%. Personnel costs are 11.4% over the total production value while in EU 28 are 23.8%. Wages in Bulgaria are 11.3%, while in EU 28 are 18.7%. Social security in the country is very low. It is the lowest in EU. Wages are lowest in the EU.

Profitability

The gross operating rate relates the gross operating surplus (value added less personnel costs) to the level of turnover, thus showing the surplus generated by operating activities after labour costs are paid. The EU13 countries displayed higher gross operating rates compared to the EU15 Members States, partially reflecting lower labour costs in EU13. Furthermore in 2011, the EU13 gross operating rate grew by 11% with respect to 2008, whereas in EU15 the indicator declined by about 12%. Obviously, it is worth stressing that performance indicators for the entire EU productive system vary substantially across countries and average figures are thus the result of mixed performances across the Union. As regards the gross operating rate, in 2011 the highest levels were recorded in UK (13.8% and 13.3%), Poland (11.3%), Slovakia (10.4%) and Austria (10%). By analysing the trend over the 2008-2011, period the best performers in terms of growth rate in the EU13 were Estonia, Slovakia, Latvia and Hungary. Conversely, almost all EU15 countries recorded declining gross operating rates over the 2008-2011 period, with the exception of Austria, Denmark and Germany. In the Bulgaria is declining from 13.8 in 2008 to 10.5 in 2011.

6.3 Availability of raw materials and components

The furniture industry is known to be essentially an assembly industry employing various raw materials such as wood-based panels, metal, aluminium, plastics, fabrics, leather and glass, as well as mechanical and ICT components. All the furniture sub-segments, with the exception of mattresses use wood or wood panels as an input, which represents a substantial share of raw materials used in production. For this reason, emphasis was put on wood.

In the last three decades, reportedly the share of European furniture manufacturers employing wood-based panels has sharply increased compared to those who use solid wood. Two main reasons have been identified: the declining prices of wood-based panels compared to sawn wood and the relative ease with which panels can be assembled. This trend has been further reinforced by the advent of RTA Wood-based panels are produced from primary processing of raw timber. The three main categories of wood-based panels are particleboard, fibreboard (mainly MDF) and plywood. They are essentially produced under heat and pressure with the addition of an adhesive to glue fibres, particles or sheets. Production requires very large plants and huge investments in machinery, thus the scale of manufacturers is generally large (compared to the furniture industry) and entry barriers are high.

6.4. Labour cost

As mentioned above, the furniture industry is essentially an assembly industry. As such, labour costs constitute a relatively important component of the final retail cost of furniture.

Being a resource- and labour-intensive industry, the entry barriers to the furniture industry are rather low. This allows new producers from emerging and transition economies to easily enter the European market. In order to retain market shares, price competitiveness is a crucial driver of success. For this reason, since the beginning of the 1990s Western European firms have been restructuring their production process, investing in new plants in low-wage countries or outsourcing part of their activities to those areas. The difference in wages and salaries paid in EU15 and in EU13 is clear. On average, the cost per employee in EU13 is 25% lower than in EU15. However, large differences exist among countries. Indeed, in Europe the incidence of personnel costs on the production in the furniture manufacturing sector is on average around 25%, while in Bulgaria is below 15%.

6.5. Investment in technology machinery

Adequate machinery endowment is widely recognised as a crucial factor in the production process, as it delivers efficiency and productivity gains. This applies to all the furniture segments, but in particular in the case of assembly-line manufactures orientation, when production is in big series. Standardization of production should go hand in hand with minimization of costs and in this process, technology (both in production and logistic) has a decisive role. Companies' capital investments in plant and machinery have also an impact in reducing waste and increasing safety.

The EU28 furniture sector recorded €2,698 million of tangible investments in 2010, resulting in an investment rate73 of 9.3% . If the total investments in tangible goods are broken-down into their four subcomponents, investments in machinery and equipment account for the largest share.

In general, tangible investments in the furniture sector concern the automation of the production process. Indeed, more than half of the total investments are for new machinery and equipment. In order to automate the production process furniture firms usually introduce Computer Assisted Manufacturing (CAM) solutions and Computerised Numerical Control (CNC) machines. Important investments are made in this area by medium-sized and large enterprises to optimise production, to create synergy between different lines or sites of production and to achieve scale economies. In particular, German and

Italian wood furniture manufacturers are at the forefront in terms of woodworking machinery technology and are considered world leaders.

The Bulgaria's gross investments in tangible goods by type in furniture production, 2010 (€million and percentage values on EU28) is not well balanced. The land consists 0.5, existing buildings and structures -1.1construction and alteration of buildings – 11.3, machinery and equipment – 12.3. These tangible goods are 25.2. The share of investment in machinery and equipment over the total investment in tangible goods is 49% very low comparatively to the EU 28 is 71 % (Excl. Greece, France, Ireland and Malta). Source: Eurostat (sbs_na_ind_r2).

6.6. R&D, innovation and design

The competitiveness of Bulgaria's manufacturers should be assessed in terms of their ability to meet consumer demand, both present and potential, through innovation and design.

R&D and innovation are crucial factors to maintain market positions. This is made necessary by consumers' changing needs and market pressure. Changing tastes, emerging needs and the introduction of innovative products are key issues. The present trend has to do with customization, ergonomics, and functionality. Eco-issues are also becoming increasingly important.

The need for **design** is another focus for the innovation policy**.** Together with new consumer needs and products trends, the globalisation of the furniture industry and the difficulties experienced by Bulgarian firms in competing with the prices of Asian imports have moved the design function to the forefront. Bulgarian manufacturers now regard design as the best means of differentiating their products from mass production and of acquiring access to the high-income market segments. Design is indeed widely recognised as offering furniture producers a competitive advantage that can counterbalance the price advantage of low-wage countries. Industrial design is generally interpreted as the sum of the aesthetic-project content of a furnishing product: from function to form, from material to colour and finishing, all are seen as the realisation of technical design. Designs and new models in the furniture industry are created in-house, or by external designers and experts. External consultants are more frequently employed by medium-sized and high-brand enterprises. Moreover, they are generally hired by companies specialising in modern and contemporary styles rather than by companies making classic and traditional style products, or companies without a particular specialisation.

In general terms, the contribution of designers is most important during the first phases of the generation of a new product.

Besides design, **innovation in materials and technologies** is another crucial competitiveness driver. Contrary to design, only a small number of Bulgarian firms carry out industrial research activities internally in order to develop new materials or technology for furniture. However, an important asset of the Bulgarian furniture industry is that it can work closely with suppliers of new materials and new technologies. In particular, innovation in materials is often carried out by firms specializing in surface finishing, while technological innovation is often achieved by component producers.

An interesting filed of innovation which can potentially affect the furniture sector in the near future is represented by **nanomaterials and nanotechnology.** Recently, a joint project by the European Federation of Building and Woodworkers (EFBWW), the European Furniture Manufacturers Federation (UEA) and the European Furniture Industries Federation (EFIC) has mapped current uses and near future perspective on nanomaterials in the European furniture sector. It is worth mentioning that research and development on nanomaterials and nanoproducts is not carried out by the furniture sector which typically exploits the findings of the research and development activities of other industries. Looking at the market of 2012, the aforementioned project found out that the use of manufactured nanomaterials in furniture products is still at an early stage of development since their costs are quite high while the confidence of furniture manufacturers and consumers is still low. The majority of nanomaterials applications can be found in the field of coatings, e.g., scratch resistant coatings, anti-graffiti coatings, easy-to-clean and water repellent coatings, UV-protective coatings, and self-cleaning coatings.

At this stage the share of R&D personnel out of the total number of employees in the furniture manufacturing sector in Bulgaria is neglect able, which is a barrier to meet the new challenges.

Process innovation is another important competitive edge for furniture manufacturers. According to the CSIL Report (2013), top European manufacturers invest in upgrading and automating their production processes through new engineering solutions. They also introduce new production methods that allow for energy savings. For instance, the furniture production line can be equipped with an environmentally-friendly woodchip burner that recycles all the waste wood and chippings and uses it as fuel in the production facilities. The energy is used directly and without any additional transport costs.

7. INNOVATION PERFORMANCE OF FURNITURE ENTERPRISES IN BULGARIA: RESULTS OF SURVEYS

The innovation performance of furniture enterprises in Bulgaria could be characterized on the base of three surveys on innovation in furniture sector in Bulgaria, taking place in the period 2006 - 2012. The applied methodology is based on those of European innovation survey – using OECD/Eurostat Oslo manual. The surveys are representative. They cover three consecutive periods, but having different objectives and scopes:

- The first one, taking place in 2006-2008 (551 enterprises - sample of all enterprises in Bulgaria), is aimed to characterize the innovation activity of SMEs in furniture enterprises in the country;
- The second one, covering a period 2008-2010 (32 enterprises - quota sample of leading enterprises in Bulgaria) is aimed to identify the predominant types of innovation activities;
- The third one, respecting the period 2010-2012 (11 enterprises - sample of enterprises with marks Verified Bulgarian Furniture of the Bulgarian Branch Chamber of Woodworking and Furniture Industry - BBCWFI), is aimed to contribute to understanding of the competitiveness of innovation, taking place in furniture enterprises.

7.1. Results of the Survey of Innovation Activity of Furniture Enterprises in Period 2006-2008

For period 2006-2008, the innovative performance of furniture enterprises is below the average in EU. The main economic factor that reflects this performance is the financing of the innovative activities. Its level is behind the EU average - just 1.48% of the turnover of furniture enterprises in the EU, which average one is 2.21%. The level of the main economic indicator that characterizes the result of innovation activities - the share of turnover and the market for new furniture, also is lower than that of the EU average. It is noteworthy that new furniture is better realized by firms with higher innovation intensity. The average European level of the index in 2008 was 13.3% according to Eurostat and the country is more twice behind.

The value of the indicator of innovation activity increases with an increase in the size of the enterprise. For example, medium-sized furniture companies are:

- 68% higher turnover of small enterprises;
- 29% higher spending on innovation by small enterprises;
- 30% higher revenues from innovative products from small enterprises.

7.2. Results of a Survey of the Types of Innovation Furniture Enterprises in Period 2008-2010

For period 2008-2010 the specific innovation activities relate to the main types of innovation and costs associated with them concern product and process, organizational, management and marketing. They are associated with innovations in key areas - new materials, technologies, internal and external organizational changes, training of human resources, certification and standardization, pricing and distribution, awards for innovation. The main types of innovation activities of furniture enterprises for period 2008-2010 are as follows:

1) The predominant product innovations are with low level of novelty - the use of new materials in the production (which are mostly new to the company and the Bulgarian market - lightweight melamine faced chipboard, MDF - matte and glossy, solid wood with special effects, veneer and plywood polycarbonate plates with natural botanical elements, hinges from leading European and world producers etc.)
2) Organizational and managerial innovations are second in importance - embedded systems for quality management (ISO 9001), followed by training of personnel.
3) Process Innovation – on the third place. Costs are made for the purchase of new machinery and equipment - mostly circular, edging machines and membrane presses. Next - a new automation of production processes is done.
4) The lowest results are in terms of marketing innovations, where leaders are the new promotion techniques and new market channels, and changes in the brand.

7.2. Results of a Study of the Competitiveness of the Innovation of Furniture Enterprises in Period 2010 - 2012

In period 2010-2012, CIS focused on the results of innovation activities of enterprises and in particular the results with a high degree of novelty that defines high competitiveness and innovation. They concern industrial property. Ownership of industrial property means ownership of assets goods that are produced or acquired for profit and control its use. Industrial property is listed in the Article 1 of the Paris Convention for the Protection of Industrial Property, to which the Republic of Bulgaria has joined in 1921, and under the Convention, the main object of protection are: inventions and utility models, trademarks and geographical indications, industrial design, company names, prosecuted unfair competition, new plant varieties, animal breeds, topographies of integrated circuits etc.

The results of the study of the innovations of 11 leading furniture enterprises participating in the Verified Bulgarian Furniture of BBCWFI (the total number of member companies is 13) for the period 2010-2012 can be summarized in the following:

- More than half of the surveyed enterprises have realized new products during the period;
- 30 % of enterprises bring 5 to 10 new products, one third of which are new to the market;
- 18% of enterprises have a registered patent, slightly below the average score for industrial SMEs in Bulgaria by 20%;
- None of the companies has registered industrial design or trademark, and other forms of protection of intellectual property;
- Half of the innovative enterprises develop the software and machines needed for their production;
- Enterprises with the highest innovative performance work actively on projects related to the improvement of competitiveness, human resource development, energy efficiency and safety;
- Innovative enterprises have implemented more innovative activities as part of a public contract for the supply of goods and services to public sector organizations;
- The purpose of product innovation furniture enterprises are increased market share and profits;

- Managers state the high cost of registration and lack of staff to deal with R & D, furniture makers, as barriers to the registration of patents.

Studies related to the innovation performance of furniture enterprises in Bulgaria, suggest that it is below the EU average or industrial SMEs. By increasing the number of employees in the furniture enterprises, their innovation activity increases. The prevailing product innovation - new furniture is introduced now, but there is a low realization of innovative products that are new to the market.

Analysis of the results allows for the formulation of the following conclusions regarding furniture enterprises in Bulgaria, as a subject of future studies:

- low level of R & D, as well as costs associated with it;
- low level of implementation of innovative products;
- low level of patent activity;
- low level of collaboration and co- innovation;
- furniture enterprises mainly finance their own innovation activities;
- lack of concrete measures and activities related to the development of innovative furniture enterprises in strategy development of the Woodworking and Furniture Industry in 2013;
- the lack of a law for innovations in Bulgaria strongly influences the potential to stimulate investment in the innovation projects of the SMEs, and the full support of innovation in enterprises.

8. CONCLUDING REMARKS

The forest-based industries are currently facing several challenges. Among them are growing global competition, the availability of energy and wood supplies, and the role of the sector in limiting climate change. The 2013 Communication "A New EU Forest Strategy" and the accompanying "Blueprint for the EU Forest-Based Industries" (F-BI) confirm the persistence of these challenges and their impact on the overall competitiveness of EU F-BI in a global context. All segments of the value chain, including the furniture sector are affected by the access to sustainably-sourced raw materials, the cost and complications of harvesting wood in the EU, price increases driven by competing demand (e.g., from the bio-energy sector), comparatively higher energy costs in the EU and a more complex and demanding policy environment. Some of these challenges have also an impact on consumption patterns. Against this background, the degree of information available to the final customers becomes of relevance.

The policy problem at hand appears mostly related to a specific type of market failure, i.e. incomplete information, which triggers a problem of adverse selection due to the following features of the furniture industry: Most of the quality features of furniture products belong to the categories of experience and credence attributes: this means that consumers might not always be entirely equipped to fully incorporate quality features in purchasing decisions, as well as to distinguish between high- and low-quality products. This can generate problems of adverse selection, in which consumers do not fully adjust their willingness to pay to the difference in quality of products available on the market.

The adverse selection problem is further exacerbated by the fact that retailers that sell both high- and low-quality furniture might not have the same incentives as manufacturers in making quality differences crystal clear for customers. The problem is also aggravated by emerging trends such as increased competition from non-EU countries, growing price-sensitivity of furniture demand generated by reduced disposable income, and the rise of online furniture stores, which make the quality features of furniture even more difficult to test in practice before purchase. It must also be recalled that online interaction between consumers might, in principle, fill some of the information gaps on experience qualities (e.g. through rating of specific pieces of furniture by other consumers), but not on credence qualities, and not for all furniture products existing on the market.

In addition, other problems have been highlighted: Existing product guarantees only partially address the issue as, in the case of furniture, quality problems can become visible after a guarantee has expired and when complaints cannot be enforced. Several factors including the **globalization of value chains, new sourcing strategies, and in particular the growing diffusion of new retail formats have** altered vertical relations between manufacturers and retailers and made competition on "quality signalling" fiercer. In addition, due to the structure of furniture production in the EU, manufacturers are more likely to be the side with less bargaining power in the vertical relationship, which also affects the type of product information that is ultimately communicated at the point of sale. As a result, consumers receive confusing messages, as different actors at different levels of the value chain may be interested in providing different types of product information to the consumer.

The lack of homogeneous market conditions seems to be hampering smaller businesses and the Single Market. Mandatory schemes with non-fully overlapping scopes and modes of implementation adopted by different Member States to signal the general quality or specific features of furniture products do not appear to have generated significant barriers to intra-EU trade at the macro-level. However in a public consultation, they hinder or make cross-border activities more burdensome for smaller businesses. Some of the mandatory initiatives that are already in the pipeline in some EU countries could further.

REFERENCES

1. Communication from the Commission: A new EU Forest Strategy: for forests and the forest-based sector, COM(2013)659 final
2. Communication from the Commission: An Integrated Industrial Policy for the Globalisation Era. Putting Competitiveness and Sustainability at Centre Stage, COM(2010)614, 28.10.2010
3. Communication from the Commission: A Stronger European Industry for Growth and Economic Recovery. Industrial Policy Communication Update, COM(2012)582, 10.10.2012
4. Communication from the Commission: Industrial Renaissance COM(2014) 3 NACE Rev. 2 Division 16 ("Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials")
5. Communication from the Commission: innovative and sustainable forest-based industries in the EU, COM (2008)113, February 2008
6. EUROSTAT, Statistics Explained, Manufacture of wood and wood products statistics – NACERev. 2, available at: http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Manufacture_of_wood_and_wood_products_statistics_-_NACE_Rev._2#Further_Eurostat_information, last accessed in August 2014.
7. European Commission: A Blueprint for the EU Forest-based Industries (woodworking, furniture, pulp & paper manufacturing and converting, printing), SWD(2013)343;
8. European Commission: the EU furniture market situation and a possible furniture products initiative. Final report, Framework Contract /ENTR/008/006, Brussels, November 2014

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DEVELOPMENT OF THE SAWLOGS SUPPLIES IN THE SLOVAK REPUBLIC

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ABSTRACT

The situation on the timber market is continuously changing. The paper deals with the sawlogs supplies analyses on the wood market in the Slovak Republic. The first analysis is focused on the evaluation of the individual supplies roundwood assortments over a period of years from 1998 until 2013. The second part of research deals with the modelling of sawlogs supplies. For over mention purpose different functions of regression analysis has been used. The results of the timber market models are used as a prediction of sawlogs future supplies.
Keywords: Sawlogs Supply, Regression Analysis, Timber Market.

1.INTRODUCTION

The Slovak economy disposes of limited volume of its own natural and energy resources so that many sectors depend on their imports (Paluš et al. 2012). On the other hand, the country disposes of renewable raw material – wood, which resources cannot be exhausted once the sustainable forest management principles are kept (Šupín, 2011).

Wood is widely available materials from energy use to production of unique musical instruments (Greppel et al. 2007). At the present time, wood as a raw material is one of the most important output from the forest, and as such it has always been one of the most used renewable material. His versatility creates new challenges due to technical and technological developments. With the values of today's society importance of wood utilisation grows connected with the idea of sustainable development. Wood as a natural and environmentally friendly material finds its application in the most diverse spheres of the economy and people's lives. Wood can by apply in construction, manufacturing, agriculture, transport, and other sectors in meeting people's everyday needs.

Globalisation is one of the most significant factors which influence the changes in Slovak economy including woodworking industry. The process of globalization creates many advantages but on the other hand, brings with it some unwanted negative effects (Dzian, 2014). Impact globalisation on the Slovak woodworking industry was measured through the indicators which are based on the data on foreign trade with wood products – the share of imports and exports to GDP. According to analysis the presence of globalisation in the Slovak woodworking industry was evident including influence of the Financial and Economic Crisis (Šupín, 2011). Analysing history of different wood assortments supply there is a clear drop most valuable assortments compared to 1990. In 2013, annual wood felling was 7.8 million m3 (about 4.8% less than in the previous year). However, one of the most important problems seems to be the share of the accidental harvesting. In that year the share of accidental harvesting was more than 39 % of the total logging. The share of accidental harvesting of coniferous wood was almost 65 % (MASR, 2014).

Except natural conditions there is market which has significant impact to wood supply. In the Slovak Republic the timber market is influenced by the imbalance of demand and supply. On the one side there is still high demand for coniferous logs and on the other side low interest on coniferous pulpwood. Opposite situation can be described for broadleaves assortments. In this case, there is a high demand for pulpwood due to big consumption of pulp and paper companies situated in Slovakia. One of the ways how to solve this situation is well-run wood foreign trade, especially between Slovakia and EU countries.

2.METHODOLOGY

The research focuses on analysis of sawlogs supply in Slovakia. According to the Slovak National Standards we analysed development of wood assortments of the III class during long period of time (16 years, from 1998 until 2013).

The subject of the research was individual supplies development carried out in the domestic market. According to data from Quarterly Timber Statistic which are published in the annual report (MA SR, 2014) the research analyses and predicts the future development of logs supply in Slovakia. The research explores the logs supply trends applying regression analysis. Regression analysis has several types, which can be used for predicting future developments. Statistical test discovers linear and exponential regression model as an optimal ways to predict the development of logs supply. In our research we try to compare these two modes and predict future development for the next five years (years 2014 -2018).

These models can express full functional dependence where the dependent variable y (sawlogs supply) only depend on explanatory variables (time). The regression model can be explained as (Pacáková et al. 2003):

$$y = f(X, \beta) + \varepsilon \qquad [1]$$

where:

f (x, β) is a regression function, β – unknown parameters,

y – sawlogs supply, ε - vector of random errors (unspecific influence).

x – time,

3.REGRESION MODELS AND PREDICTION OF LOGS SUPPLY

The first approach describes linear regression model to analyse development of logs supply. Value of logs supply has been extremely increased from 1.46 mil m3 in 1998 to 5.29 mil. m3 in 2014: Actually, there is estimation that supply will be increased for next years and this year reach a value 5.52 mil. m3. Based on the linear regression model we predict continuous growth to 6.18 mil. m3 in 2018. It means there is real possibility to reach value of logs supply six time higher compare with year 1998. Real development as well as model is described on the fig 1. Linear regression model has positive trend and has the following form:

$$y = 224\,029x + 1\,483\,336$$

The second model applies exponential function to predict sawlogs supply in Slovakia (fig. 2). Base on principles exponential function we predict faster growth of sawlogs supply by reason of the growing demand for coniferous sawnwood.

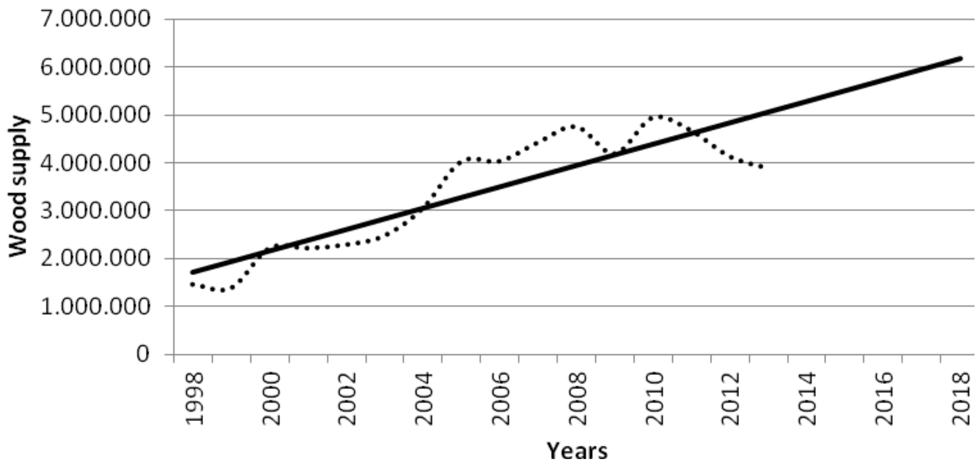

Figure 1 Predicted development of sawlogs by applying linear regression

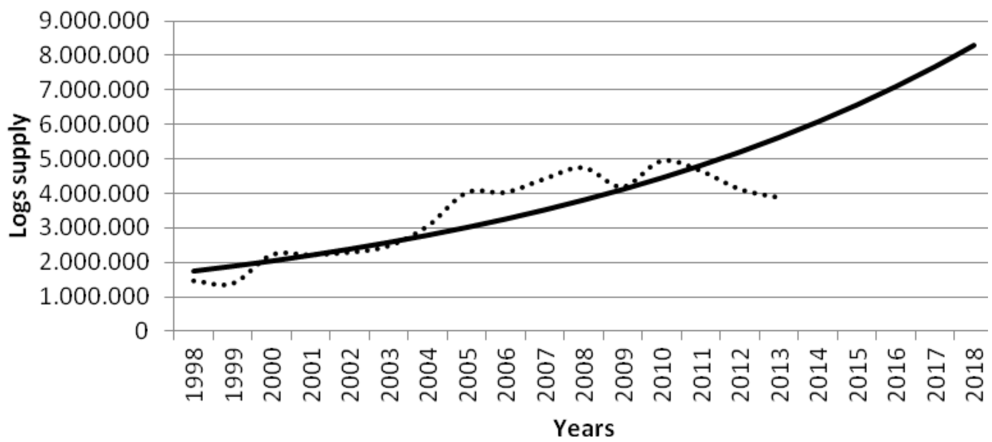

Figure 2 Predicted development of sawlogs by applying exponential regression

Compare with the above mention linear model, exponential model assumes 1.47 mil. m3 in 1998 and 6.09 mil. m3 in 2014 assuming unchanged other conditions. Exponential equation for logs will take the following form:

$$y = 1\ 626\ 462 *1{,}081^x$$

Variability of real sawlogs supply can be used as a measure of the model quality. The curve flattening of modeled empirical values is tested by coefficient of determination. For our linear model the value of coefficient of determination is quite high about 0.78 and compare to the exponential model it is a more accurate estimate of the future development. The similar results are confirmed by the standard error of the estimate. In the linear model standard error is 586 320 which means that the difference between reality and model sawlogs supply can vary by 0,586 mil. m3.

4.CONCLUSION

In Slovakia wood is an important strategic renewable material and its importance continues to grow. Logs is one of the most important roundwood assortment. The analysis confirmed positive development of logs supply. During the period the volume of supply has increased several times, although the trend line showed the effects of different political, economic or natural factors. Particularly, after 2010 the impact of the crisis caused a drop of the supply to the current value of 3.89 mil. m3. However, relation to the baseline year (1998) is a significant increase in the value of 2.42 million. m3. Predicting the development of logs are modelled future supplies of sawlog, apart from the impact of those factors that have a significant effect on the possible change of scenario. Applying mathematical and statistical methods clearly confirmed the suitability of a linear function to predict the development of roundwood supply in Slovakia, while in the short term is a prerequisite for their moderate growth.

REFERENCES

1. Dzian M. (2014): Prostredie šírenia WOM na Slovensku v rámci generácie Y. In Globalizácia a je sociálno-ekonomické aspekty ´14. ISBN 978-80-554-0927-6. s. 89-95.
2. MA SR. (2014.):Správa o lesnom hospodárstve v Slovenskej republike za rok 2013. Zelená správa 2014. [online]. Bratislava: MPSR, 2014. [cit.13.03.2015] Dostupné na internete: < http://mpsr.sk/index.php?navID=123&id=8915>.
3. Pacáková, V. Labudová, V., Sipková, Ľ., Šoltés, E., Vojtková, M. (2003): Štatistika pre ekonómov. [online] Bratislava: Ekonomická univerzita v Bratislave, 2003. [cit. 25.03.2015] Dostupné na internete: <https://svalzbety.files.wordpress.com/2010/05/statistika-pre-ekonomov-teoria-i.pdf>. ISBN 80-89047-74-2.
4. Greppel, E., Šulek, R., Drličková, E., Paluš, H. (2007): Kvalita dreva a obchod s drevom. [online]. Zvolen: Národné lesnícke centrum vo Zvolene, 2007. [cit. 11.03.2015] Dostupné na internete: <http://www.nlcsk.sk/files/1503.pdf>. ISBN 978-80-8093-028-8.
5. Paluš, H., Maťová H., Kaputa, V. (2012): Consumer preferences for joinery products and furniture in Slovakia and Poland. In Acta facultatis xylologiae Zvolen : vedecký časopis Drevárskej fakulty. - ISSN 1336-3824. - Roč. 54, č. 2 (2012), s. 123-132.
6. Šoltés, E.(2008): Regresná a korelačná analýza s aplikáciami. Bratislava: Iura Edition, 2008. 288 s. ISBN 978-80-8078-163-7.
7. Šupín, M. (2011): Analýza vplyvu globalizácie na slovenský drevársky priemysel v prvej dekáde 21. storočia. In Marketing a obchod 2011 : vplyv volatility a interdependencie v svetovom hospodárstve na marketing a obchod. Zvolen : Bratia Sabovci, 2011. ISBN 978-80-89241-41-5, s. 282-286.
8. Triznová, M. (2014): Manažment vzťahov so zákazníkom. Zvolen : Technická univerzita vo Zvolene, 2014. 86 s. ISBN 978-80-228-2640-2.

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NEW OPPORTUNITIES ON THE MARKET WITH WOOD CHIPS IN CENTRAL SLOVAKIA

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ABSTRACT

Biofuels in the EU are on the rise, mostly due to the need to diversify the fuel base of the EU member states and subsequent increased energy security, as well as the decision to decrease greenhouse gasses emissions into the atmosphere and mitigating the effects of global climate change. Due to the changes caused by the global economic crisis in the wood processing industry, and subsequent intensification of the competition the demand for lower quality raw wood assortments decreased. The energy production sector has the potential to ensure sales of these assortments in competitive prices. In Slovakia the demand for these assortments will increase. This is based on installation and reconstruction of energy plants to enable wood chips firing. Based on the output capacity of these new or reconstructed plants, we calculated the consumption of wood chips in 2016 at about 600 000 tons per year, in comparison with 240 000 tons per year in 2012. The greatest consumption was presumed in January and the smallest in August, due to the prevailing type of energy plants – heating or combined heat and power plants.

Key words: woodchips, heating plants, combined heat and power plants

1.INTRODUCTION

Using biofuels is on the rise in the European Union (EU). It is mostly caused by the need to diversify the fuel base of the EU member states, i.e. increasing their energy security, as well as the decision to decrease the emissions of greenhouse gasses, thus mitigating the development of global climate change. One of the main goals of the EU is to achieve 20% share of renewables in total energy production (Díaz-Yáñez et al., 2013).

From the view of heat and power production the most used biofuel is wood chips, which are produced from the logging residue from raw timber assortment production or other low quality woody material. In many countries the potential of wood chips is not being effectively utilized (Hetsch, 2008; EUWOOD, 2010), which means that increasing the share of bioenergy will have a positive effect on the local economy as well as energy security of the country.

Due to the changes in the wood processing industry and other industries using timber, caused by the global economic crisis, and subsequent intensification of the competition the demand for low quality assortments has decreased (Hetemäki and Nilsson, 2005). The energy sector has the potential to ensure market such timber at competitive prices.

The share of energy produced from renewable resources increases continually in Slovakia (Table 6). In regions with low rate of natural gas offtake for households, woody fuels are considered the ideal substitute, but an increase can be seen in all regions, the largest consumers of wood chips being energy enterprises which generate heat and power in separate or combined cycle and supply them to industrial consumers or households.

The demand for wood chips is affected by increasing its consumption in newly installed of reconstructed heat and power plants with wood chips as the main fuel. The expansion of using wood chips as a fuel started with subsidising its use by the state as a part of limiting the share of energy mix in Slovakia. Slovakia committed to use biofuels in its strategy for energy security, in the so-called conservative scenario (Table 6) (Ministry of Economy of the Slovak Republic, 2008). The obligatory share of biofuels consumption can be sanctioned by the EU if Slovakia does not comply with them. That is the reason why further actions for the intensification of biomass use were developed and published in the Action plan for biomass use for the years 2008 – 2013 (Ministry of Agriculture and Rural Development, 2008).

Table 6 Strategy of energy security of Slovakia - conservative scenario of using renewable resources (Ministry of Economy of the Slovak Republic, 2008)

Item	2010	2015	2020	2025	2030
	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]
Biomass	31 000	48 000	66 000	85 000	120 000
Solar energy	300	1 000	6 000	14 000	20 000
Geothermal energy	200	1 000	3 000	4 500	7 000
Hydro energy	18 000	20 000	22 000	23 000	24 000
Wind energy	300	x	x	x	x
Energy waste	200	x	x	x	x
Total	50 000	70 000	97 000	126 500	171 000
Share of renewables [%]	6,4	9,0	12,0	16,0	21,0

One of the regions with high share of heat and power production from renewable resources is Central Slovakia and we anticipate further increase of using renewable resources in this region in future. The goal of this article is to determine the predicted balance of wood chip consumption in the region and to define the monthly consumption of wood chips so that the supply would cover the consumption at optimal quality and logistic costs during the whole year.

2.MATERIALS AND METHODS

During elaboration of this study, we used methods of analysis and synthesis of available publications, which cover the area of timber availability (National Forestry Centre, 2011, 2012, 2013, 2014). In analysis of the capacities of the technologies of heat and power production we used a questionnaire survey, as well as field survey, which ensured relevance of presented data.

Based on the input data – availability of woody material, logistic costs, holding costs, optimal payment conditions, as well as assessment of the natural conditions in individual months, we were able to form optimal supply into each analysed enterprise, which enable continuous heat and power production as well as efficient utilization of capital contributions.

To calculate the total annual and monthly consumptions of wood chips in particular heat and power plants, we used methods described by Karafiát (2001).

3.RESULTS AND DISCUSSION

We predict an increase of wood chips consumption in the region, because new heat and power plants are being built in the region and multiple existing plants are being reconstructed to enable the use wood chips as a main fuel. Based on the installed output of these plants, we predict the wood chips consumption in 2016 will be more than 600 000 tonnes in the region.

In connection with biomass use the following plants were or will be built/reconstructed in the region:

1. Heating plant Radvaň, Banská Bystrica: district heating plant, nominal output 10 MW_{th}, wood chips consumption 30 000 t/year,

2. Biomass power plant joint with sewage processing plant, Banská Bystrica: 6 MW_e/18 MW_{th} wood chips consumption 60 000 t/year,
3. District heat and power plant, Žiar n/Hronom: intensification of wood chips consumption, 12 MW_e/80 MW_{th}, wood chips consumption 200 000 t/year,
4. Power plant, Žarnovica: 9,8 MW_e/30MW_{th}, wood chips consumption 120 000 t/year,
5. District heat and power plant, Zvolen: intensification of wood chips consumption, 24,5 MW_e/65 MW_{th}, wood chips consumption 200 000 t/year,
6. Biomass power plant, Banská Bystrica: 6 MW_e /18 MW_{th}, wood chips consumption 60 000 t/year,
7. Heating plant Sásová, Banská Bystrica: 18 MW_{th}, wood chips consumption 40 000 t/year

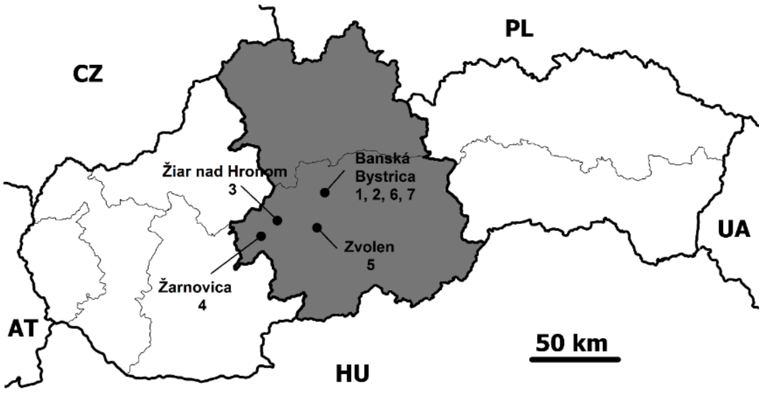

Figure 2 Graphical depiction of the localities of particular energy plants

The demand for wood chips before construction of heating plants, power plants or combined heat and power production plants (CHP) is shown in Table 7. The largest consumer of wood chips in the region was Zvolen's heat and power plant. Wood chips were used as a secondary fuel in this plant, the main fuel being brown energy coal. Figure 3 shows the differences of particular types of plants. In separate power production, the fuel consumption does not change during the year, as the plant produces the same amount of power throughout the year. In combined heat and power production the trend is not linear and depends on the demand for heat and hot water from the district heating system. Fuel utilization is higher in combined heat and power production. A specific case was Zvolen's CHP, as it produced heat and power in combined cycle and instead of decreasing the overall fuel usage, it decreased the use of brown coal, thus increasing the share of wood chips on fuel usage.

Table 7 The montlhy consumption of wood chips in the plants for the year 2012 (in metric tonnes)

Plant	Total	1	2	3	4	5	6	7
January	23 600	3 600	5 000	0	0	10 000	5 000	0
February	22 800	2 800	5 000	0	0	10 000	5 000	0
March	22 800	1 800	5 000	0	0	10 000	6 000	0
April	22 200	1 200	5 000	0	0	10 000	6 000	0
May	22 000	1 000	5 000	0	0	10 000	6 000	0
June	20 400	400	5 000	0	0	10 000	5 000	0
July	7 900	400	5 000	0	0	0	2 500	0
August	7 900	400	5 000	0	0	0	2 500	0
September	22 000	1 000	5 000	0	0	10 000	6 000	0
October	23 000	2 000	5 000	0	0	10 000	6 000	0
November	22 400	2 400	5 000	0	0	10 000	5 000	0
December	23 000	3 000	5 000	0	0	10 000	5 000	0
Annual	240 000	20 000	60 000	0	0	100 000	60 000	0

Figure 3 and Table 7 show the development of wood chips consumption throughout the year 2012. In Zvolen's CHP wood chips had less than 40% share of its fuel and in the Biomass power plant joint with sewage plant in Banská Bystrica further processed the wood chips through fermentation. In these cases the power subsidised by the state does not have to be produced in high efficiency combined heat and power production regime, but only in combined heat and power production regime and the plants are entitled to full state subsidy, which was in form of increased purchase price of power.

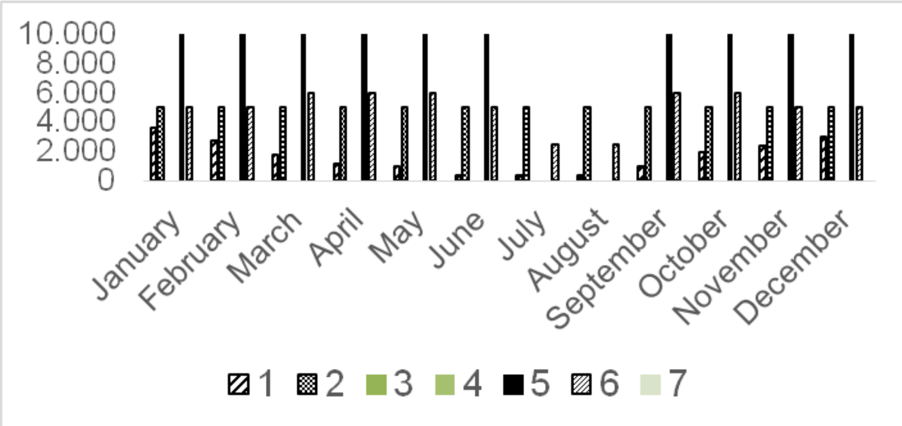

Figure 3 Model of wood chips consumption in the region in the year 2012

In 2013 there was a significant increase of total wood chips consumption in the region, because the CHP in Žiar nad Hronom was successfully reconstructed and put into operation. The CHP supplies households with heat and hot water and also supplies local companies with technological steam or hot water. This enables a more balanced production in the summer, when the demand for heat and hot water from the households is smaller. During 2013 the power plant in Žarnovica was also put into operation. This power plant generates power throughout the whole year. These two plants, and their models of heat and/or power generation, partially eliminate the seasonal effects of demand for wood chips and have overall positive effect on the economic performance of wood chips producers.

Table 8 Monthly consumption of wood chips in the plants for year 2013 (in metric tonnes)

Plant	Total	1	2	3	4	5	6	7
January	52 600	3 600	5 000	24 000	5 000	10 000	5 000	0
February	49 800	2 800	5 000	22 000	5 000	10 000	5 000	0
March	49 800	1 800	5 000	22 000	5 000	10 000	6 000	0
April	47 200	1 200	5 000	20 000	5 000	10 000	6 000	0
May	43 000	1 000	5 000	16 000	5 000	10 000	6 000	0
June	39 400	400	5 000	14 000	5 000	10 000	5 000	0
July	26 900	400	5 000	14 000	5 000	0	2 500	0
August	12 900	400	5 000	0	5 000	0	2 500	0
September	37 000	1 000	5 000	10 000	5 000	10 000	6 000	0
October	42 000	2 000	5 000	14 000	5 000	10 000	6 000	0
November	47 400	2 400	5 000	20 000	5 000	10 000	5 000	0
December	52 000	3 000	5 000	24 000	5 000	10 000	5 000	0
Annual	500 000	20 000	60 000	200 000	60 000	100 000	60 000	0

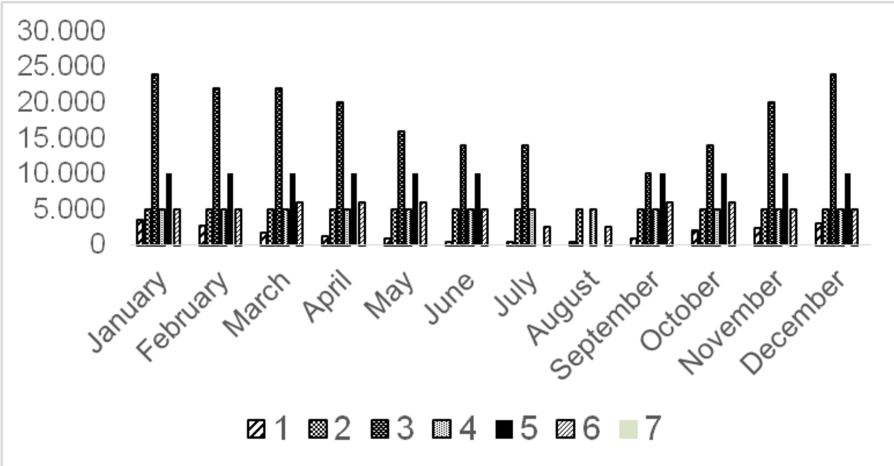

Figure 4 Model of wood chips consumption in the region for year 2013

In 2016 all of the observed plants will be put into operation, with the exception of the heating plant in Sásová, Banská Bystrica. The predicted total wood chips consumption will be 600 000 t/year in the region. Zvolen's CHP will change its fuel base to 100% wood chips consumption in stead of using brown coal, wood chips, and natural gas. The total heat output of the plant will reach 65 MW_{th}. By this it will double its wood chips consumption to about 200 000 t/year. The monthly consumption will be similar to the model used by CHP in Žiar nad Hronom.The largest wood chips consumption will be reached in winter, due to the demand for heat and hot water from households. Technological offtakes will ensure demand for heat and hot water in the summer season.

Table 9 Monthly wood chips consumption in the plants for 2016 (in metric tonnes)

Plant	Total	1	2	3	4	5	6	7
January	64 600	3 600	5 000	24 000	5 000	22 000	5 000	0
February	59 800	2 800	5 000	22 000	5 000	20 000	5 000	0
March	59 800	1 800	5 000	22 000	5 000	20 000	6 000	0
April	55 200	1 200	5 000	20 000	5 000	18 000	6 000	0
May	51 000	1 000	5 000	16 000	5 000	18 000	6 000	0
June	45 400	400	5 000	14 000	5 000	16 000	5 000	0
July	42 900	400	5 000	14 000	5 000	16 000	2 500	0
August	12 900	400	5 000	0	5 000	0	2 500	0
September	41 000	1 000	5 000	10 000	5 000	14 000	6 000	0
October	48 000	2 000	5 000	14 000	5 000	16 000	6 000	0
November	57 400	2 400	5 000	20 000	5 000	20 000	5 000	0
December	62 000	3 000	5 000	24 000	5 000	20 000	5 000	0
Annual	600 000	20 000	60 000	200 000	60 000	200 000	60 000	0

For a more visual comparison, we created Figure 6. From a relatively balanced consumption in 2012, caused mainly by the production regime in Zvolen's CHP, a nonlinear consumption can be seen in 2013, which was caused by operation regime of the Žiar nad Hronom's CHP. In 2016, we predict the 2013 model to be sustained, due to the fact that Zvolen's CHP will also change its production regime to seasonal. The fuel base in Zvolen's CHP will be changed from brown coal, wood chips, and natural gas as a stabilization fuel to wood chips and natural gas (having the same purpose as before). By this change of its fuel base, that plant will be required to generate power in high efficiency combined heat and power production to sustain the state subsidies for power production. The demand for wood chips in the summer season will be partially sustained by Biomass power plant joint with sewage processing plant in Banská Bystrica, power plant in Žarnovica, and the Biomass power plant in Banská bystrica (plant n. 6).

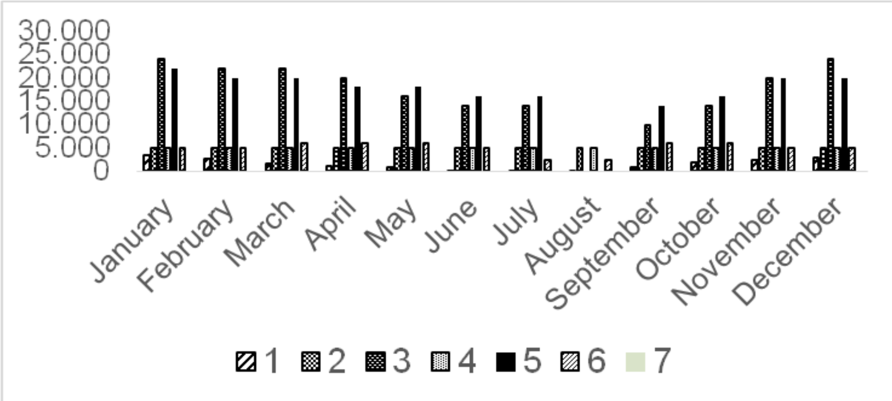

Figure 5 Model of wood chips consumption in the plants for 2016

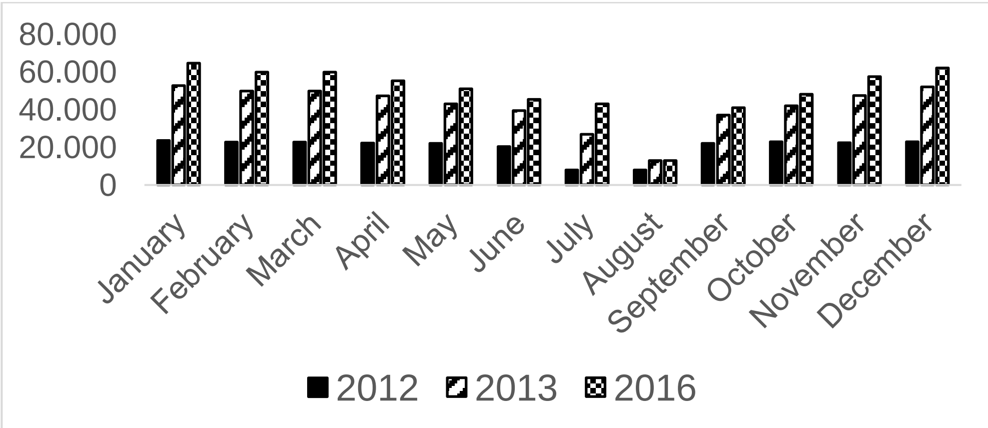

Figure 6 Model of monthly wood chips consumption in the years 2012, 2013, and 2016

4.Conclusions

Based on elaborated analyses of the demand for wood chips in the region of Central Slovakia, as well as the projects which expand heat and power production in the region, we can formulate the following conclusions:

1. The availability of woody biomass needed for production of wood chips is sufficient in the region. The usable potential of woody biomass in forests is 2,91 mn.t in Slovakia, with most of the potential laying in Central Slovakia (NLC, 2013).
2. The heat and power production plants have secured enough wood chips throughout the whole year. The problem is to optimize the supply mainly in the winter season, or to optimize the storage effectiveness and the capital locked in wood chips storage.
3. During the analysis of the wood chips suppliers, we found that the logistic processes are not efficient, mainly supply from particular forest districts. There is a need to decrease logistic costs. This problem is connected with the problem of purchase price of wood chips and terms of payment.

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REFERENCES

1. Díaz-Yáñez, O., Mola-Yudego, B., Anttila, P., Röser, D., Asikainen, A. (2013): Forest chips for energy in Europe: Current procurement methods and potentials, Renewable and Sustainable Energy Reviews, 21, 562-571, http://dx.doi.org/10.1016/j.rser.2012.12.016.
2. EUWOOD (2010): Real potential for changes in growth and use of EU forests. Final Report of EUWOOD project.
3. Hetemäki, L., Nilsson, S. (Eds.) (2005): Information technology and the forest sector: IUFRO WorldSeries, 18, 235 pp.
4. Hetsch, S. (2008): Potential sustainable wood supply in Europe. UNECE/FAO Timber Section report.
5. Karafiát, J. (2001): Teplárenství (District Heating). In: Vladimír Valenta (ed) Topenářská příručka (Handbook of Heating). 2432 pp.
6. Ministry of Agriculture and Rural Development (2008): Action plan for biomass use for years 2008 - 2013. [online] 8. June 2015 Available at
7. <http://www.mpsr.sk/sk/index.php?navID=2&navID2=2&sID=26&id=1214>
8. Ministry of Economy of the Slovak Republic (2008): Strategy for energy security of the Slovak Republic. Ministry of Economy of the Slovak Republic, 139 pp. [online] 8. June 2015 Available at
9. <http://www.siea.sk/materials/files/poradenstvo/legislativa/strategia_eb/seb.pdf>
10. National Forestry Centre (2011): Report on the state of forestry in Slovakia for the year 2010, National Forestry Centre, Zvolen. 84pp.
11. National Forestry Centre (2012): Report on the state of forestry in Slovakia for the year 2011, National Forestry Centre, Zvolen. 67pp.
12. National Forestry Centre (2013): Report on the state of forestry in Slovakia for the year 2012, National Forestry Centre, Zvolen. 83pp.
13. National Forestry Centre (2014): Report on the state of forestry in Slovakia for the year 2013, National Forestry Centre, Zvolen. 84pp.

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COMPARISON OF THE PRICE FORMATION METHODS OF RAW WOOD IN THE CZECH REPUBLIC AND THE SELECTED EU MEMBERS

Petra Hlaváčková, David Březina, Andrea Sujová

ABSTRACT

The price of wooden material is a complicated indicator in methodical terms. In each country different factors influence the price development. The price development of raw wood in the Czech Republic is extraordinary in many aspects. The price issues of individual ranges of raw wood and their development come under the market mechanism and its relation of demand and offer. The paper deals with the pricing models of raw wood in the Czech Republic and the selected EU members. The material for the analysis of pricing models was obtained from secondary research based on getting information from the publicly available scientific and specialised literature, domestic and foreign internet sources, information from statistical databases and consultations with experts from practice. Achieved results were processed by fundamental statistical methods and possibilities of changes in price formation of raw wood were formulated.
Key words: price formation, price index, raw wood, wood processing industry

1. INTRODUCTION

The article deals with price formation models of raw wood in the Czech Republic and in neighboring countries (Austria and Germany) in the reference period from 2003 to 2013. The analysis of wood markets is a difficult endeavor for several reasons. First, wood markets tend to be imperfect markets. Uncertainties exist regarding the long-term development of forest wood supply due to varying climate change scenarios and the possible occurrence of calamities. Second, the theoretically available amount of wood is limited by natural tree growth and long-term ecological concerns, leading to the prescription of the *annual allowable cut* (*AAC*). This measure can be relatively easily estimated, yet the actually available amount of wood on a market depends strongly on other factors. For example, technological advances, especially in the harvesting industry, have increased productivity in recent decades, leading to long-term changes in production costs. Political agendas and legal restrictions also can enforce increased or decreased wood production, beyond what is economically justifiable. Societal values might demand accessibility to forests for functions other than wood production. (Kostadinov et al. 2014). Other word authors deal with raw wood market issues for example Ranta et al. (2007) in Finland, Olsson, Hillring (2013) in Sweden, Olsson, Hillring (2014) in Denmark, Knauf (2015) in Germany.

The healthy development of the market for timber requires diversification of customers, thorough knowledge of the market, and development of good business relationships. The entities that create market supply include forest owners, forest management, forest companies, and purchasers of timber. The fast-growing European and global interconnection in the markets for raw wood requires a thorough orientation of sellers on needs and requirements of demanders in provisional markets.

Demand for raw timber is related to the internal competitiveness of the timber plants and also to the ability of sawmills to adapt to changes in demand in home and foreign markets for lumber. The downstream industry of the sawmill industry is the industry of wood materials, such as manufacturers of chipboards and fibreboards, after which follows the furniture industry, which determines fashion trends in furniture and thus also it largely creates the demand for deciduous woods. Last but not least, the demand for raw timber is created by the pulp-and-paper industry enterprises.

The companies influencing supply and demand also include energy companies which burn various fuels, wood chips, and also waste products. The impact of energy companies and their demand on forestry is constantly increasing. A major industry which affecting the demand is the construction industry. (Hlaváčková 2014 et. al)

The market prices realised by forestry for its production of timber are one of the most important factors in this industry. They fundamentally affect the level of funding achieved by individual forest estates and by the industry as a whole. Basically, they influence forestry´s position in the Economy. The level of timber prices determine the ability to maintain and develop production and non-production effects of forests and their extended reproduction in both private and public interest. (Bluďovský 2005).0

Timber prises are affected by many microeconomic and macroeconomics factors. Currently, in the Czech Republic the market timber prices are deformed primarily for reason that the market structure is oncoming to the oligopoly. (Hlaváčková, Březina, Sujová 2014).

Evaluations of changes in price levels are commonly performed by using price indices that compare the relative price change between the current and base period. In terms of statistics, there are several possible ways of calculating price indices. The most common procedures include usage of such conventional indices as Laspeyres price index (uses weight of the base period), Paasche price index (uses weight of the current period), and Fisher price index (geometric mean of the two previous indices). (Tošovská et al. 2010).

In Austria, forests cover 39,581 km^2, i.e. 47.2% of the county´s territory. This density of forest ranks Austria among the most forested countries in the EU (Vančura 2009a; edited).

Matějíček, Lišková (2011) say that according to official figures there are 170,548 forest owners in Austria. Less than one percent of owners own half of Austrian forests (on average more than 1,000 hectares per owner). On the other hand, 99% of forest owners own less than 200 hectares and approximately 38% of forest owners own even less than 3 hectares.

The Federal Republic of Germany has an area of 357,023 km^2 of which the forest area accounts for approximately one third (31%, i. e. 11,075,799 hectares). Most of the forests are owned by private owners (43%), the State controls 34% of forest land and municipalities (and other subjects) the remaining 23% of forest land. (Vančura 2009b; edited)

In the Czech Republic, forests cover 33.3% of the territory, i.e. 2,599,142 hectares. State controls 60% of forest land, municipalities 17%, private individuals 22%, and the church and forestry cooperatives 1%. (MZe 2014; edited)

2. MATERIAL AND METHODS

The material for the analysis of pricing models was obtained from secondary research based on getting information from the publicly available scientific and specialised literature, domestic and foreign internet sources, information from statistical databases and consultations with experts from practice.

The dependence of spruce raw wood prices in the Czech Republic on individual factors (salvage cutting, the cost of logging, the price index) was subject to research. It was used the application of basic statistical methods that are listed below.

Formula for calculation of the correlation coefficient is:

$$R = \sqrt{1 - \frac{\sum(y - \hat{y})^2}{\sum(y - \bar{y})^2}} \quad (1)$$

Wherein:

y = the measured value of the indicator

$\hat{y}$ = the model value of the indicator

$\bar{y}$ = average of indicator values

The test of the correlation coefficient significance (t_R) was performed by the formula:

$$t_R = \frac{R.\sqrt{n-2}}{\sqrt{1-R^2}} \quad (2)$$

Wherein:
R = the correlation coefficient
n = the number of measurements

The null hypothesis (H0) for this test argues that the correlation between variables is not provable in the base data file. The formula of test criterion of significance of the pair wise correlation coefficient has a Student distribution with (n – 2) degrees of freedom. If | t_R |> t_{α}, n – 2 (critical value), then we reject H0 (Drápela 2002). Test results were determined at the significance level α = 0.05, i.e. the reliability of tests is 95%.

The actual calculation and graphical representation of results was performed in Microsoft Office Excel 2013.

3. RESULTS AND DISCUSSION

In the Czech Republic, raw wood pricing models for forests owned by the state (59.9% of state-owned forests is a property of Lesy ČR) are different from the models used for state forests in Austria and Germany.

Austrian Federal Forests, a. s. sell almost 90% of its raw wood at roadside ("OM" model). Forestry procurements are usually announced for 2 – 3 months, or longer (up to a maximum period of one year). (Reichl 2010; In Lesnická práce 2007)

Trade with timber cut in Bavarian state forests (non-profit company) is the basic competence of the company itself. Bavarian State Forests sell most of the timber at roadside ("OM" model). During the last years, the company has been shifting to the end-customer-sales model (timber mill). Procurements take place at the level of the district of the relevant forest plants, always for one partial forestry activity (e.g. procurement for logging, skidding, or hauling). (Reichl 2010; In Lesnická práce 2007)

Within their economic activity, Lesy České republiky, s. p. (LČR, in English "Forests of the Czech Republic") use a complex procurement system, or "Contracts on forestry activities and sale of wood." These contracts are of a long-term nature (4 years). LČR sells a tree to a forestry company, the company fells the tree, skids it to roadside, ensures its bucking and the subsequent sale. Furthermore, on the basis of projects of LČR the forestry company ensures afforestation and the subsequent silvicultural treatment.

The comprehensive agreement stipulates that prices will be adjusted depending on changes in the total wood price index for the group of deciduous and in the total wood price index for the group of conifers.

In the Czech Republic, price indices and mean prices of raw wood are quarterly published by The Czech Statistical Office. There are several factors that have influenced and influence the price of raw timber in the forestry-wood sector. These factors are not only economical, but also of a meteorological nature. In this part we will focus on two of these factors – salvage cutting and the cost of logging.

The development of salvage cutting caused by biotic and abiotic factors follows the growth or decline in prices.

The most important factor influencing the amount of salvage cutting in the Czech Republic during the last years was wind. For this reason, the authors conducted dependence testing of coniferous raw timber (spruce) prices on the amount of salvage cutting due to an abiotic factor – wind (see. tab. 1).

Tab. 0. The test of the correlation coefficient significance – the dependence of the average annual price of softwood roundwood on the amount of the salvage felling due to the abiotic factor (wind) in years 2003 – 2013

Class quality	The correlation coefficient	The test criterion	The critical value
I. class quality	0,5976	1,8256	2,2010
II. class quality	0,5791	1,7399	
III. class quality	-0,0088	-0,0216	
III. class quality	-0,0373	-0,0913	
III. class quality	-0,0995	-0,2449	
V. class quality	-0,1348	-0,3332	

Source: own processing

The significance tests did not prove any statistically significant correlation in none of the six classes of spruce logs. The quality classes I and II show a moderate, statistically insignificant dependence, but this finding may be affected by a small amount of realised class I and II assortments. The probability of dependence of spruce-log prices and the amount of salvage cutting in other quality classes in future years cannot be predicted.

The authors will also explain the relation between the average annual prices of coniferous raw wood – spruce and costs of logging divided to the cost of logging and skidding. (see tab. 2, 3).

Tab. 2 The correlation coefficient of logging costs of the raw wood

Class quality	The correlation coefficient
I. class quality	0,0571
II. class quality	-0,2349
III. class quality	-0,0516
III. C class quality	-0,2067
III. D class quality	-0,2210
V. class quality	0,1898

Source: own processing

Tab. 3 The correlation coefficient of skidding costs of the raw wood

Class quality	The correlation coefficient
I. class quality	0,0360
II. class quality	-0,1778
III. A/B class quality	0,3062
III. C class quality	0,2216
III. D class quality	0,2110
V. class quality	0,4263

Source: own processing

As it is shown in Table 2 and 3, the dependence between spruce-log prices and the cost of logging and skidding was not proved. A very weak dependence was identified only between prices of Class III and Class V spruce logs and the cost of skidding. Yet the dependence was absolutely statistically insignificant. Therefore, it can be stated that the average price of spruce logs does not depend on the development of logging and skidding costs.

The analysis of the prices of raw wood and the price index used by the Czech Statistical Office for the most traded raw material in the Czech Republic (spruce roundwood Class A/B) was based on publicly available data with characteristics of aggregated indicators. The course of time series of Class A/B spruce-log prices and the price index was fitted of with the trend with the highest coefficient of determination R^2. The trend values were used for calculation of the correlation coefficient in order to determine the dependence of spruce logs´ prices on the price index. The calculated correlation coefficient was subjected to the test of significance of the correlation coefficient. The critical value was exceeded, which confirmed a statistically significant dependence of Class III A/B spruce-log prices on the price index. This simple statistical test proved the correlation dependence of price indexation in one of the three main important business assortments of spruce in the Czech Republic.

A deeper analysis and confirmation of the hypothesis of a strong mutual influence of the indexation system over market prices would require determination of time series for both variables, e.g. employment of the Box-Jenkins methodology.

4. CONCLUSION

The paper dealt with development of prices and pricing models of raw wood in the Czech Republic and in neighbouring countries (Austria and Germany).

State forests in Austria and Germany sell their raw wood at roadside ("OM" model). Sales of raw wood by the largest owner of state forests in the Czech Republic, Lesy ČR, s. p., are performed via comprehensive forestry orders on contractual territorial units (CTUs) – "at trunk model" which uses price indexation of raw wood and which is specific for the Czech Republic. Employment of statistical index for adjustments of prices in contractual relations of Lesy ČR, s. p. has faced much criticism. However, the idea of updating wood prices via indexation is not completely wrong and the system as such can be functional if designed neutrally both for the seller and the buyer.

The results led to the following recommendations and scenario solutions for indexation of raw wood prices in the Czech Republic (regarding trade relations between Lesy ČR, s. p., as the seller, and subjects that buy wood):

- retention of the current system of index-based pricing and continue with its further improvements,
- creation of a price index which would include prices for goods and services characteristic for forestry,
- change in the margin range of Lesy České republiky, s. p.,
- utilisation of mean prices obtained through the commodity exchange of raw wood,
- employment of the Czech National Bank´s method of inflation targeting (adapted to the forestry-wood sector).

Currently, forestry and wood processing industry are facing to many difficulties and challenges. They are directly affected by climate change, competition for wood resources, changes in consumer demand, increasing competition, and increasing complexity of production processes.

European forests will mainly have to adapt to the changing climatic conditions the impacts of which will vary according to different geographical areas and forest types.

In conclusion we can say that the Czech Republic has sufficient resources of raw wood and it is a country with raw material base of very high quality for the timber industry.

REFERENCES

1. Bluďovský, Z. 2005. Souvislosti vývoje cen surového dříví. Lesnický průvodce 1/2005. Jíloviště-Strnady: Výzkumný ústav lesního hospodářství a myslivosti. 44 s.
2. Drápela, K. 2002 Statistické metody II. Mendelova zemědělská a lesnická univerzita v Brně, Ediční středisko MZLU v Brně, 160 s.
3. Hlaváčková, P., Březina, D., Sujová, A. 2014. Modely tvorby cen dříví v obchodních vztazích. Mendelova univerzita v Brně. s. 38.

4. Hlaváčková, P., Březina, D., Sujová, A. Šafařík, D. 2014. Analýza toků surového dříví pocházejícího z lesů v ČR. Mendelova univerzita v Brně. s. 43.
5. Knauf, M. 2015. An Analysis of Wood Market Balance Modelling in Germany. Forest Policy and Economics, 50: 319 – 326.
6. Kostadinov, F., Holm, S., Steubing, B., Thees, O., Lemm, R. 2014. Simulation of a Swiss wood fuel and rundwood market: An expolorative study in agent-based modeling. Forest Policy and Economics, 38: 105 – 118.
7. Matějíček, J., Lišková, B. 2011. Rakouským lesům vládnou „měšťáci“. Lesaktualně.cz [online] [cit. 28. 11. 2014]. In Zprávy lesnického výzkumu sv. 56, č. 1. Available at: <http://www.lesaktualne.cz/vyzkum/ekonomicko-pravni-a-socialni-aspekty-soucasne-situace-malych-lesnich-podniku-v-rakousku-a-predpokladane-vyvojove-trendy-pri-jejichsdruzovani>.
8. MZe. 2014. [online]. Zprávy o stavu lesa a lesního hospodářství. Praha: Ministerstvo zemědělství České republiky. Available at: <http://www.eagri.cz>.
9. Olsson, O., Hillring, B. 2013. Price relationships and market integration in the Swedish wood fuel market. Biomass and Bioenergy, 57: 78 – 85.
10. Olsson, O., Hillring, B. 2014. The wood fuel market in Denmark – Price development, market efficiency and internationalization. Energy, 78: 141 – 148.
11. Ranta, T., Lahtine, P., Elo, J., Laitila, J. 2007. The effect of CO2 emission trade on the wood fuel market in Finland. Biomass and Bioenergy, 31: 535 – 542.
12. Reichl, M. 2010. Obchod s dřívím v podmínkách lesní správy LČR. In Lesnická práce sv. 86, č. 12. Diplomová práce. Mendelova univerzita v Brně. s. 9 – 11.
13. Tošovská, E., Sidorov, E., Ritschelová, I., Farský, M. 2010. Makroekonomické souvislosti ochrany životního prostředí. 1. vyd. Praha: Nakladatelství C. H. Beck. 201 s.
14. Vančura, K. 2009a. Lesní hospodářství Rakouska. Silvarium.cz [online] [cit. 25. 11. 2014]. In Lesnická práce. sv. 88, č. 3. Available at: <http://www.silvarium.cz/lesnicka-prace-c-3-09/lesni-hospodarstvi-rakouska>.
15. Vančura, K. 2009b. Lesní hospodářství Německa. Silvarium.cz [online] [cit. 25. 11. 2014]. In Lesnická práce. sv. 88, č. 3. Available at: <http://www.silvarium.cz/lesnicka-prace-c-3-09/lesni-hospodarstvi-nemecka>.

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MODEL FOR ESTIMATING VALUE ADDED OF BEECHWOOD PRODUCTS

Jože Kropivšek, Matej Jošt, Anton Zupančič

ABSTRACT

According to the principles of sound management of scarce resources, which include wood and energy, the provision of high value added is crucial to achieve the economic efficiency of operations. In this study, we wanted to locate the position of value added indicator in financial analysis. The main focus of the research was on development of the (expanded) model to calculate value added of beechwood products and identification of practical problems in the estimation and acquisition of data. If we want to do a more detailed interpretation and application of the value added indicator of individual products, we need some other financial indicators as well. The biggest problem at estimating and collecting data to calculate a value added of product is at determination of the price of both inputs and outputs, which is closely linked with the problem of incomparability of quality determination standards used within entire chain, from the standing tree in the forest to the sawn wood and wood products.
Key words: value added, financial analysis, beechwood product, wood-industry

1. INTRODUCTION

Slovenia is by its forest coverage at the third place in Europe. The fact that the percentage of forest cover in Slovenia is increasing and that a lot of wood is exported completely unprocessed (in the form of logs), dictate that we begin to think about the possibilities of producing more wood products with higher value added. At beechwood, whose share in the forests increased in recent years and is even 40% of the wood raw material, this problem is even more delicate. First of all, we can see that the wood of beech (*Fagus sylvatica* L.) can be widely used. The literature states that beechwood can be used for at least 250 different products (Čufar et al., 2012), but all uses are not comparable in terms of operational efficiency. From an economic point of view, just some uses provide products with higher (or high) value added. Manufacturing products with greater value added is important strategic goal of every industry, such as wood industry with their wood products. According to the principles of sound management of scarce resources, which include wood and energy, the provision of high value added is crucial to achieve the economic efficiency of operations.

Value added is defined as the difference in economic value between the physical inputs and outputs of a production process, and is generally analysed at the firm or national economy level (Sathre and Gustavsson, 2009). When calculating value added, the cost of materials/supplies and energy must be subtracted from the value of production output. Specifically, value added production is defined as follows (Lantz, 2005) (Eq. 1):

$$\text{Value Added} = [\text{Value of Output}] - [\text{Costs of Materials Supplies}] - [\text{Costs of Purchased Energy}] \qquad (1)$$

Value added is an important indicator within financial analysis, which goal is to assess the performance of a company in the context of its stated goals and strategy (Palepu et al., 2004). Financial analysis is a set of tools and techniques that allow you to measure the current fiscal condition of a government or business and predict trends in its future fiscal condition (Friedlob and Schleifer, 2003). According to Helfert (2001), financial analysis is the process of determining and weighing the financial impact of business decisions.

In this study, we wanted to locate the position of the value added indicator in financial analysis. The main focus of the research was on development of the (expanded) model for calculate value added of beechwood products and identification of practical problems in the estimation and acquisition of data. We assume that the value added of products indicator gives sufficient information for making the right decision on the product priority for production only in conjunction with some other indicators.

2. METHODS

Development of a model for value added calculation of products based on the definition that the value added is the difference in economic value between the physical inputs and outputs of a production process (Sathre and Gustavsson, 2009; Ringe and Hoover, 1987). Value added is a measure of the contribution of production factors, economies of scale, and technological change that completely accounts for total product (Ringe and Hoover, 1987).

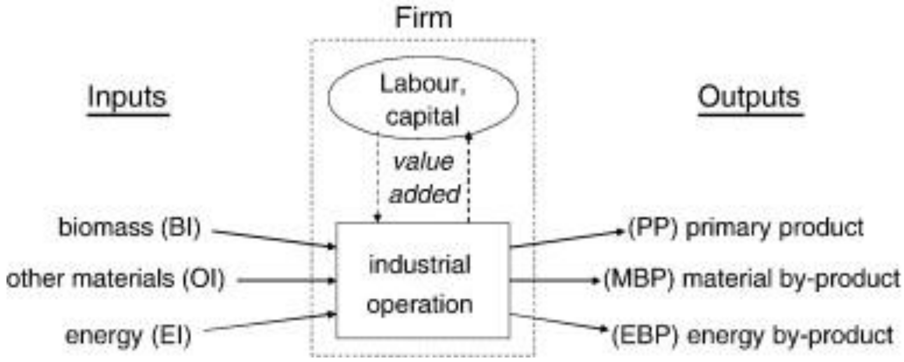

Figure 1. Conceptual diagram of the process of adding exchange value within a forest products industry firm (Sathre and Gustavsson, 2009).

Given a forest-based industry process with a range of inputs and outputs such as that illustrated in Fig. 1, value added can be determined based on the identification and economic valuation of material and energy flows (Sathre and Gustavsson, 2009).. They suggest the following general definition to determine the total value added by a forest industry process (Eq. 2):

$$VAT = (V_{PP} + V_{MBP} + V_{EBP}) - (VC_{BI} + VC_{OI} + VC_{EI}) \qquad (2)$$

where

- VAT is the total value added by the operation;
- V_{PP} is the value of the primary product produced by the operation;
- V_{MBP} is the value of the material by-products produced by the operation;
- V_{EBP} is the value of the energy by-products (fuels and electricity) produced by the operation;
- VC_{BI} is the value of the biomass inputs (roundwood, residues) to the operation;
- VC_{OI} is the value of the other material inputs (non-biomass, non-energy) to the operation;
- VC_{EI} is the value of the energy supply inputs (fuels and electricity) to the operation.

After defining the model for value added assessing, we created the MS Excel application for the evaluation of products' value added and determine the mode of data acquisition.

3. RESULTS

3.1. Development of (expanded) model for calculate value added of beechwood products

The model for calculating value added of product based on the definition of the authors Sathre and Gustavsson (2009) is in Eq. 3.

$$VAT_p = \left(\sum V_{pb}\right) - \left(\sum vc_w + \sum vc_o\right) \quad (3)$$

where

- VAT_p is the total value added of product (€/item)
- V_{pb} is the value of primary product and by-product(s) (€/item)
- vc_w is the variable cost of wood material in product (€/item)
- vc_o is the variable cost of other material and/or energy in product (€/item)

The value added of each product, in its absolute value, is a limited information. It does not allow comparability between products, particularly due to the different proportions of wood in the structure of the materials used in the product, as well as various technological and other production requirements of each product. Therefore, we calculate the value added for quantity (m^3) of used wood in product, as we get the actual value, which is added to the value of timber in the product (Eq. 4). So we get the results on which we can carry out a comparison between the products - i.e., which product has the most value added per m^3 of used wood.

$$VAT_{pw} = \frac{VAT_p}{\sum Q_w} \quad (4)$$

where

- VAT_{pw} is the total value added on quantity of used wood in product (EUR/m^3)
- Q_w is the quantity of used wood for one product (m^3/item)

Furthermore, we calculate the value added related to wood or biomass (Eq. 5), whereby the calculated value added of product is divided on the used materials according to the value proportions in the product. This way we try to eliminate the influence of the value other built-in materials to value added of product and so calculate value added only for wood.

$$VAT_w = VAT_{pw} \times \frac{\sum vc_w}{\sum vc_w + \sum vc_{om}} \quad (5)$$

where

- VAT_w is the total value added on share of value of used wood in product (EUR/m^3)
- vc_{om} is the variable cost of other material in product (€/item)

Even more important information we obtained from the calculation of the share of value added in selling price of the product (Eq. 6). This way the products can be ranked according to profitability, as we have the information about the share of selling price to cover labour costs, indirect costs and profit.

$$\%VAT_p = \frac{VAT_p}{sp_p} \quad (6)$$

where

- $\%VAT_p$ is the percentage of value added in the selling price

We prepared a template for data collection (Figure 2). Input table contains information on the quantities and prices of built-in materials (separately for wood, other materials and energy) per unit of the primary product. Output table contains data on the quantities and sell prices of the primary product and by-products. To calculate the value added it is particularly important to get data on the quality of used wood and also the maximum capacity of production of the primary product per year. The data for capital, work and other overhead costs per unit of product are also interesting, but are not necessary for the calculation of value added.

Product:

INPUT								
WOOD and other BIOMAS					OTHER materials and/or ENERGY			
Input material	units	Q_w	p_w	vc_w	units	Q_o	p_o	vc_o
				0,00 €				0,00 €
				0,00 €				0,00 €
				0,00 €				0,00 €
Total				**0,00 €**				**0,00 €**

OUTPUT					
PRODUCT and BY-PRODUCTS					
Output product	Category of product	units	Q_{pb}	sp_{pb}	V_{pb}
	primary product		1		0,00 €
	by-product				0,00 €
					0,00 €
Total					**0,00 €**

Legend: Q_w = quantity of used wood, p_w = price of used wood, vc_w = variable cost of used wood material,
Q_o = quantity of used other materials or energy, p_o = price of used other materials or energy, vc_o = variable cost of used other materials or energy, Q_{pb} = quantity of product and by-product, sp_{pb} = sell price of product and by-product, V_{pb} = value of primary product and by-product.

Figure 2. Template for data collection

3.2. Practical problems in obtaining and evaluating data and possible solutions

If we want to do a more detailed interpretation and application of the value added indicator of individual products, we need some other financial indicators as well. In obtaining data we have a problem:

- overhead (indirect) cost allocation, where different methodologies are used within companies; among indirect costs extremely low depreciation cost are calculated due to obsolete equipment, which could allow the company, even with a relatively low value added of product, to achieve high profit,
- evaluation of by-products and residues for (own) heating,
- obtain information about the quantities (potential and actual) produced, as we often have unique products that do not differ much from other products and can be potentially combine into groups.

The biggest problem at estimating and collecting data to calculate a value added of product is at determination of the price of both inputs and outputs, which is closely linked with the problem of incomparability of quality determination standards used within entire chain, from the standing tree in the forest to the sawn wood and wood products. The fact is that from the certain quality of raw material we can economically produce only certain products. Ringe and Hoover (1987) suggest the concept of marginal log, which says that producing the product from logs of higher grade than marginal log would not be feasible. Well, here arises the problem of determining those limits of quality / price for inputs of certain products, but at this stage we have not dealed with that problem.

In practice we often encounter a situation that value added of certain products increases only on the basis of the reduction in prices of input raw materials, i.e. the use of cheaper raw materials to produce the same output without any change and the production and/or productivity. In such cases value added is not a measure of the pure contribution of primary inputs, it is an indicator of economic welfare instead.

At the company level, it is extremely important that the value added of product is supplemented with the indicator of value added per employee, where gross value added (GVA) per employee is the ratio of (gross) value added and number of employees (Rebernik, 2008; Hornby et al., 1997). The value added of product is exclusively oriented to economical consumption of scarce natural resources, while the value added per employee is related to the organization, human motivation, management and also to technological equipment. This way the company management gets additional information about the employment potential and other measures in the field of human resource management. Return on sales (ROS) is also very interesting indicator, as it is a widely used ratio (net income/sames) to evaluate a company's operational efficiency. ROS is also known as a firm's "operating profit margin" (Slapničar, 2004; Peršak, 2011; Hornby et al., 1997). With this indicator we can obtain additional information on the profits from the sale of different products with various value added, which further can be a good basis on a number of business decisions.

4. DISCUSION IN CONCLUSION

The main focus of the research was on development of the (expanded) model to calculate value added of beechwood products. In this context, we were looking for the possibility of calculating the indicators which would allow a comparative analysis between the different products according to value added. Value added by itself is the absolute value which can not be compared between different products. We found that the basic indicator of value added of product only in combination with some other indicators gives sufficient information for decision on priority for production of product. The problem lies in the fact that in the various products the proportion of wood in the structure of used materials varies, as well as a variety of technological and other requirements of the production of each product exists. Thus, we suggested to calculate the value added on quantity of used wood in product, the value added on share of value of used wood in product and the percentage of value added in the selling price of product.

At testing the model, where estimation and acquisition of data were implemented, several practical problems were encountered: from the lack of comparability of certain data, due to different calculation methods within the companies, confidentiality of certain data/information, to the problem of incomparability of quality determination standards used within entire chain, from the standing tree in the forest to the sawn wood and wood products. A special problems were caused at estimating of quantities and/or production potential of individual products.

We can conclude that the value added of product is an extremely important indicator, but only together with some other indicators, can be used for important business decisions. From the beechwood in the whole chain hundreds of products can be produced, therefore decisions about what to do from the available raw materials are even more difficult and more important. Based on the presented model, these decisions could be easier.

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REFERENCES

1. Čufar, K., Gorišek, Ž., Merela, M., Pohleven, F. (2012). LASTNOSTI BUKOVEGA LESA, PREDELAVA, PROBLEMATIKA IN RABA V ARHITEKTURI. V: Bončina, A. (ur.), Bukovi gozdovi v Sloveniji : ekologija in gospodarjenje. Ljubljana, Biotehniška fakulteta: 445-458.
2. Friedlob, G.T., Schleifer, L.F. (2003): ESSENTIALS OF FINANCIAL ANALYSIS. John Wiley & Sons, Inc., Hoboken, New Jersey.
3. Helfert, E.A. (2001): FINANCIAL ANALYSIS TOOLS AND TECHNIQUES: A GUIDE FOR MANAGERS. McGraw-Hill, New York.
4. Hornby, W., Gammie, B., Wall, S. (1997): BUSINESS ECONOMICS. Addison Wesley Longman Ltd., New York, London.
5. Lantz, V. (2005): MEASURING SCALE, TECHNOLOGY AND PRICE EFFECT ON VALUE-ADDED PRODUCTION ACROSS CANADIAN FOREST INDUSTRY SECTORS. Forest Policy and Economics, 7 (3), pp. 333–344.
6. Palepu, K.G., Healy, P.M., Bernard, V.L. (2004): BUSINESS ANALYSIS & VALUATION: USING FINANCIAL STATEMENTS. Third Edition. Mason, Ohio.
7. Peršak, C. (2011): VEDNO JE PRAVI ČAS ZA ANALIZO. Podjetnik, No. 5, 26-29.
8. Rebernik, M. (2008): EKONOMIKA PODJETJA. Gospodarski vestnik, Ljubljana.
9. Ringe, J.M., Hoover, W.L. (1987): VALUE ADDED ANALYSIS: A METHOD OF TECHNOLOGICAL ASSESSMENT IN THE U.S. FOREST PRODUCTS INDUSTRY. Forest Products Journal, 37 (11–12), pp. 51–54.
10. Sathre, R., Gustavsson, L. (2009): PROCESS-BASED ANALYSIS OF ADDED VALUE IN FOREST PRODUCT INDUSTRIES. Forest Policy and Economics, 11 (1), pp. 65–75.
11. Slapničar, S. (2004): ANALIZA RAČUNOVODSKIH IZKAZOV. Ekonomska fakulteta, Ljubljana.

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TIMBER WOODEN CONSTRUCTION PROBLEMS IN POLAND

Renata Stasiak-Betlejewska, Stanisław Borkowski

ABSTRACT

Wooden houses easily associated mainly with frame houses from the United States, Canada and Scandinavia, in recent years, have been also recognized in Poland. They are built mostly with applying technologies such as: Canadian log technology and prefabrication. Today, timber construction is growing mainly due to a change in the Polish mentality, because it allows finishing the construction investment in a short time. In Poland, all the best technologies and materials in an energy efficient and durable timber construction are well known already. EU regulations force manufacturers and developers to use of energy-efficient technologies and new building materials applying. Owing to mandatory energy efficiency, there is noted increase of the interest in timber materials and construction technologies providing energy standard buildings. The paper presents view on timber construction in Poland through of its advantages and disadvantages for its users and the environment including examples of such buildings.
Key words: timber construction, log homes, prefabrication, energy efficiency

1. INTRODUCTION

Most European residential construction has historically used masonry or concrete block, except in Scandinavia where tradition of building with wood is strong. Timber frame construction has recently gained ground in several European countries, most notably the UK, Ireland and France. Scotland is the country with the highest share of wood construction outside Scandinavia, with a timber frame market share of nearly three-quarters in residential housing in 2006. A number of recent trends are supporting the expansion of timber frame structures similar to those built in North America [Whal, 2008].

Contemporary timber construction is supported by strong arguments related to innovations and improvements in the form of wooden prefabricated residential construction. It caused changes important for the construction industry as: transition from on-site construction to industrial prefabrication, transition from stick-building to modular construction, increased use of glued lumber in construction, development of environmentally friendly solutions for wood protection [Humar et al. 2004], and the shift from small to large panel system construction [Kitek Kuzman, Grošelj 2012]. This way timber construction has became competitive field for the traditional construction within the production and investment costs and organization of the investment and production.

Despite the business changes related to the production/service organization and market trends, there are other factors that affects the construction industry such as climate changes and environmental pollution increase. Approximately 40% of the energy consumed in Europe is the energy needed for heating residential houses.

Due to the pressure of the public opinions in recent years, an environment-friendly way of thinking has started to penetrate into areas where initially its opponents seemed to be the strongest, i.e. into the economy and industry [Oblak 2007]. Timber construction is perceived as the solution for the mentioned problem within CO_2 savings to account for about 25% of the reductions prescribed by the Kyoto protocol. The other advantage of wood as material for construction purposes is tackling the climate change [Medved, 2008].

Timber building is a part of the future energy efficient building. Wood is sustainable, CO_2 neutral, and highly effective insulator creating excellent living conditions [Kitek Kuzman, et al. 2010].

One of the most specific advantage of wood is its ability to reduce energy consumption. It caused that the choice of a construction material is the most important decision and it has long term consequences for the owner of the structure [Johnson, 1990].

Growing importance of wood as a construction material in Europe results mainly from promotion of energy efficiency idea related to greenhouse gas emission. It is supported by European directive on energy efficiency that requires new building to meet energy audit attributes. In order to reduce the need for heat and carbon dioxide emissions, some countries in European Union have started the educational programs supportive for the construction of energy-efficient wooden houses. Undoubtedly, the primary need is the consumers' education in the field of timber construction advantages.

Increase of wood construction use in European countries is also connected with growing European consumers' awareness of environmental issues. European citizens generally perceived wood use in construction as positive phenomenon in the environment because of wood that is considered carbon neutral. But there is still lack of awareness of other positive aspects of wood using as the construction material. Research findings from Slovenian timber construction market shows that less than half of the respondents are familiar with the advantages of wooden buildings: environmental friendly material, energy conservation, short construction time, fire resistance, more living space etc. The results of the survey show, that less than half of the respondents (47%) knew the advantages of wooden construction, therefore we could claim that general knowledge about wooden construction was poor [Kitek Kuzman, et al. 2010].

Timber as a construction material is positively associated with well-being, aesthetic and eco-friendliness, which are important factors in the choice of a certain building construction mode, however these attributes are not sufficient on their own to trigger the choice of timber as a construction material [Gold and Rubik 2009]. The advantages of using more timber materials with lower embodied global warming potential, embodied carbon, and realistic end-of-life disposal options, position timber as the building material with the lowest carbon footprint [John et al. 2010].

2. CHARACTERISTICS OF TIMBER CONSTRUCTION IN POLAND

In Poland, the wood construction has been known for centuries. Regardless of the region, there are objects characteristic for this type of construction. In the past, the popularity of wooden structures was related primarily to the forests' abundance, which provide valuable material for construction. Later this trend in Poland has been continued as the result of numerous wars caused by the slow industrialization process, the loss of independence in the eighteenth century, as well as favourable to its development of the partitioning powers policy in the nineteenth century. As a result, wooden buildings were replaced by brick until the 60's of the twentieth century, however, the trend for wooden buildings has not returned relatively quickly, with the return of emigrants who inspired construction of the Scandinavian countries, USA and Canada, returned to the ecological, beautiful and cosy wooden buildings. A growing popularity of wooden construction result from the fast pace economic change and the development of trade, new technologies and new building materials.

The biggest problem of wooden architecture in Poland there is a mental barrier that is a belief of society that structures made from that material have not a long-term durability since wooden buildings are exposed more than others to factors such as fire, weather conditions or biodegradation. Each of these, however, can be effectively overcome and the advantages associated with its use compensate each of the above-mentioned disadvantages. Undoubtedly, Polish users and designers of timber houses are aware of some its advantages. The biggest advantage of wooden houses is the fact that it is a kind of healthy building. Wood is a natural building material and it has ability of self-regulation humidity, creates a unique microclimate. Moreover, there are other advantages such: a short construction time (making prefabricated buildings takes only a few days), the possibility of building even in winter, as well

as the lightness of the structure. Functional and flexible design gives users the ease and speed of any reconstruction or modernization. Excellent thermal insulation saves on heat insulation of the building.
In conclusion, timber construction in Poland is becoming more and more popular, as having a unique charm, seamlessly combining with the mountain landscape, green forests and fields.

2.1. Wood construction companies in Poland

The demand for wood and wood-based panels in the domestic construction industry increases every year, but in-depth statistics would justify advisability of making investment decisions with regard to obtaining relevant raw material, its processing deliberate and thorough timber processing.
In accordance to experts' data from Research and Analysis Emmerson, the number of new residential constructions of wood for 2010 is estimated between 1.5 and 2 thousand of units. The best time for this kind of single-family housing was in years 2007 – 2008, when the number of completed homes clearly exceeded 3 thousand. Recorded over the last two years, a decline can be explained rather the general situation in the property market than reversal of the previous trend of gradual growth of interest in wooden houses.

Timber construction technology is becoming an important building technology of the house and public buildings, even though, unfortunately, some of them being the work result of more than 750 Polish companies dealing with the broad wooden construction, are provided for foreign customers. The available data suggest, that 377 companies specializes in the construction of houses in the Canadian system, 41 companies builds prefabricated houses production system, 207 companies specialize in log houses technology and 127 limited companies build holiday cottages. There are also 11 companies dealing with half-timbered structures. It is estimated that approximately 5 – 6% of the single-family housing is implemented in technologies based on wood including also multifamily buildings with timber frame, as well as sports halls and swimming pools. Based on the data of 27 companies belonging to the the Wooden House Society in Poland results that in 2013 these companies began and ended with the construction of 293 houses and 89 construction investment of buildings has been finished (its construction began in 2012 and it was completed in 2014). In addition, in 2013, there was started the construction of 109 buildings which were submitted to live at the beginning of 2014. In total, there are 491 buildings, carried out by the 27 companies belonging to Society [Stowarzyszenie Dom Drewniany, in Polish: The Wooden House Society, 2015].

According to the Information Department of the Central Statistical Office in Poland, in the first three quarters of 2013 there were completed 51 658 new residential buildings in the individual construction, primarily in the single family housing including 222 buildings built with timber construction technology applying and 3364 buildings including 1 house built in frame wooden technology [GUS, 2014].

According to the Centre for Timber Building, 750 of the mentioned companies involved in the construction using timber technology perform each year about 4000 – 5000 of buildings in different timber technologies. Approximately one company builds a minimum of six homes a year. Getting to know the actual size of timber construction in Poland would be helpful if wholesalers, sawn milling plants and State Forests. So far, it is assumed that since timber construction may be about 5.5% of total completions homes, and the average area of such a house is 146 m^2, is to realize these objects need about 131 000 m^3 of sawn timber, assuming that there is needed 0.2 m^3 per every m^2 [Centrum Budownictwa Drewnianego, in Polish: Centre for Timber Building, 2015].

2.2. Timber houses building methods known in Poland

Houses made of prefabricated wooden framework in Poland are still little known, while in the United States, Germany and Canada are very popular. They have all the advantages of wooden houses since the frameworks vary even shorter construction time. All the design elements are made in a factory. Ready walls with doors and windows come in a package for the construction site and there are assembled. It is also prefabricated roof structure. In the final foundation of the house installation takes several days. Interior finish lasts up to three months.

The other popular timber housing method is modular construction which is a method based on highly advanced fabrication. Spatial home modules are prepared at factory. Such houses are the easiest to install: folding almost completely finished parts look-like containers (with the floor, walls and roof). The modules include: windows, doors, finished floors and installed sanitation. It shall be set on a foundation with connected water, gas, electricity and connector seals. Installation of the house lasts one day, and his finish a week or two.

The best-known method of building wooden houses in Poland is a light wood-frame technology. This method of construction is widely used in the United States and Canada. House in the technology is mounted directly on the construction site. The basis of its design is the wooden skeleton of the walls, ceiling and roof set on a traditional foundation or foundation slab. A skeleton includes: boards or planks, a layer of thermal insulation (mineral wool vapor barrier, wind isolation) and elements of electrical and sanitary installations. The vapor barrier protects the structure and thermal insulation against excessive exposure to water vapor that penetrates to the outside, that could cause moisture (it is placed inside of the building). The interior of the house is finished with sheets of plasterboard. A very important element is the quality of wood used for construction (it should be four sides planed wood, rounded at the corners and dried in the kiln).

Log house system is the oldest way of building with wood in Poland. To build so-called logs homes there are used balls with special grooves, which allowed for the sealing. Log home don't need to be warmed so log thickness at its thinnest point must be 20 cm. There are several building systems with balls. The block (coronary) logs stacked on one another, properly profiled are connected to the tongue and groove. The other system uses horizontal and vertical columns of balls, which is inserted into horizontal notches balls.

2.3. Home users' opinions on energy efficiency in the construction

In accordance with research findings of White Wallboard Material Producers Association "White Walls" obtained within the study "Energy efficiency and economy", which was aimed at evaluation of individual investors' awareness measurement in the field of energy-saving solutions, in 54% of individual investors opinion the energy savings are important factor for the choice of building materials. A higher number of indications has been reached by the price (65.7%).

Investors rely on energy efficiency mainly due to the lower operating costs of the building in the future (approximately 90% of respondents) [Millward Brown, 2014]. Investors largely show a working knowledge of energy efficiency by choosing construction materials.

Approximately 44% of respondents draws attention to the real factors associated with this aspect. As many as 82% had heard of the heat transfer coefficient, but only almost every second investor is oriented, what a U-value will have his house walls. A large group of investors do not reach for this knowledge, leaving the decision in the hands of the designer.

3. BARIERS FOR TIMBER CONSTRUCTION DEVELOPMENT IN POLAND

There are some barriers for timber construction development in Poland such as [Belle Maison, 2015]:

1. Mental barrier - a large number of Polish investors do not believe that a house with a wooden structure may be characterized by long-term durability due to the absence of such houses in Poland. Overall it is concluded that the house should be like "fortress" built on 100 or 200 years,

although for such a long time can be changed styles and architectural and technological capabilities.

2. Lack of education at schools of building about the timber construction. Only a few schools and technical colleges treat wood construction as a proven technology. At many universities it seems to be still treated as less important "building curiosity".
3. Depth deficit of the knowledge and experience of many professionals in the timber construction, which causes problems both in the design phase and during construction. For a large number of architects, contractors, or people with construction supervision, construction of wood-frame building is limited to the installation of a wooden structure, without drill down for all the issues this technology. Humidity and thermal issues or problems with the acoustics of the building are completely unknown.

Deciding to build a timber house, unfortunately investors do not have too much choice with regard to technology, which is not very widespread and requires extremely high accuracy and technical culture. Therefore, the entire building should be ordered at the company which specializes in timber housing.

4. The lack of native technical assembly criteria of realization and investment admission both for buildings constructed in lightweight frame or prefabricated houses, as well as for log houses. However, works go on the development of the necessary requirements.
5. There are no programs for timber home design. However, there are already more available projects of finished wooden houses in the construction market. Majority of construction companies implemented service offers its own design and redesign of the traditional house project at WOODEN HOUSE.

4. CONCLUSIONS

Stereotypes about building of this type of houses result mainly from the fact that Polish companies have yet very little experience in building of prefabricated houses and often incorrectly produce it (using low quality of materials in inappropriate conditions of temperature and humidity) and then badly assemble. Negative opinions about a group of companies are reflected on the entire sector this type of services. Often people confuse the notion of a prefabricated building with frame construction and hence the belief that homes should be so structurally weak as houses popular in the United States (there is opinion in Poland that home should have strong construction with solid walls). Finnish modular buildings looks completely different. Among the myths about wooden modular homes there can be also found an opinion about its flammability.

Despite identified problems, timber construction in Poland is growing very quickly, what is confirmed by growing number of contractors who do not complain about a lack of orders and the increase of the timber construction houses. In comparison with nineties, there has been a huge improvement in the house quality. Construction companies in caring for position in the market and its own reputation train their employees and keep the technological regime.

Scientific institutions and certifying recognize the increasing role of timber buildings and also contribute to a better quality enforcement through the development of standards which are in force in Poland. Such an obligation forces Poland to join the European Union. The activities of organizations promoting wood construction, media support and specialized research centers not only speeds up timber construction advance, justifying its permanent place on Polish and European market.

REFERENCES

1. Belle Maison, (2015): 5 głównych problemów polskiego budownictwa drewnianego, available at www.domek.com.pl/5-glownych-problemow-polskiego-budownictwa-drewnianego/, 2015.
2. Centrum Budownictwa Drewnianego, in Polish: Centre for Timber Building, 2015.
3. Gold, S., Rubik, F., 2009: Consumer attitudes towards timber as a construction material and towards timber frame houses-selected findings of a representative survey among the German population. Journal of Cleaner Production 17: 303-309.
4. Holmstedt, I. (2015): OBALAMY MITY NA TEMAT DREWNIANYCH DOMÓW PREFABRYKOWANYCH, Finkomfort.
5. Humar, M., Pohleven, F., Amartey, S.A., Šentjurc, M., (2004): Efficacy of CCA and Tanalith E treated pine fence to fungal decay after ten years in service. Wood Research 49(1): 13-20.
6. John, S., Perez, N., Buchanan, A.H., (2010): The carbon footprint of multi-story timber building compared with conventional materials. World conference on timber engineering (WCTE 2010), 20-24 Jun 2010, Riva del Garda, Italy, 9 pp.
7. Johnson, K., (1990): Timber bridge design, engineering and construction manual. 4th ed. Wheeler Consolidated. St. Louse Park, MN, 1000 pp.
8. Kitek Kuzman, M., Grošelj, P. (2012): WOOD AS A CONSTRUCTION MATERIAL: COMPARISON OF DIFFERENT CONSTRUCTION TYPES FOR RESIDENTIAL BUILDING USING THE ANALYTIC HIERARCHY PROCESS, WOOD RESEARCH, 57 (4): 2012, 591-600.
9. Kitek Kuzman, M., Medved, S., Vratuša, S. (2010): EVALUATION OF SLOVENIAN CONTEMPORARY TIMBER CONSTRUCTION, Drewno. Pr. Nauk. Donies. Komunik. 2010, vol. 53, nr 183
10. Medved, S. (2008): Wood based products and climate changes. In: Acker J. van (ed.); An European wood processing strategy: future resources matching products and innovations; May 30th and June 2nd-3rd 2008, Milan, Italy. Milan, Ghent University, Universita degli studi di Firenze, 127–134
11. Millward Brown, (2014): Energooszczędność i ekonomia (in Polish: Energy efficiency and economy), Wallboard Material Producers Association "White Walls", Warszawa.
12. Oblak, L. (2007): Environment – friendly economic development in enterprise. At: Marketing and trade 2007 – The influence of globalization on foreign trade policy, Zborník z medzinárodnej vedeckej konferencie, Zvolen, november, 2007, Zvolen, Technická univerzita vo Zvolene, 233–237
13. Research and Analysis Emmerson, 2008 – 2010.
14. Stowarzyszenie Dom Drewniany, in Polish: The Wooden House Society, 2015.

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ENERGY-EFFICIENT TIMBER BUILDINGS

Manja Kitek Kuzman, Martina Zbašnik-Senegačnik

ABSTRACT

The choice of materials for a building with high energy efficiency becomes much more important and strategies for reducing the use of primary energy for the production of materials and components becomes key. The positive trend towards wooden construction is dictated by international guidelines, where a wooden building is an important starting point, not only for low-energy, but also low-emission building with exceptional health and safety aspects. In Europe, the most comprehensive and widely used is a concept of ultra-low energy house, more precisely, the passive house concept.

Most Slovenian buildings combine contemporary styling with a degree of energy efficiency that comes close to passive house standards. It is widely recognised that the Slovenian construction industry is relatively advanced in the field of low energy buildings. In the light of the growing importance of energy-efficient building methods, it could be said that timber passive house would play an increasingly important role in the future.

Key words: timber construction, energy efficiency, passive house, sustainable development~~, Slovenia.~~

1. INTRODUCTION

Timber as a material for load bearing construction represents a future challenge for residential and public buildings. Being a natural raw material, timber represents one of the best choices for energy efficient construction since it also functions as a material with good thermal properties if compared to other construction materials. In addition, it plays an important role in reduction of the CO_2 emissions (Natterer, 2009), has good mechanical properties and ensures a comfortable indoor living climate. Timber construction has better thermal properties than conventional brick or concrete construction methods, even with smaller wall thickness. Considering the growing importance of energy-efficient building methods, timber construction will play an increasingly important role in the future.

The dominating methods of timber construction in Slovenia include a timber-frame construction, balloon and massive construction (Figure 1).

Figure 1. Panel construction, Wood frame construction, Solid wood construction

Currently, most Slovenian companies offer houses with timber-frame construction. Timber panel construction has had its own production in Slovenia for more than 35 years. Over the past thirty years, timber construction has undergone major changes. The most important (Žegarac Leskova and Premrov, 2013) are the following introduced changes: transition from on-site construction to prefabrication in a factory, transition from elementary measures to modular building and development from a single-panel to a macro-panel wall prefabricated panel system. All of these greatly improve the speed of building.

In timber-frame buildings the basic vertical load bearing elements are panel walls consisting of load bearing timber frames and sheathing boards. Dependant on the wall dimensions, one can distinguish between single-panel and macro-panel wall systems. The single-panel was based on the individual smaller elements in dimensions of 1.30 m (1.25 m) x 2.5 m to 2.65 m (Figure 2a). The height of the wall elements was meeting the height of the floor and the length of the ceiling elements the span of the bridged field. The macro-panel system was developed from the single-panel system in the last two decades and represents an important milestone in panel timber frame building. The aim of the system is that whole wall assemblies, including windows and doors, are totally constructed in a horizontal plane in a factory from where they are transported to the building-site. Prefabricated timber-frame walls as main vertical bearing capacity elements, of usually typical dimensions with a width of 1.250 m and a height of 2.5–2,6 m, are composed of a timber frame and sheets of board-material fixed by mechanical fasteners, usually staples, to one or both sides of the timber frame (Figure 2c).

Between the timber studs and girders a thermal insulation material is inserted the thickness of which depends on the type of external wall. Composition of wall elements is in detail presented in Table 1 (Premrov and Žegarac L., 2013).

a.) b.) c.)

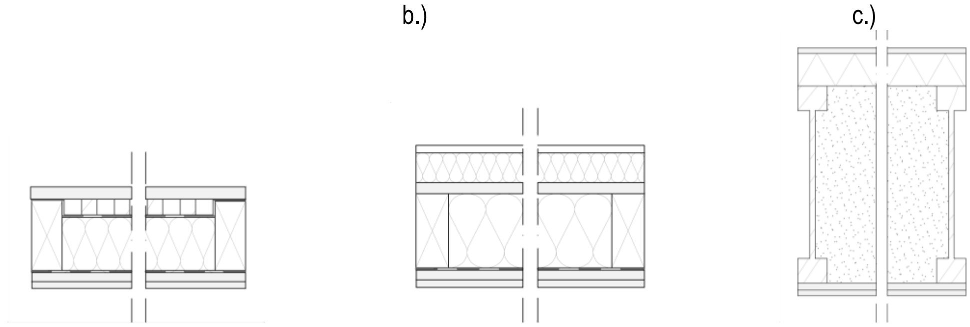

Figure 2. a.) Single-panel system (TFCL2); b.) Renovated single-panel system (TFCL 3), c.) Timber-frame wall element with I-studs (TF 3).

Table 1. Composition of analysed macro-panel (TF 3) and single-panel (TFCL 2, 3) timber-frame wall elements.

TF		**TFCL 2**		**TFCL 3 – renovation**	
material	d[mm]	material	d[mm]	material	d[mm]
rough coating	10	wooden planks	22	rough coating	10
wood fibreboard	60	/	/	mineral wool	40
/	/	TSS*** /open air gaps /	0.5	gypsum fibreboard	15
cellulose fibre / TF*	360	TSS*** /open air gaps / TF*	20	mineral wool / TF*	100
		bitumen sheet cardboard /	0.5		
		mineral wool / TF*	80		
OSB**	15	aluminium foil		aluminium foil	
gypsum plasterboard	12.5	particleboard	13	particleboard	13
		gypsum plasterboard	10	gypsum plasterboard	10
total thickness [mm]	457.5	total thickness [mm]	146	total thickness [mm]	188
U_{wall}–value [W/(m^{2}K)]	0.102	U_{wall}–value [W/(m^{2}K)]	0.48	U_{wall}–value [W/(m^{2}K)]	0.30

*timber frame, **oriented strand board, ***timber sub-structure.

Because of the reduction of energy losses in the newly built residential objects, the first measure introduced by the producers was gradual reduction of the thermal transmittance of the external wall elements, resulting in the increase of the timber-frame wall elements thickness, thus enabling thicker thermal insulation instalment. Detailed composition of the older single panel external wall elements construction, as well as newer macro-panel system, are explicitly presented in the Table 1, with additional graphic presentation in Figure 2.

Therefore, all prefabricated timber framed objects set up before the year 1992 are considered as a fund needing energy efficient renovation till the year 2020. The latter refers to the wide-ranging package on climate change adopted by European Union, the overall 20-20-20 targets, which are binding for buildings as well. Therefore, energy performance of existing buildings has to be improved through a complex process of energy efficient renovation, likewise the sustainable new construction of energy-efficient buildings with the use of renewables has to be performed.

2. ENERGY-EFFICIENT BUILDINGS

Researching energy efficiency of buildings is not a matter of the last decade only, since the first intensive studies related to energy and buildings were already carried out in the seventies and eighties of the last century. Many studies focusing on the research of specific parameters influencing energy performance of buildings, such as Johnson et.al. (1984) and Steadman and Brown (1987) have been performed since then. From the existing research findings we summarize that the process of defining the optimal model of a building is very complex. The most important parameters influencing energy-performance of buildings are: location of the building and climate data for the specific location, orientation of the building, properties of installed materials, such as timber, glass, insulation, boards etc., building design (shape factor, length-to-width ratio, window-to-wall area ratio, building's envelope properties, windows properties), selection of active technical systems. According to the Slovene legislative framework, particularly to the Energy Act, the system of energy performance certification is defined in Rules on the methodology of construction and issuance of building energy certificates (2009). On the basis of rules, the classification of energy-efficient houses was carried (Table 2).

Table 2. Classification of energy-efficient houses on the basis of "Rules on the methodology of construction and issuance of building energy certificates".

Degree / Classification in accordance with the rules	**Generally used classification in practice**	**Variation of execution**	**Q_h* (kWh/m²a)**
Class C	minimal requirements for low-energy house	classical prefabricated construction, conventional heating system, contemporary windows (doors), no central ventilation system	35 – 50 (60)
Class B2	low-energy house	thermally improved building envelope conventional heating system, contemporary windows (doors), central ventilation system	25 – 35
Class B1	very low-energy house	thermally improved building envelope + HRV** + improved U-value of windows (doors)	15 – 25
Class A2	passive house	additionallythermally improved building envelope + HRV + improved U-value of windows (doors)	10 – 15
Class A1	passive house	additionally thermally improved building envelope + HRV + improved U-value of windows (doors)	≤ 10

* specific annual heating demand, **heat recovery ventilation

Table clearly shows that energy efficient objects can be constructed only by adequate combination of external envelope efficient insulation and high quality glazing installation. Respecting climate change conditions and the subsequent European directions related to energy performance of buildings, which are forcing the building industry into constructing a nearly zero energy house by 2020, searching for the optimal model of an energy-efficient house has therefore become of major importance.

2.1 Passive house

In Europe, the most comprehensive and widely used concept of ultra-low energy, more precisely, the passive house concept was developed by Dr. Wolfgang Feist of the Passive House Institute (Feist, 1998, Galvin and Sunikka-Blank, 2012). It sets forth the maximum permissible energy consumption for the heating of the building and limits the total primary energy consumption. In its essence, it is an upgrade of the low-energy house standard. Passive houses are buildings that ensure a comfortable in-door climate during summer and winter without requiring a conventional heat distribution system (Feist, 1998). The passive house standard means that the space heating peak load should not exceed 10 W/m^2 living area in order to use supply air heating. The resulting space heating demand will approximately be 15 kWh/m^2 but will vary depending on climate (Feist, 2005). The term ‘passive house’ refers to a construction standard that can be met through a variety of technologies, designs and materials such as solid (masonry, concrete, and aerated concrete) and wood structures.

The following considerations are particularly important when choosing the material and the construction type: the construction type should be standardized; the construction system should be based on natural and environmentally-friendly materials; the thermal envelope should meet the standards of a passive house; the construction should be wind-tight, airtight and diffusion open.

In order to design and implement a high-quality passive house project, attention should be paid to the materials used. The choice depends on personal preferences, in particular on the cost. There is a growing movement especially in Germany, Austria and Switzerland to build passive houses that are based on energy conservation measures and an efficient mechanical ventilation system with heat recovery. Over the past few years, the number of different types passive houses (Figure 3) has been seen a continuous increase in Europe.

Figure 3: Different types of passive houses: a) Single family passive house; b) Multy storey timber frame passive house; c) Industrial building. Passive houses built in Slovenia: d) Commercial building built (Ekoprodukt d.o.o.); e) Kindergarten (Jelovica d.d.); f) Single-family house (Marles hiše Maribor d.o.o.)

The greatest challenge facing civil engineers, wood science and technology engineers and architects today is how mitigate and adapt to climate change. They have recently focused their efforts on finding environmentally-friendly solutions and construction methods that bolster energy efficiency and thus reduce the environmental burden. The choice of a construction material is one of the most important decision with long-term consequences for the owner of the building (Johnson, 1990). The analysis by Kitek Kuzman et al. (2013) showed that wood as a renewable raw material is one of the best choices for energy-efficient construction because it is also a good thermal insulator, has good mechanical properties, and ensures a comfortable indoor climate.

2.1.1. Certificates

In recent decades several methodologies have been developed to assess the quality of buildings: in the UK there is BREEAM (BRE Environmental Assessment Method) in France HQE (Haute Qualite Environmentale), the USA has LEED (Leadership in Energy and Environmental Design), Germany has DGNB (Deutsche Gesselschaft für Nachhaltiges Bauen) and so on. These certificates demonstrate the environmental and energy indicators of buildings, as well as the economic, socio-cultural and technical aspects of construction. For those buildings in the highest energy class, for instance passive houses, special systems of certification have been developed: in Switzerland the Minergie P and in Germany the Passive House Certificate. In some countries (Germany, Austria and Switzerland), the two certificates are the basis for allocating subsidies for passive houses. Within the profession they are highly valued – as a good promotional tool representing a market advantage.

In the Slovenian market there are already a large number of components bearing the Passive House Certificate. Components with this certificate are most commonly manufactured by large foreign firms that have representatives in Slovenia, but also by a number of Slovenian firms that is growing each year. Currently there are few houses in Slovenia built with the Passive House Certificate and with the Minergie P certificate.

3. CONCLUSION

Energy efficiency is essential in the efforts to achieve a 20% reduction of primary power consumption by 2020. It is widely recognized that the potential of energy saving in buildings is large. Considering the tendencies of energy production and price, it is becoming urgent to reduce energy consumption in buildings. Most Slovenian buildings combine contemporary styling with a degree of energy efficiency that comes close to passive house standards. It is widely recognised that the Slovenian construction industry is advanced in the field of low energy buildings. In the light of the growing importance of energy-efficient building methods, it could be said that timber passive house would play an increasingly important role in the future.

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REFERENCES

1. Feist, W. (1998): DAS PASSIVHAUS – BAUSTANDARD DER ZUKUNFT?. Protokollband Nr. 12, Passivhaus Institut, Darmstadt.

2. Feist, W. (2005): QUALITÄTSSICHERUNG BEIM BAU VON PASSIVHÄUSERN. Protokollband Nr. 18, Passivhaus Institut, Darmstadt.
3. Galvin, R., Sunikka-Blank, M. (2012): Including fuel price elasticity of demand in net present value and payback time calculations of thermal retrofits: Case study of German dwellings. Energy and Buildings. 50:219-228.
4. Johnson, K. (1990): Timber Bridge Design, Engineering and Construction Manual. Wheeler Consolidated. St. Louse Park, MN.
5. Johnson, R. et al. (1984): Glazing energy performance and design optimization with daylighting. Energy and Buildings. 6:305–317.
6. Kitek Kuzman et al. (2013): Comparison of passive house construction types using analytic hierarchy process. Energy and Buildings. 64:258–263.
7. Natterer, J. (2009): Massivholz-konstruktionen: Herausforderung für eine nachhaltige Ökobilanz. In: Kitek Kuzman (Ed.). Building with Timber, Challenge and Opportunity for Slovenia. University of Ljubljana, Biotechnical Faculty, Ljubljana, pp. 18-21.
8. Premrov, M., Žegarac L., V. (2013): Energy-Efficient Timber-Glass Houses. Springer, 178 p.
9. Rules on the methodology of construction and issuance of building energy certificates, Official Gazette RS, 77/2009.
10. Schnieders, J., Hermelink, A. (2006): CEPHEUS results: measurements and occupant's satisfaction provide evidence for Passive Houses being an option for sustainable building, Energy Policy, 34, pp. 151–171.
11. Steadman, P., Brown, F. (1987): Estimating the exposed surface area of the domestic stock. Energy and urban built form. Centre for Architectural and Urban Studies, University of Cambridge, pp. 113-131.
12. The International Passive House Association. Passive house. Darmstadt, Germany. http://www.passivehouse-international.org/.].
13. BREEAM, http://www.breeam.org/ (Accessed December 2014)
14. HQE, http://www.interfaceflor.co.uk/web/sustainability/green_building/hqe (Accessed December 2013)
15. LEED, http://www.usgbc.org/DisplayPage.aspx?CategoryID=19 (Accessed March 2015)
16. DGNB, http://www.dgnb.de/ (Accessed March 2015)
17. Minergie P, http://www.minergie.ch/ (Accessed March 2015)
18. Passivhaus Institut dr. Wolfgang Feist, www.passiv.de (Accessed March 2015)

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TECHNICAL, ECONOMIC AND SOCIAL ASPECTS OF PREFABRICATED (MODULAR) WOODEN HOUSE CONSTRUCTION

Renata Stasiak-Betlejewska, Stanisław Borkowski

ABSTRACT

The current practices in the construction industry are labour-intensive and surrounded by significant risks associated with market, site and weather conditions. In addition, the construction industry has been criticised for lower productivity relative to other US industries in the last forty years. There are needed efficient improvements with respect to time, cost and quality. As it was confirmed by producers and investors, modular construction moves the construction site to manufacturing facility for a major part of the building and, in this way, improves its predictability, increases productivity, and reduces risks inherent in construction. Modular buildings also generate great cost savings opportunities as a result of compressed construction schedules. It is energy efficient solution characterized by high quality houses resulted from environment-friendly materials processing in the well controlled factory-environment. In a paper there are enumerated technical, economic and social benefits that result from prefabricated construction connected with construction investment process realization by designers, investors, producers.
Key words: sustainable development, prefabricated house, construction investment, energy efficiency

1. INTRODUCTION

Contemporary construction, especially in accordance to energy efficiency policy, is focused on the choice of construction materials and technologies following issues of the sustainable development idea understood as continuous improvement of life quality and well-being of present and future generations. The concept of "sustainable development" refers to the process of development, which, striving to fully meet needs of the present generation, doesn't reduce the potential of future generations [Report of the World Commission, 1987].

There are three groups of aspects classified within sustainable development in the construction industry: environmental, social and economic. Environmental aspects (in particular those related to carbon dioxide emissions and primary energy demand) have been the subject of both a wide range of scientific studies as well as standardization work. Social and economic aspects have been so far, due to difficulties in establishing clearly definable and quantifiable indicators, the object of less interest to the world of science and technology [Stasiak-Betlejewska, 2015].

In the construction investment designers and builders pay particular attention to applied construction materials which have a great influence on the building quality that meet so current technical requirements as clients (investors) needs including their health safety and economical efficiency. It is also confirmed, that the quality of materials for the house walls construction affects the value of building. In view of the above, a choice of construction material and technology is defined by issues related with sustainable development in accordance to regulations and industry requirements including available solutions.

Wood is one of the most popular material currently used in residential construction where energy saving technologies and economic efficiency are related to designers/producers/builders/clients capabilities. Wood is a natural construction material (due to the origin and type of material). It is the oldest building

material, which is obtained from coniferous trees (pine, spruce, fir) and hardwood (oak, ash, beech, elm, alder, birch and hornbeam) [Stasiak-Betlejewska, 2013].
Wood carries some other benefits that make it an excellent candidate for use in a wide array of construction projects. Wood, as the construction material, is light in proportion to its tensile strength and has remarkably strong qualities for heavy-duty building materials such as structural beams. It is also characterized as the environmental friendly material that is safe for users with regard to CO_2 emission and its pests' resistance. In terms of economic aspect, wood is often considered to be the cheapest and best approach for small housing structures [Borkowski, Stasiak-Betlejewska, 2014].
In the educational system in the United States, wood as a construction material receives scant attention in the training programmes for architects and engineers. Without an understanding of the attributes and basic characteristics of wood, it cannot be used effectively [Liska, 2015].

2. CONSTRUCTIONS TYPES

Construction of houses varies significantly between Europe and North America. European houses are typically built with masonry, while North American houses are usually made of wood. A tradition of construction has developed in North America what results from the fact that this country possesses large area of forests used mainly as the primary construction material. By contrast and the law of supply and demand, European wood prices are significantly higher than they are in North America. There is also a tradition of construction in Europe which involves masonry, and which goes back several hundred (even thousands) of years [Azari, Javanifard, Markert, Strobel, Yap 2013]. Construction types in Europe differ from construction types in America within factors such as: materials type, building structure and technology applied in the construction investment. Economics motivates designers and builders to select energy-efficient solutions. Research indicates that for 54% of Polish clients/investors, energy savings is an important factor in the building materials choosing [Energy efficiency and economy, 2014].
There are various types of building construction systems that can be met in European and American countries. Differences are related to cultural expectations, lifestyle and attitudes of European and American inhabitants [Kitek Kuzman, et al. 2012].
There is no single system of building construction classification and it is believed that such a classification was relative to the user/producer and varied from one to another, usually based on the choice of construction technology. Based on this, there are determined four systems known as the main structural and enveloping materials of the building: timber, steel, cast in-situ concrete, and precast concrete systems. There was also suggested that for further classification, the geometric configuration of the components of the building's mainframe could be used as follows: linear or skeletal system (beams and columns); planar panel) system; and three-dimensional (box) [Warszawski, 1999]. Wood framed construction is widely used for residential and low-rise structures and the light wood framed construction is one of the most popular types of building methods for homes in the United States and some parts of Europe. This kind of construction allows quick construction investment realization with no heavy tools or equipment. It is able to adapt itself to any geometric shape, and can be clad with a variety of materials. There are a huge variety of products and systems tailored to this type of construction [http://www.understandconstruction.com/].

3. RESEARCH OBJECT - PREFABRICATION TECHNOLOGY

Several studies indicate that the definition of prefabrication is as widely varied as its terms of reference. It could either be classified under IBS (Industrial Building System) or modularization, or defined independently. According to Haas et al. (2000), the various definitions which exist are subjective to time, industry and the purpose of the study as there is no organization monitoring the progression of these technologies, besides the Manufactured Housing Institute for the residential sector. In addition, several terms are used interchangeably in reference to prefabrication (depend on the user's philosophy and understanding and also varies from country to country). The associated terms are defined briefly below, in order to gain an understanding of the fundamentals of prefabrication [Okodi-Iyah, 2012]:

- Modularization defined as the off-site construction of a whole system prior to its transportation to the site of construction. The modules may often be required to be broken down into smaller sizes for ease of transportation. Modularization usually involves more than one trade.
- Prefabrication that involves a single skill or trade and is generally defined as a production process, which normally takes place at a specialized factory where different materials are combined to form the component of an end-product. As long as the component is manufactured at a factory and is not a whole system, it is regarded as prefabricated.
- Preassembly as the combination of various materials and prefabricated components at a separate facility before installation as a single unit. This installation is carried out similar to the process of modularization in which the manufactured components are assembled close to the site, followed by on-site instalment. Commonly regarded as a combination of modularization and prefabrication, preassembly usually involves works from various crafts and parts of different systems.
- Industrialization that refers to an inclusion of all three aforementioned categories of offsite construction. Industrialization is based on the concept of manufacturing and is defined as the procurement of technology, equipment and facilities in order to increase productivity, reduce manual labour and improve production quality.

According to Kok (2010) definition, prefabricated home is one having walls, partitions, floors, ceiling and roof composed of sections of panels varying in size which have been fabricated in a factory prior to erection on the building foundation. According to the definitions above, the general perception is that prefabrication is a process that primarily occurs in a factory or facility (factory); in other words, anywhere but on the actual site of construction. However, prefabrication is not limited to a factory or an offsite location. The manufacture of components can be carried out at the actual site of construction or in close proximity [Okodi-Iyah, 2012].

Types of prefabrication approaches that can be used include: volumetric systems, partial modularization of components, prefabrication of elements of the construction. Modularization or modular design has been described as the key to prefabrication [Mass Housing Design Principles and Prototypes. Open Architecture and Modular Design]. Modular design refers to construction using standardised units or standardised dimensions. Modular buildings do not have to be built using prefabrication techniques, but they are usually involved. Frame construction is one route for introducing prefabricated elements into the construction process, and timber frame in particular is an approach which has continued to have a presence in the UK construction industry [Phillipson, 2001].

Prefabricated housing is defined as the manufacture of whole houses or significant housing components, offsite in a factory setting prior to installation or assembly onsite. This is a promising innovation with a clear relationship to more environmentally friendly building practices [Hampson, Brandon, 2004].

Prefabrication for the first time in the history of construction has been indicated as the needs of Arabian and Australian Aborigines for moveable/mobile dwellings. According to historical records, the first ever prefabricated building noted as wooden panellized house was indicated in 1624 in Britain and it was reassembled later on in the United States. An early example of prefabrication/modularization use can be found in Britain's Great Exhibition of 1851, featuring a building called the Crystal Palace. However, this production method became unacceptable in Western Europe as the people became more interested in variety and freedom of choice. Thus, prefabrication was slowly discarded. While Europe's closed system prevented interchange ability, the desire of builders in the United States for independence led to the evolution of the Open System. This system required considerable coordination for efficient integration of building components from different suppliers [Okodi-Iyah, 2012]. It should be noted that CEI Bois report on European's perceptions of wood noted that [Indufor, 2004]:

- Consumers and building professionals perceived wood as natural, renewable, economical to use, and acoustic material. But wood is not perceived as strong, durable, modern, and fire proof.
- Wood promotion campaigns, e.g. in UK and Austria, have demonstrated that perceptions of wood can be changed both among consumers and building professionals.
- Compared to the late 1980s and early 1990s the environmental tension around forestry and wood industry has reduced, but trade and legal issues have become more pronounced.

Germany has the largest industrial demand for wood construction products in European Union (about 15% in 2006) [CBI, 2008a]. In the United Kingdom (UK), 12% of the land area is – i.e. 3 million hectares – is covered with forests. There is potential for increased domestic supply of wood to meet an increased demand for wood construction because (in 2005) annual felling of wood is about 10 million m3 over bark and the annual increment is about 21 million m^3 [Eurostat, 2008]. Sweden's industrial demand for wood and wood products was 65 million m3 in 2006, which was second highest in the EU [CBI, 2008b].
Recent achievements within the prefabrication/modularization are connected with innovations concerning processes and materials development towards building higher quality complex facility types. Prefabrication has became recently more widely recognized as a resource – efficient and greener construction process (example of Fort Sam Military Barracks in San Antonia, Texas, that are on track to meet LEED Silver certification due to reduced material waste and pollution and increased use of recycled materials [National Research Council of the National Academies, 2009].

4. BENEFITS OF PREFBRICATION - DISCUSSION

Generally, benefits of prefabrication applying are mainly connected with costs' reduction. Its productivity is relatively high since time of the construction investment and labor conditions are save for the construction investment. Polat (2010) and Pheng and Hui (1999) endorse the implementation of prefabrication based on the results of research and studies carried out to determine the true benefits of prefabrication over traditional construction methods.

4.1. Economic benefits

Increased use of wood for building construction may have economic benefits [Stone and Stone, 2000; Boverket, 2006]. Wooden buildings can be produced faster than a concrete building because there are no wet trades and trades can work independently although they need to work in sequence. Furthermore, wood is a light weight material which makes it easy to handle and the foundation cost could be low. An increase in production of wooden buildings will increase demand for value addend wood products, with a potential to generate employment in wood products industry often located in rural areas [Krushna and Gustavsson, 2009].
Following benefits provided by prefabrication in comparison to conventional construction there were noted: improved quality, increased construction time by 50%, waste reductions of 70%; up to 10% savings in project capital costs, and the advantage of JIT delivery to the site. Conclusions on research findings within prefabrication's benefits concern mostly short time of the construction investment, high quality (within the production process), transportation costs, environmentally good practice, reduction of labour involvement, level of the construction safety (safety solution for earthquake areas), economy of scale with regard to production demand.
Cost savings identified in the prefabrication are related to preliminary stage of the construction and ROI indicator including the construction schedule predictability. According to research survey results, site preliminaries are typically estimated to range between 8% and 15% of the overall construction cost. It is

known that prefabrication provides 50% savings in time which in turn leads to a beneficial proportionate savings in the cost of these preliminaries. Although dependent on the type of operation, at the least, the client earns savings on the charged interest on land cost and mean construction cost over the shortened construction time. At the most, the client benefits from the early earning potential of the structure due to early operation [Okodi-Iyah, 2012].
Economy of scale is the other important aspect of prefabrication since factory production is related to benefits of speed and quality. Design stage at construction investment is strictly connected with costs optimization what results also in waste reduction. It can also appeal to home builders who participate in green building certification programs because the most popular of these programs give points for minimizing waste [Salant, 2008]. Time is the next category linked with economic aspects of prefabrication because of products delivery which is faster than traditional one. There can be noted Just in Time concept since the production and delivery of the right quantity with right quality level [Chan, Chan and Kung, 2004].

4.2. Technical benefits

Prefabrication is connected with a high quality of performance within the production and work conditions because of the quality control supported on every production stage and at the construction site. According to Rogan, Lawson and Bates-Brkljac (2000), since quality is a highly critical issue to clients in their concern for the post-construction operation of their finished buildings, the implementation of prefabrication system means pre-installation trials of products can be carried out to ensure quality and client satisfaction. The high quality of prefabrication is also reached by applying information technology what result in the production processes automation including design process. It is identified as aimed on Toyota's lean production paradigm related to the production on demand. Due to that fact, the assumptions of prefabrication are following: production costs reduction, waste limiting through Just in Time application, high level of customization.
Crucial role of the prefabrication is connected with the sustainable development idea within the European energy saving policy. Modular wooden construction supports energy saving properties by using: treenail and avoiding using nails (which can be thermal bridges), avoiding bonding elements that requires chemical substances (environmentally friendly solution) and supporting construction durability. Wooden prefabricated buildings are characterized mostly with reducing thermal bridging effect through applying wooden connections of wooden elements in the entire construction. Modular systems are driving value of heat escape down to approximately 5% of the wall area. A characteristic feature of prefabricated houses offered by one of the Polish wood construction company Wolf System is an excellent thermal performance (the prefabrication element Ultra-Thermo-Mega-Wand reaches U parameter = 0.14 W/m^{2}K). Importantly, to minimize the amount of heat escaping outside the building, reduced the operating costs of such houses by 40-60% compared to traditional buildings. This reduction relates primarily heating bills.
The other technical aspect that reflects ecological dimension of prefabrication/modularization is use of renewable natural resources what is safety for natural environment of the construction site. It is ecological investment since prefabrication doesn't pollute the environment and doesn't affects the human health.

4.3. Social benefits

The perception of prefabricated technology is much worse than that of conventional technology in Poland even it does have its advantages. The prospect of sustainable development that is being achieved from year to year in countries of the European Union may contribute to a growth of interest in

prefabricated construction systems, but the main road to success for prefabrication is a reliable construction company that can boast knowledge of technology and capable performance of services. The pace of life and the search for comfortable and convenient decision-making solutions conclusively speak in favour of prefabrication technology systems. The time required to build a ready-made house from prefabricates is only several days [Radziszewska-Zielina, Gleń, 2014].
According to report of McGraw-Hill Construction, only 40% of all contractors consider their capabilities in the prefabrication and modular construction as a part of their company's strategic initiative. Although the use of prefabrication for some project assemblies is not new, the amount of use and the move in some sectors to using more modular construction in a multitrade environment are growing trends. There are a few of the driving forces that include [Bernstein, 2011]:

– the constant pressure to lower price,
– the need to achieve a competitive edge in markets increasingly calling for the use of prefabrication and modularization, i.e., hospitals, hospitality, education,
– the lack of, or impending lack of, skilled construction labor,
– the need to increase productivity.

Research report also indicated that the level of prefabrication technology use is expected since the number of market players using this technology on over 50% of construction projects in 2013 (there was 37% in 2009). Contractor non-users expect to engage in prefabrication/modularization at much higher levels than their industry counterparts—23% report they will use it on over 25% of projects by 2013, compared to much lower percentages in 2009.

5. CONCLUSIONS

Contemporary wood construction industry is strictly linked with the sustainable development idea. One of the most popular wood construction technology is prefabricated construction that becomes more popular material because of its properties and comfort comparing with traditional construction materials. Modular houses prefabricated, manufactured in a factory, constitutes an alternative to traditional methods of a house building. Technology has been present on a construction market for years, but recently it has began to be noticed and attractive for investors who appreciate time of construction realization. It result from the set of benefits reached by prefabrication as an alternative solution for the traditional construction. There is only observed a lack of the consumers' awareness on the high efficiency of the mentioned technology within the economy. It has a great influence not only on the life economy, but also affects the construction innovativeness as a reply on the technological progress within the material advance.

REFERENCES

1. Azari, R., Javanifard, N., Markert, D., Strobel, K., Yap, J. (2013): MODULAR PREFABRICATED RESIDENTIAL CONSTRUCTION CONSTRAINTS AND OPPORTUNITIES, University of Washington | Skanska Innovation Grant Fall 2012 PNCCRE Technical Report #TR002.
2. Borkowski, S., Stasiak-Betlejewska, R. (2014): ANALYSIS OF WOODEN HOUSE CONSTRUCTION COSTS IN THE CHOSEN COMPANY, Management in Sustainable Construction Industry. Monograph. Edited by Arnold Pabian, Piotr Tomski, Wyd. Politechnika Częstochowska, 103-112.
3. Boverket, (2006): SUNDSVALL'S INNER HARBOUR – A DEVELOPMENT AND INFORMATION PROJECT FOR SOLID WOOD CONSTRUCTION [Sundsvalls inre hamn – ett utvecklings- och informationsprojekt för trähusbyggande i massivträ]. *Diarinummer 504-2239/2004*, Boverket, www.boverket.se (in Swedish).

4. CBI (2008a): THE WOOD AND WOOD PRODUCTS MARKET IN THE EU, CBI Market Survey,August 2008. Centre for the Promotion of Import from Developing Countries, www.cbi.eu.
5. CBI, (2008b): THE WOOD AND WOOD PRODUCTS MARKET IN SWEDEN, CBI Market Survey, August 2008. Centre for the Promotion of Import from Developing Countries, www.cbi.eu.
6. Chan, J. K. W., Chan, A. P. C. & Kung, F. W. C. (2004): USING INNOVATIVE PREFABRICATIONS AS THE SOURCE OF COMPETITIVE ADVANTAGE FOR CONTRACTORS—CASE STUDIES IN HONG KONG. Architectural Science Review [online]. Vol. 47 (2), 245, 183-192. Available at http://dx.doi.org/10.1080/00038628.2004.9697042.
7. Eurostat, (2008): FOREST INCREMENT AND FELLINGS, http://epp.eurostat.ec.europa.eu/portal/page/portal/forestry/data/main_tables, accessed on May 01, 2009
8. Haas, C. T., O'Connor, J. T., Tucker, R. L., Eickmann, J. A. & Fagerlund, W. R. (2000): PREFABRICATION AND PREASSEMBLY TRENDS AND EFFECTS ON THE CONSTRUCTION WORKFORCE. Centre for Construction Industry Studies (14) [online]. Available at http://www.caee.utexas.edu/org/ccis/a_ccis_report_14.pdf.
9. Hampson, K.D., Brandon, P. (2004): CONSTRUCTION 2020-A VISION FOR AUSTRALIA'S PROPERTY AND CONSTRUCTION INDUSTRY. Brisbane: CRC Construction Innovation.
10. Jelacic, D., Pirc, A., Hornakova, R., Meloska, Z. (2009): SEEKING AND IMPLEMENTATION OF INNOVATION OPPORTUNITIES, WOOD RESEARCH, Vol. 54, Issue: 4, 129-142.
11. Kitek Kuzman, M., Motik, D., Bičanić, K., Vlosky, R., Oblak, L., (2012): A COMPARATIVE ANALYSIS OF CONSUMER ATTITUDES ON THE USE OF WOOD PRODUCTS IN SLOVENIA AND CROATIA. Drvna industrija, 63 (2): 71-79
12. Kok, T. S. (2010): COST EFFECTIVENESS COMPARISON OF PRE-FABRICATION WITH CONVENTIONAL CONSTRUCTION METHOD FOR RMAF GROUND DEFENSE BUNKER. M. Sc. Thesis. Universiti Teknologi Malaysia [online]. Available at http://eprints.utm.my/10636/.
13. Krushna M., Gustavsson, L., (2009):GENERAL CONDITIONS FOR CONSTRUCTION OF MULTI-STOREY WOODEN BUILDINGS IN WESTERN EUROPE, School of Technology and Design Reports, No. 59 Växjö University, Växjö, Sweden.
14. Indufor, (2004): CEI-BOIS ROADMAP 2010: SUMMARY OF WORK PACKAGES 1.1, 1.2 AND 5.1, EUROPEAN CONFEDERATION OF WOODWORKING INDUSTRIES (CEI-Bois), http://www.roadmap2010.eu/about/PDFs/Reports/Indufor_summary.pdf.
15. Liska J.A. (1971): WORLD CONSULTATION ON THE USE OF WOOD IN HOUSING, An International Review of Forestry and Forest Products, Food and Agriculture Organization of the United Nations, Vol. 25, No 101-102-103.
16. Millward Brown Company (2014): ENERGY EFFICIENCY AND ECONOMY, Stowarzyszenie Producentów Białych Materiałów Ściennych „Białe murowanie" (in Polish: Energooszczędność i ekonomia)
17. National Research Council of the National Academies (2009): ADVANCING THE COMPETITIVENESS AND EFFICIENCY OF THE U.S. CONSTRUCTION INDUSTRY. The National Academies Press. Washington DC.
18. Okodi-Iyah E., Y. (2012): A COMPARATIVE EVALUATION OF THE ENVIRONMENTAL IMPACT OF PREFABRICATION VERSUS CONVENTIONAL CONSTRUCTION IN UAE'S CONSTRUCTION INDUSTRY, Dissertation submitted in partial fulfilment of the requirements for the degree of MSc Sustainable Design of the Built Environment, Faculty of Engineering & IT, The British University in Dubai.
19. Pheng, L.S. & Hui, M. S. (1999): THE APPLICATION OF JIT PHILOSOPHY TO CONSTRUCTION: A CASE STUDY IN SITE LAYOUT, Construction Management and Page | 257 Economics [online] Vol. 17 (5), 657-668. Available at http://dx.doi.org/10.1080/014461999371268.

20. Phillipson, M. (2001): CURRENT PRACTICE AND POTENTIAL USES OF PREFABRICATION, DTI Construction Industry Directorate Project Report, Project report number 203032, Building Research Establishment Ltd., BRE Scotland.
21. Polat, G. (2010): PRECAST CONCRETE SYSTEMS IN DEVELOPING VS. INDUSTRIALIZED COUNTRIES. Journal of Civil Engineering and Management [online]. Vol. 16 (1), 85-94. Available at http://dx.doi.org/10.3846/jcem.2010.08.
22. Radziszewska-Zielina E., Gleń, M., (2014): STUDIES OF THE PREFABRICATED HOUSING CONSTRUCTION MARKET IN POLAND, SSP - JOURNAL OF CIVIL ENGINEERING Vol. 9, Issue 2, 2014, DOI: 10.2478/sspjce-2014-0012
23. REPORT OF THE WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT: OUR COMMON FUTURE, Transmitted to the General Assembly as an Annex to document A/42/427 - Development and International Co-operation: Environment 1987.
24. Rogan, A. L., Lawson, R. M., & Bates-Brkljac, N. (2000): BETTER VALUE IN STEEL: VALUE AND BENEFITS ASSESSMENT OF MODULAR CONSTRUCTION. The Steel Construction Institute [online]. [Accessed 10 December 2011]. Available at http://www.designforhomes.org/wp-content/uploads/2012/03/ModularSteel.pdf.
25. Salant, K., (2008):DESPITE GRAND PLANS, PREFABRICATION STILL HASN'T REALIZED ECONOMIES OF SCALE, Washingtonpost, Real Estate, 1 November 2008.
26. Stasiak-Betlejewska, R. (2015): ENERGY EFFICIENT CONSTRUCTION STRATEGIES AS AN ELEMENT OF THE SUSTAINABLE DEVELOPMENT STRATEGY IN POLAND, Book of proceedings of 11th International May Concefernce on Starategic Management – IMKSM2015, 29-31 May 2015, Bor, Serbia, Univerity of Belgrade, Technical Faculty in Bor, Management Department, Serbia, 304 – 317.
27. Stasiak-Betlejewska, R. (2013): CONSTRUCTIONS OF THE ENERGY-SAVING WOODEN HOUSES AND ITS ADVANTAGES ON THE EXAMPLE OF POLISH CONSTRUCTION, Wood is Good - User Oriented Material, Technology and Design. 24th International Scientific Conference. Proceedings. 18th of October, Zagreb. Faculty of Forestry, Zagreb University, Croatia, 143-150.
28. Stone, G., Stone, P., (2000): MULTIFAMILY WOOD HOUSES: COST COMPARISON BETWEEN ALTERNATIVE CONSTRUCTION METHODS [Flervånings trähus: kostnadsjämförelse mellan alternativa byggmetoder]. Rapport TVBK, 0349-4969; 3040, Division for Structural Engineering, Lund University, Sweden.
29. THE ENCYCLOPEDIA OF CHICAGO. Housing, Mail Order. Web. April 8, 2011. 3 The Steel Master Building Systems. Quonset FAQ's. Web. April 8, 2011.
30. Warszawski, A. (1999): INDUSTRIALISED AND AUTOMATED BUILDING SYSTEMS, Technion-Israel Institute of Technology. E & FN Spon.
31. http://www.understandconstruction.com/

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THE CONCEPT OF FACILITY MANAGEMENT IN THE FOCUS OF ENERGY EFFECTIVE HOUSES

Marek Potkány

ABSTRACT

Facility management is an effective form of outreach business management which aims to provide relevant, cost-effective services to support the main business processes and allow them to optimize. With the continual increase of world population energy consumption is growing continually as well and in parallel there is an increase in CO_2 emissions. The most suitable solution means building houses with low energy demands which do not harm the environment. There exist several types of buildings which actively cope with the requirements of minimising the energy consumption of their operations. These buildings are understood as so called energy effective houses. The aim of the article is to present possibilities of the influence of facility management in the preparatory phase of investment process focused on construction of energy effective building itself.

Key words: facility management, energy effective houses, life cycle of building

1. INTRODUCTION

A basic need and desire of every responsible man is to provide for own housing. Lately, the countryside perks with building activity and we can an increased interest in building family houses. A worldwide increase of population causes an increase in energy consumption which simultaneously increases CO2 emissions. Buildings consume during 40% of total energy, while their operation to heat/cool makes up 60% - 70% of the portion with the production 1/3 of the world production of CO2. Construction of ecological houses with low energy demands is a preferred, solution. Building industry can contribute in this way more than any other industry to better management of limited resources, energy saving and dowering emissions. The only renewable raw material we have in Slovakia is wood. We are the fourth most forested country of Europe, but at the production of round timber more than ¼ of it is exported. (according to Green Report 2014, e.g. in 2013 we exported up to 2,58 m m3 of round wood representing 35% of its production). A partial solution may be to support building energy efficient houses based on wood which guarantee savings on heat, ecology of their production and further use. A good example might be northern countries with a great market share of wooden houses production, so they are the countries where is historical ecology awareness (Germany, Austria). There is also a growing trend in wooden houses production.

Facility management is a term which is closely associated with building management. More broadly, facility management should not only be understood as general building management connected with everyday building operation but it should also include long term planning and focus on its users. This should already be essential in the preparatory phase of investment process focused on construction of building itself.

2. MATERIAL AND METHODS

There exist several types of buildings which actively cope with the requirements of minimising the energy consumption of their operations. Globally these are understood as so called energy effective houses, which include low energy houses, energy passive houses, energy self-sufficient houses, energy independent -autarkic houses as well as plus energy houses. In this article we will closely focus only on low energy and energy passive houses. Division of these buildings according to heat consumption is presented in Figure 1.

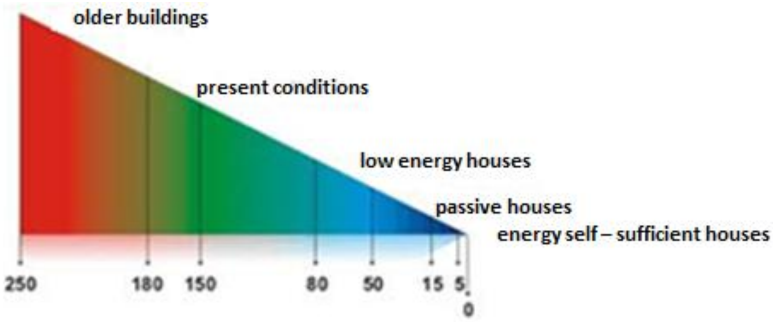

Figure 1. Division of buildings according to heat consumption (kWh/m^2/per annum)
Source: [online] http://www.modernerodinnedomy.sk/archives/684

Tywoniak (2010) states that, low energy houses are according to the TNI 730329 standard those buildings which, heat consumption is maximum up to 50 kWh/m^2, no matter what the shape of the building is. This criteria is more reasonable when a building has more compact shape rather than too structured one. Other criteria of energy effective houses are also recommended, but not precisely stated – the basis represents mainly the conceptual approach. The most important seem to be the following: temperature insulation standard and non-breathability of construction envelope, lowering the influence of thermal bridges, increased solar profits, controlled ventilation with heat recovery, usage of renewable energy sources and active (usually low temperature) heating system.

Higher development level of low energy house is an energy passive house which is known for even lower energy consumption and its need for heat will not exceed according to the TNI 730329 standard 15 kWh/m^2. This parameter most frequently interpreted on the contrary to low energy house is the only one of the most demanding requirements. Central principle of energy passive house is such a significant reduction of heat losses from buildings that traditional heating method is not necessary. Energy passive house counts for basic and usually the only source of externally supplied heat even during the coldest time of year representing a small amount of „residual heat demand“ for air heating supplied by the system of controlled ventilation. A passive house is in principle an advanced low energy house. A passive house is a building in which comfortable room temperature both in winter and summer can be achieved without conventional heating and cooling systems. There is no need of conventional heating with the use of furnace and heaters, fuel storage, chimney and gas connection. This type of house is designed in such a way that comfortable room temperature can be achieved by passive energy sources. These include delivery of sun heat through windows, heat radiation from household appliances and its residents. Heat consumption is so low, that such a house is, with the exception of few days of heavy frosts, self-sufficient and needs no extra or permanent heating. To cover the period of heavy frosts, only appliances with the capacity of approximately 4- 5 kW are fully sufficient. Energy performance of buildings present figure 2.

Energy-self-sufficient buildings are nowadays designed on the technological basis typical for passive houses. Suitable combination of house location, its direction, use of surrounding energy sources by heat pumps, application of solar power collectors and installation of high quality air-conditioning with reverse heat acquisition and controlled ventilation can lower the consumption of an energy self-sufficient house below the level of 5 kWh/m^2.

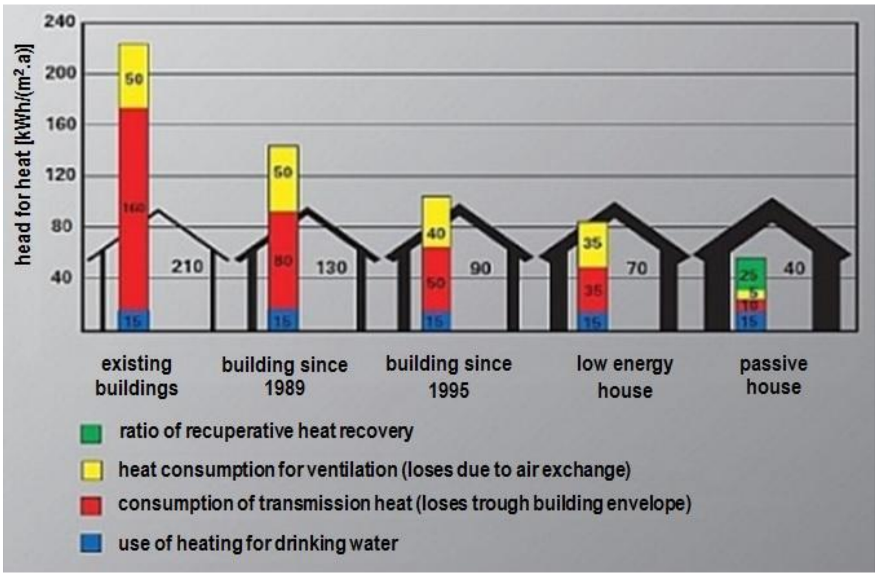

Figure 2. Energy performance of buildings
Source: [online] http://www.encerti.eu/termovizia/p0/n84

3. THE BENEFITS OF ENERGY EFFICIENT HOUSES

Wood as a material has excellent properties, namely mechanical, physical or even aesthetic, can be excellently machined and it is as a material by all means the most pleasant to touch. It also smells good and it is an excellent heat insulating material which can regulate humidity within its environment. In comparison with other building materials wooden buildings used in building industry have excellent heat insulation properties. Creation of building mould is not possible as well as the presence of allergic substances. Humans have naturally a positive connection with wood as such. Wood processing for building purposes itself saves energy, as well as its deconstruction is a low energy and ecologically non demanding process without any harm to the environment.

Good quality wooden buildings have a possibility to regulate interior moisture due to the balanced moisture of wood itself. These can keep an optimum climate in the air so that in the period of increased moisture the wood accepts it and on the other hand when it is dry, it gives the moisture back to the environment. Due to its construction and design, sandwich construction, it has also good acoustic properties, muffle noise, its absorption by the surface on the bases of wood or wood fibres. Wood is also good insulation material with low natural radiation. At certain level of residual moisture (mostly reaching about 10 %), wood has a low electro static conductivity. That means that it can conduct the charge of electric field from a person or from a building. Because of its sandwich construction which fundamental part is putting materials with various densities in layers offers also a very good fire protection. One of the advantages of wooden buildings belong also wood properties such as elasticity. Natural texture, its colour and smell influence human senses in a very positive way.

Frequent reasons for production of energy effective houses as wooden buildings are also their advantages when compared with classic silicate (brick) buildings. On the bases of the study presented by the company Atrium we can say that environmental asset of good quality wooden building in comparison with heavy silicate construction lies except significant use of wood and wood fibre materials as a renewable recourse especially in saving of its total weight and related production and transportation costs as well as the influence on the environment. The comparison is presented in the following table 1:

Table 1. Comparison criteria of silicate and low energy fabricated houses

Comparison criteria	Silicate (brick) building	Low energy house (wood building)
Ground plan dimension	96.76 m^2	95.35 m^2
Interior utility area	80.76 m^2	84.15 m^2
Wall thickness	40 cm	28 cm
U- value of building shell	0.53 W /(m^2 K)	0.22 W /(m^2 K)
Yearly heat consumption and heating	13, 500 kWh	5, 400 kWh
Weight of building material	115 t	17 t
Consumption of energy for production	253, 760 kWh	120, 080 kWh
Equivalent CO2	23.7 CO^2 ekv	9.1 CO^2 ekv

Source : [online] http://www.atrium-sk.sk/images/pdf/Atrium_speci_2014_web.pdf

The most significant differences when compared with classic silicate buildings and at the same time the biggest advantages when designing modern wooden buildings are the construction method and the speed of construction. Demands for the construction site equipment and its influence on the construction neighbourhood are during the process of the construction minimized. One can live in such a house within a few weeks. The building process is very exact and fast. One of the significant advantages of such a construction is also dry construction process. Wet construction process can be in the process of wooden building constructions completely excluded, and also defects and faults caused by the influence of technological dampness. After completing the construction, wooden building can be used immediately and its investments are appraised immediately.

4. LIFE CYCLE OF BUILDING IN THE CONTEXT OF FACILITY MANAGEMENT

Major part of operation costs and effectiveness of facility management processes is defined already at project of building. Pre-set limitations have a long term impact on operation of building and therefore should be set as soon as possible considering also the main strategic aims. An important factor is also the ecological aspect of building influence on the living environment due to materials used for its construction as well as energy consumption necessary for its operation.

Life cycle of a building can be according to United Nations International Development Organization (UNIDO) as well as conditions of the Slovak Republic defined into three basic phases (Ivanička, 2007). Differences are presented in figure 3.

Building life cycle phases

	Building acquisition		Building use	Building deconstruction
UNIDO	Pre-investment phase	Investment phase	Operational phase	
Slovak Republic	Phase of building preparation	Phase of building acquisition	Phase of building use	Phase of building deconstruction

Figure 3. Life cycle of building according to the UNIDO and conditions of the Slovak Republic

Building life cycle begins with acquisition phase (including investment project, project preparation, design of operational projects, building construction and final building approval). Then it continues with a use phase, which in course of time requires rebuilding, revision, maintenance and reconstruction. Final phase of the building life cycle is the deconstruction phase.

Very often the tasks and competencies of a facility manager correspond with the phase of building use, i.e. building operation, especially with the need of operational costs management

(Mračková, E., Hitka, M., Sedmák, R. 2014). Facility manager though can take part in the building life cycle much earlier. An ideal approach is if the role of a facility manager is implemented already in the initial phases of building life cycle. Such a solution has many advantages and brings about also significant savings of finance both at investment costs as well as later the operational ones (Miške, 2010). Engagement of facility managers into individual phases and building life cycle stages with more detailed specification of their tasks and competencies is presented in Figure 4.

Building life cycle phases						
Investment objective, project preparation	**Operational project design**	**Building Acquisition**	**Final building approval**	**Building use**	**Maintenance, servicing, re-constructions**	**De-construction**
-counselling and procedure consultations, -defining of facility management requirements,	-consultancy and notes to individual project types, - design optimisation,	- continual control of task within individual projects,	- acceptance of building, operational documentation, - testing operation,	-coordination of support processes operation, - setting an effective and optimal building operation,	- calculation of effective use of building, -definition of maintenance, rebuilding and reconstruction requirements, - design of time frame schedules,	- deconstruction design , or calculation of further building effective use.
Tasks of a facility manager						

Figure 4. Tasks of a facility manager in individual building life cycle phases

An important phase of a building life cycle where it is possible to influence the future basic operational costs on a maximum rate is the phase of building acquisition (pre-investment phase). It can be stated that 50% - 70% of future building operational costs can be influenced already in the acquisition phase (project design) of a building. The output of project process which is the part of preparatory phase of an investment process is the project documentation. It sets the space-disposition and material solutions of the building. Most of the operational costs are conditioned by the area and material equipment. These factors are the most crucial in setting energy demands of the building and its operational maintenance.

Future amount of basic operational costs of a building in the project phase of the investment process is decided directly by a building acquisition manager (investor, developer, project designer, but also facility manager) and indirectly also valid standards, limits, state and other subsidies. Including a facility manager into the beginning of building acquisition already at the investment project design is from the aspect of strategic aims of the manager absolutely necessary.

5.CONCLUSION

For ages a man has had a positive and natural attitude towards wood. Processing wood for building purposes and its liquidation presents energetically and ecologically undemanding process. Wooden houses have excellent thermally insulating properties compared to other materials, formation of moulds and allergens is excluded. During realisation of the house there is a dry process of construction, ecology and time of its realisation a great competitive advantage.

Construction of energy efficient houses has a great potential to increase their market share, but it is important to note that approximately 70% of future building operational costs can be influenced already in the pre-investment phase. Here a role to play facility manager. Facility manager as a consultant should take part in formulating the limiting conditions in the project design phase. Facility managers can on the bases of their experience define requirements for the use from the point of view of future basic operational costs. It specifies an optimum functional programme of the spatial use of the building (e.g. limiting unused areas) from the point of view of future users, surface of some constructions (walls, floors) concerning the future maintenance, building material solutions from the point of view of future maintenance and repairs, as well as detailed, infrastructure and technical equipment necessary for the technical equipment support of the building. Early and correct definition of such requirements for a building is necessary. Facility manager mainly in co-ordination with investor and project designer define requirements for the building from the point of view of strategic objectives and so it can cause lowering the investment costs and better facility management services towards building users.

Somora (2006) comments, that facility manager, based on experience of operating similar buildings, can formulate their requirements in the area standard and type of technical equipment of a building, standard and type of the interior surfaces and the exterior form the point of view of resistance, durability and tidiness of surfaces. An important area are also requirements about area coordination of technical distribution equipment concerning monitoring and maintenance, ideas about the system of secondary measurements and media operation, ideas about tidying up a building – its interior and exterior, ideas about possible building security check and ideas about the operation of waste management.

REFERENCES

1. Anonymous. 2014. Green report 2014. Ministry of Agriculture and rural development, 84 p.
2. Defining Life Cycle Assessment (LCA). US Environmental Protection Agency. 17 [online] [cit. 2015-06-25]. Available at: http://www.gdrc.org/uem/lca/lca-define.html.
3. ISO 14040 (2006): Environmental management – Life cycle assessment – Principles and framework, International Organisation for Standardisation (ISO), Geneve.
4. Ivanička, K. et al. 2007. Trh nehnuteľností a developerský proces. Bratislava : STU, 2007. ISBN 978-80-227-2661-0.
5. Miške, R. 2010. Implemeting Facility Management in the Prepatory phase of an investment process. [online] [cit. 2015-06-25]. Available at: http://www.stuba.sk/new/docs//stu/ustavy/ustav_manazmentu/NAB2010_1/paper9.pdf.
6. Mračková, E., Hitka, M., Sedmák, R. 2014. *Changes of anthropometric characteristics of the adult population in Slovakia and their influence on material sources and work safety*. Advanced Materials Research, Vol. 1001, 2014, p 401-406. ISSN 1022-6680, DOI: 10.4028/www.scientific.net/AMR.1001.401
7. Potkány, M. 2015. *The Task of Facility Managers at the Individual Stages of Building Life Cycle,* Klaipeda: Klaipeda University , Lithuania: p. 160-168. ISBN 978-9986-31-466-0.
8. Somora, B. 2006. Dokonalé zadanie – predpoklad spoločného úspechu realizácia stavebného objektu. In: *Facility management – metóda efektívneho spravovania stavebného objektu.* Bratislava : STU, 2006. ISBN 80-227-2541-2, p. 67.
9. Tywoniak, J. 2010. Deklarativní výpočty pro pasivní a nulové domy, 2010, [online] [cit. 2015-06-25]. Available at: http://stavba.tzb-info.cz/normy-a-pravni-predpisy-nizkoenergeticke-stavby/7456-deklarativni-vypocty-pro-pasivni-a-nulove-domy
10. *http://www.encerti.eu/termovizia/p0/n84* [online] [cit. 2015-06-25].
11. http://www.atrium-sk.sk/images/pdf/Atrium_speci_2014_web.pdf [online] [cit. 2015-06-25].

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PROCESSES' ASSESMENT OF WOODEN ARCHITECTURE ELEMENTS MANUFACTURING

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ABSTRACT

In the survey concerning the quality and the standardization type importance within the grooved wooden fence (with cuts) manufacturing there was used Pareto-Lorenz diagram and a set of factors that describe standardization types in accordance with the Sixth Toyota Management Principle and BOST methodology. The quality control department data show, that the major nonconformities in the wooden fence manufacturing are: unstable structures, components' features, improper slats mounting (35%; 29%; 12% respectively). In the workers' opinion the most important standardization type in the given production condition concerns: process, training and a task execution time. During the execution of the manufacturing process standardization of the information flow and standardization of warehouses has no significant influence on the manufacturing process. Based on the survey results, the enterprise owner increase supervision scope on the fence installation and its transport and training system has been maintained based on an analysis of research findings.
Key words: process, architecture elements, Toyota principles, BOST, standardization

1. INTRODUCTION

The manufacturing process is a detailed range of activities, which resulted in a finished product with a fixed use value. The aim of each manufacturing process is to produce products that meet the quality requirements.

Quality management is the management decisions that relate to processes, resources and units forming quality, but the most important task is to continuously improve products and activities [Hamrol, 2004]. The final result of the organization activity is affected by the overall efficiency of the organization processes efficiency, which interact with each other. Therefore, any organization wishing to use its own resources and achieve high results, must be able to identify all of its processes and its interactions. It is reflected in ISO 9001:2000, which was targeted for important processes of an organization such as leadership, resources, improvement [Łunarski, 2008].

The terms process and related process management constitute a fundamental category in the quality management. Process approach means that the organization focuses primarily on processes performed in it, and not on organizational units, workstations or functions. The overall objective of any organization is the result of a process because it processes and its results are the source of client desired product [Lock, 2002]. It can be said, that every process is a system, but the system cannot be called a process. In the case of a process approach to management, both work within the processes and compounds occurring between these processes are managed. In such an approach, the complete chain of activities, which are characteristic of a product or service, are managed [Łunarski, 2008]. During the processes implementation the consumption of resources is followed, therefore the processes should be planned so with minimal use of resources to get the greatest increase [Szołtysek, Dziuba, 2009]. The organization is so effective how processes are efficient. It follows that [Rummler, Brache, 2002]:

– processes should be closely linked to the organization strategy,

– company structure should be adapted to the designed processes to successfully support their implementation,
– company increase its efficiency and competitiveness through improvement and optimization of business processes.

Application of the process approach in the organization management is connected with the need to overcome such obstacles as [Łunarski, 2008]:

– poor understanding of processes importance for the organization by senior and key strategic level management,
– strong resistance of the functional structures to make changes in the direction of supporting the flowchart,
– lack of a comprehensive identification processes in the enterprise and adequate methods of management,
– lack of recognition processes which prevent management, which consequently no effective improvement of the organization.

In the company there are different divisions of processes. Key processes are the most important processes, which have the greatest impact on strategic achievements of the organization. The processes are also divided into: main processes, supportive processes, auxiliary processes, operating processes and processes of general management [Lock, 2002]. The idea, in which the most important is wide commitment to quality, says that the quality of products or processes effectiveness is determined by the human, his motivation, willingness to cooperate and the culture.

The aim of this study is to analyze the manufacturing organization in the enterprise XY within the production of the chosen garden architecture element - a wooden fence. This analysis is designed to test and determine the level of the enterprise functioning and to investigate whether the company's management in a manner appropriate manages the production processes. Pareto – Lorenz diagram and BOST survey have been applied for the analysis of the results. Obtained research results have been used to form corrective actions for the organization management.

2. RESEARCH METHODS CHARACTERISTICS

One of the basic quality management tools that gives possibility to prioritize factors affecting the studied phenomenon is Pareto – Lorenz diagram (hereinafter referred to as P-L diagram). This diagram shows graphically the relative and absolute distribution of types of errors and problems and its causes [Łańcucki, 2001]. It is based on 20/80 principle stated, that 20% of the causes determines about 80% effects. The majority of nonconformities is due to a small number of causes. This technique allows identifying activities that lead to the improvement of processes and qualitative characteristics of material products and services [Borkowski, 2004]. In the case of using P-L analysis, the action is focused on the realization of corrective actions in relation to the most significant 20% of the causes of nonconformities [Łańcucki, 2001].

In order to identify and improve processes, analysis included research findings on employees' opinion in terms of quantifying the standardization type importance in accordance with the Sixth Toyota Principle management. For this purpose an innovative method BOST was applied. BOST is protected by law regulations of the intellectual property protection. The name and its structure is protected by the principle of first date (AAK Attorney Office in Częstochowa, Poland 2012). It is research methodology consists of opinions on importance level of the organization development determinants within the Toyota principles realization in accordance to market and clients' requirements. Some areas identified within the survey are related to Toyota principles such as: E2 - concerns the enterprise development concept, E5 - concerns implementation of the manufacturing process and E6 - related to the standardization aimed at continuous processes improvement [Borkowski, 2012a, Borkowski, 2012b]. The research paper presents examination findings on E6 area related to standardization types importance.

3. RESEARCH OBJECT – CHARACTERISTICS OF THE COMPANY

The analyzed company XY Ltd. is a private company which deals with the wood processing with entirely Polish capital. It was founded in 1988. The organization is equipped with modern machinery that produce with using the new technology. All plants together employ about 700 employees. Production plants process about 250 000 m^3 of round wood and lumber annually. It is certified by FSC, which was introduced in the company in 2003 and it is evidence of the ecology principles implementing in the processes of the forest production. The high quality of products and environment-friendly production were certified in 2004 by the quality management system compliant with ISO 9001: 2008.

4. RESEARCH FINDINGS – DISCUSSION

4.1. Quantification of quality problems based on the Pareto – Lorenz diagram

For the quantification of quality problems the Pareto – Lorenz diagram was applied. It allows determining defects occur during the wooden fence elements production and collecting information on its occurrence frequency in the study period 2010 – 2014. There 9 nonconformities have been identified: convexity of boards (N1), blue stains boards with intense color (N2), irregularities on the surface elements (N3), deep cracks of elements (N4), resin pockets (N5), unstable construction of the fence (N6), knotholes (N7), scratches on fence' parts (N8), poor fixation of slats (N9). Based on data collected from the quality control department that concern identified nonconformities in the analyzed company Pareto – Lorenz diagram was formed (Figure 1).

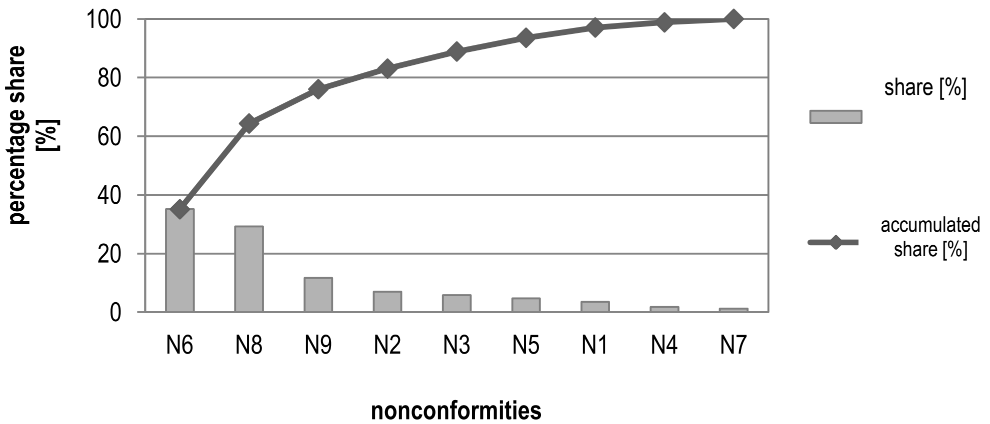

Figure 1. Pareto – Lorenz diagram presenting nonconformities occurrence in the wooden fence elements manufacturing in research period 2010 – 2014.
Source: own study.

Research results presented in Figure 1 confirms, that nonconformity N6 (unstable construction of the fence) and nonconformity N8 (scratches on fence' parts) account for 20% of the total number of nonconformities which are responsible for 64.33% of all nonconformities in the manufacturing process identified in the research period. It can be stated that 64.33% of the costs incurred as a result of nonconformities corresponds to only 20% of nonconformities. Proposals of the manufacturing process may cause the product quality level improvement up to 64.33%.

4.2. The standardization importance level in the manufacturing process

The analysis object in this article is the area E6 (the Sixth Toyota Principle). The results are shown in Table 1. The basis for the construction of table 1 is opinion of workers with regard to question on: *what kind of standardization is the most important in ensuring the continuous improvement of business processes*. The respondents graded importance level of standardization type with scale 1÷7, where 1 is the least important factor, and 7 is the most important factor. Factors in the area E6 are as follows:

– standardization of one task execution (CW),
– standardization of process (PU),
– standardization of workstation storage (MP),
– standardization of documents (DO),
– standardization of trainings (SN),
– standardization of information flow (PI),
– standardization of employment (ZA).

Table 1 presents the percentage structure of employee evaluation on the standardization types affecting the manufacturing processes.

Table 1. The structure of ratings [%] for E6 factors. It refers to the wooden fence elements production.

Rating	Factors' denotation [%]						
	CW	PU	MP	DO	SN	PI	ZA
1	9,7	0,0	38,7	25,8	0,0	22,6	3,2
2	3,2	0,0	19,4	9,7	3,2	38,7	25,8
3	12,9	0,0	9,7	41,9	12,9	19,4	3,2
4	22,6	9,7	12,9	16,1	12,9	9,7	16,1
5	25,8	22,6	12,9	3,2	22,6	3,2	9,7
6	9,7	32,3	3,2	3,2	19,4	3,2	29,0
7	16,1	35,5	3,2	0,0	29,0	3,2	12,9

Source: own study.

Based on data presented in Table 1, it was found that in the case of assessment of the standardization of one task execution (CW) rating 5 was admitted by 25.8% of the respondents who consider this factor as moderately significant. While the standardization of process (PU) has proved to be a very important factor in the mission of the company, none of the respondents admitted lowest ratings (1, 2, and 3). The highest score 7 was admitted by 35.5% of workers and rating 6 was admitted by 32.3%. Standardization of workstation storage (MP) was evaluated by the lowest variant of the assessment (1) by 38,7% of respondents. Almost 42% of respondents believe that the standardization of documents (DO) is important. Another factor, which is the standardization of training (SN), was assessed by 29% of workers as the most important, because it has a major impact on the development of the company. Standardization flow of information (PI) was rated low. This proves a small attention of workers in information transfer within the company.

However, the level of standardization types importance cannot be determined at this stage of the analysis. For this purpose pie charts have been created that illustrate the percentage structure of ratings for E6 factors (Figure 2). This area concerns the most important kind of standardization in ensuring the continuous improvement of business processes. Analyzing the data presented in figure 2h, following series of E6 factors importance level can be formed:

$$PU > SN > CW > ZA > DO > MP > PI \quad (1)$$

The analysis of pie charts in Figure 2, it can be concluded what area of standardization is the most important in ensuring the continuous improvement of processes, according to the company's workers opinion. Equation (1) indicates that the analyzed case study of E6 factors importance level analysis, the most important factor is the standardization of process (PU). Data presented in Figure 2h presents the assessments averages on individual factors and it can be concluded, that the most important type of standardization is to standardize of process (PU) in opinion of 21.2% of respondents. Nearly 20% respondents consider the standardization of training (SN) as the most important, because this kind of standardization enables continuous development of the company and the enhancement of qualifications of employees.

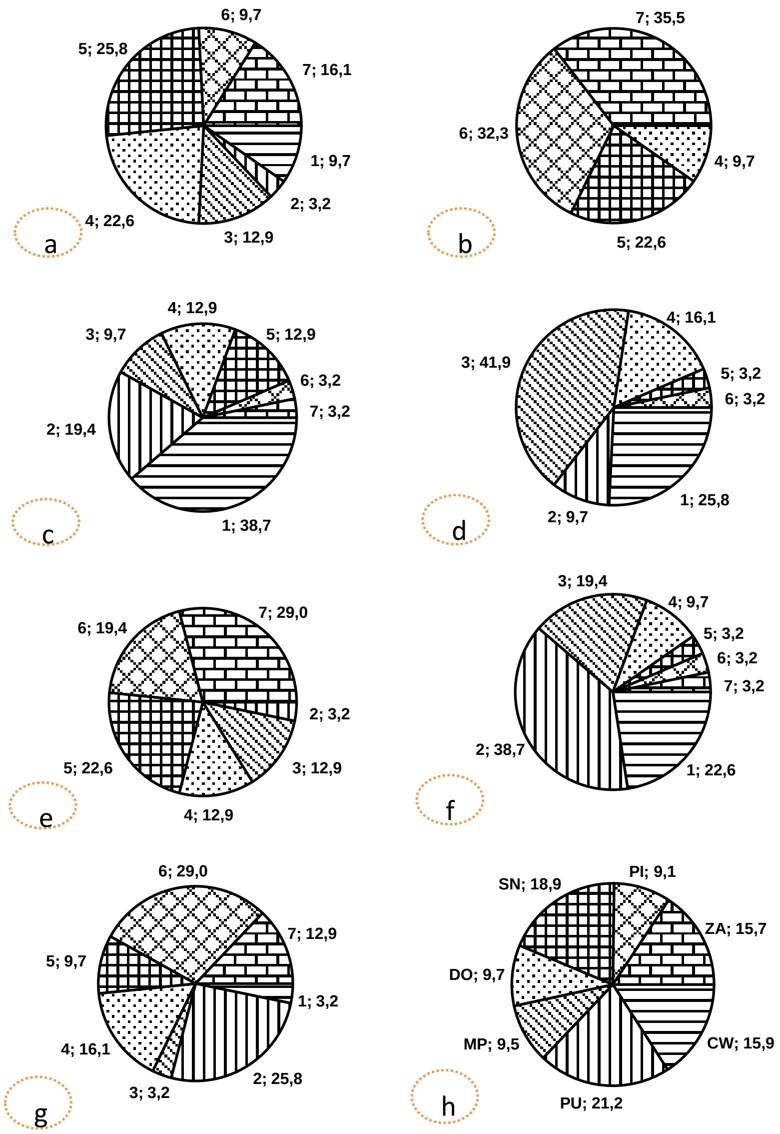

Figure 2. Pie charts for the E6 area factors - structure of the ratings for: a) CW, b) PU, c) MP, d) DO, e) SN, f) PI, g) ZA, h) the average. It concerns the production of a wooden fence elements.
Source: own study.

Regarding standardization factor, i.e. standardization of one task execution (CW), it can be stated that 15.9% of respondents consider it to be important. The company's mission plays an important role, because standardization in ensuring continuous improvement in execution time of one task may interfere less time for performing data operations. Lower percentage of respondents (15.7%) believes that standardization of employment (ZA) is also significant and essential in the enterprise.

5. CONCLUSIONS

Regarding the E6 factors importance analysis results, respondents recognized as the most important standardization type – standardization of process (PU) and standardization of training (SN). Based on the analysis, it can be also stated, what are the least important factors for the respondents. The most important task for the management seems to be to improve the position of the company, its development and increase employee satisfaction company. Analysis of employees opinions with regard to manufacturing process assessment can be appreciated and it can create positive attitudes of workers since it allows improving the company culture of team work. Identification of nonconformities in the production process and comparison of the research results with workers opinions on standardization of process and other factors in the company creates directions of quality improvement instead of clients remarks.

REFERENCES

1. Borkowski, S. (2012b): Toyotarity. BOST Method as the Instrument of Assessment Process Functioning according to Toyota Prinicples. Faculty of Logistics. University of Maribor. Maribor. pp.14 – 15.
2. Borkowski, S. (2012a). Toyota management principles in the questions. The research findings BOST. Wyd. PTM. Warszawa. pp. 34- 36.
3. Szołtysek, K., Dziuba, S., (2009): ISO 22000 international standard in food safety management in the production of bread with additives. In: Effectiveness of the machines maintenance and processes Edited by Borkowski, S., Selejdak, J. Novosibirsk State Technical University. Novosibirsk
4. Hamrol, A., Mantura W. (2004): Zarządzanie jakością. Teoria i praktyka. Wydawnictwo Naukowe PWN. Warszawa.
5. Lock. D.(2002): Podręcznik zarządzania jakością. Wydawnictwo naukowe PWN. Warszawa 2002.
6. Łańcucki, J. (2001): Podstawy kompleksowego zarządzania jakością TQM. Wydawnictwo Akademickie w Poznaniu. Poznań.
7. Łunarski. J. (2008): Zarządzanie jakością. Standardy i zasady. Wydawnictwo Naukowo-Techniczne. Warszawa.
8. Prístavka, M., HRUBEC, J., Kotus, M., (2010): The integrated management system in manufacturing organization. In: Research Methods Improvement, Dnipropetrovsk.
9. Rummler, G. A., Brache, A. P. (2002): Podnoszenie efektywności organizacji. Wydawnictwo PWE. Warszawa.

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INTERACTION OF FOREST MANAGEMENT AND WOOD PROCESSING INDUSTRY IN SELECTED SEE COUNTRIES

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ABSTRACT

In almost all European countries, the net annual increment is higher than the annual felling. In the European region, approximately 40 percent of the increment is utilized (MCPFE, Oslo 2011), thus suggesting that wood harvests could be increased sustainable. The value of wood assortments sale depends on a number of elements: volume and structure of production of net wood mass according to the sorts of wood, technical, quality and thickness structure, supply and demand on the domestic and foreign markets, type of sale, place of delivery, quality of treatment and measurement, level and intensity of state regulation of commodity flow and domestic prices of wood assortments, exchange rate, etc. The paper will analyse the significance and interaction of forestry in the region, like growing stock and annual cut per assortments and wood processing industry production in Croatia, Bosnia and Herzegovina, and Serbia in added value chain.
Key words: forestry production, wood assortments, trade values

1. INTRODUCTION

With forestry management, men consciously intervene in nature and affect the development of forest ecosystems that people put at the disposal of certain goods. Modern human society in front of the forestry and forest resource management make increasing challenges in terms of socially responsible managements, stronger contribution to the development of rural areas and ensuring ecological stability of forest ecosystems for the benefit of future generations (Schmithusen, et.al. 2009). The sustainability principle defined by forestry in Central Europe is the most important aspect of use forests like renewable resources. This definition assumes that volume of current consumption resources and space and options for future action options always have impact on decisions about forest management. The necessity of sustainable forest management shows in Central Europe as a result of the continually growing demand for wood and obvious wood scarcity. Rapid growth of regional and international trade with logs and sawn brings to increasing demand and higher prices of wood which are expressed in many forest areas in central Europe (Kohm, Frenklin 1997). The demand for wood by forest industries has been projected to increase by 15–35% in 2030 compared to 2010 (Mantau et al., 2010). Forests are considered an important resource to meet these renewable energy targets, because (i) wood and wood waste represent currently about half of all the renewable energy production (EUROSTAT, 2010), and (ii) forests are arguably not managed to their full extent as fellings are generally well below the annual increment.

In Croatia, the main task of the Croatian Forests Company is managing forests and forestland of the Republic of Croatia. It also ensures reproduction of state owned forests, i.e. in forests included in the forestial economic territory (Article 19 of the Law on Forests). The "Croatian Forests" Ltd. is a company and an economic subject and the main goal of the Company's business is, therefore: successful managing of state owned forests and forestland, as well as economically sound business. Total land surface of the Republic of Croatia is 56 594 m², of which 42.4% accounts for forest covered surfaces, while the forests cover 47.5% of the land surface in relation to total forestland. This makes Croatia a densely forested European country (Anon 2006). According to the First National Forest

Inventory in the Republic of Croatia (Čavlović, 2010), total forests and forestland area equal 2 580 826 ha, while forested areas account for 2,377,686 ha, of which 77% are state owned and 23% are privately owned. According to that, total growing stock is 552,146,000 m^3 (Čavlović, 2010). The annual cut in state forests is 7 325 000 m^3, and 1 087 000 in private forests (Posavec, S. et al., 2011). Croatian forests are composed predominantly of broadleaved (62.07%), then coniferous (6.45%) and mixed forests (18.58%), while the rest of forests are young plantations (12.85%). Tree species with the biggest share in growing stock are: beech (36.44%), oaks *Quercus robur* L. (14.83 %) and *Quercus petrea* L. (8.35%), hornbeam (5.34%), and fir – *Abies alba* Mill. (9.38%). The share of natural or semi natural forests is 95%, with majority autochthonic tree species (96.35%). In terms of forest types and forest origin, most of them are high forests (57.90%) some belong to coppice (23.56%) and some to mixed forest (15.36%). There are only 0.06% of plantations and 2.65% of cultures in Croatia. The average growing stock in Croatia is 232.22 m^3/ha, in state forests it is 255.84 m^3/ha and in private forests 155.84 m^3/ha.

In Bosnia and Herzegovina, forests represent one of the major natural resources of the country. Due to their natural and diverse structure, as well as extensive natural regeneration, they represent crucial resources for the further development of Bosnia and Herzegovina. Professional development and management in the forestry sector have focused on traditional systems, and has recently undergone changing demands in terms of contributing more to protecting and enhancing all important forest functions, ranging from economic viability, to social responsibility and environmental and ecological sustainability. In general, since the end of the war the forest-based sector is facing significant structural changes and strong modernisation needs in order to be competitive on global markets. According to latest national statistic data, forests and forest land in Bosnia and Herzegovina encompass an area of 3 231 million ha (which is around 63% of the total land area), out of which 1 652 million ha are high forests, and 1 252 million ha are coppice forests. The rest is characterised as other wooded land and comprises shrubs, barren forest land, and other forest areas. In total, about 63 percent of total territory of BiH are covered with forest and other wooded land, one of the highest values in Europe. In terms of forest ownership, around 80% are public forests, and around 20% privately owned. Recent NFI data show that 5.7 million m^3 are harvested per year as a 10-years average. As compared to an annual increment of more than 11 million m^3 this means that only around 50 percent of the annual increment is used for wood production. The harvesting rate in coppice forests is at a rate of 43 percent even more marginal. The volume of annual felling in public high forests (4 416 000 m3) represent 59 percent of its total annual volume increment (7 481 000 m3). In case of private-owned high forests, this percentage is even smaller (around 36 percent).

In Serbia based on the National Forest Inventory, conducted in the period of 2006-2008 (NIŠ, 2008), forests cover an area of 2,252,400 ha or 29.1% (excluding Kosovo) of the total area of the Republic. According to the inventory, other forest land, as well as barren land, include 474,400 ha (6.1%), so that, according to the present situation, about 35% of the area of the Republic is exclusively related to forests and forestry. High level of forest are of coppice origin (1.45 million ha or 64.7% of the total forest area), high forest cover 621 000ha (27,5% of forests) and artificialy established forest cover around 175 000ha (7,8% of all forest). Coppice forests have a very low average wood volume (124.4 m^3/ha) increment (3.1 m^3/ha), so that their production potentials are significantly reduced comapring to the high forest stands with 253m/ha average standing volume and annual increament of 5,5m3/ha. Growing stock amounts 362.5 million m^3 or 160.9 m^3/ha and an annual increament of 9.08 million m^3 or 4,0 m^3/ha. State forests are characterised by insufficient production volume, unfavourable age structure, unsatisfactory density of stocking and forest cover percentage, unfavourable stand condition. Broadleaves account for 87.7% of the total growing stock (beech forests account for 40.5% of the total growing stock, oak forests take around 27%, hornbeam 4,2% ,black locust around 3,1%, poplar 1.7%) while conifers accounts for 12.3% out of total growing stock. Natural and semi natural forest cover around 92% while plantation take some of 8% of the total forest cover. The State Enterprises manage with 1,375,553 ha, which is 51.4% of the area of forests and other wooded land in Serbia. The

remaining forest area is managed by private owners, other public enterprises like national National Parks, Water management company. State Enterprise for forest management “Srbijašume” was established on October 1st, 1991 based on the Forest Law from 1991 while Vojvodina Šume was established in year 2000 and was responsible for management of forest in province of Vojvodina.
The total annual harvesting volume in Serbia based on official statistic data is 2,696 000 m3, where 968 000m3 was industrial round wood and fuel wood amount 1 728 000m3. (Statistical yearbook of Serbia 2010. RZS, Belgrade). Different studies confront official data to critics regarding unregistered harvesting volume (Wisdom Serbia). Glavonjic and other define consumption of wood as firewood in season 2010/2011 for energetic purpose in amount of 6,400 000m3. While statistic have reliable data from state forests discrepancy can be explained with unregistered use of wood in private forest and wood outside the forests.

2. RESEARCH GOALS

The aim of the paper is to analyse the values of forestry production in the region, like growing stock and annual cut per assortments and wood processing industry production in Croatia, Bosnia and Herzegovina, and Serbia. The paper presents significance of forestry and wood processing industry in national economy in added value chain. From the analysed secondary data, paper will focus on aspects like, forest resources and management, and forest-based sector incl. industries & forest-based products. With the purpose to determine the significance of forestry and development of the wood sector, the results will express:

- Background and key figures of the sector
- Trade flow of timber production and wood industry production values through import and export data in selected countries.
- Consumption of wood per capita with a comparative analysis of the relationship between growing stock, annual production, and wood industry production values.

3. TIMBER PRODUCTION

Regarding the timber production BiH has a similar amount of forest available for wood supply compared to Serbia and Croatia, and along with Croatia the highest growing stock per ha in the region. The amount of private forest owners is below those of Serbia, Montenegro, and Croatia, which implies a rather strongly public forest-dominated landscape. As regards use of timber, BiH together with Croatia have the highest felling/increment ratio, while still staying wide below using the annual increment (Sources: MCPFE, 2011, FRA 2010).

Table 1: Production of timber per assortments from 2008-2013 in Croatia

Year	Roundwood	Thin technical wood	Wood for processing	Fuelwood	Total
	m3				
2008	2.256.873	27.666	-	1.768.988	4.356.561
2009	2.017.515	15.013	-	1.782.334	4.174.156
2010	1.991.541	12.263	-	1.941.566	4.295.449
2011	2.323.717	51.079	1.090.026	1.467.708	4.932.530
2012	2.259.801	35.279	1.002.516	1.428.436	4.726.032
2013	2.259.031	41.689	872.953	1.611.871	4.785.544
2014	2.242.972	35.929	694.988	1.850.720	4.824.609

The global energy crisis has reinstalled the wood's position as an important energy product, which will increase the demand and prices. A price of the workforce is another impeding factor in forestry. Productivity increased, but it is limited by biological laws of the forest growth as well as disposal and ownership right.

Table 2: Sales value of wood assortments in Croatia from 2008 to 2014

Year	Logs	Thin roundwood	Cellulose wood	Firewood	Total
	EUR				
2008	155.196.539	1.902.548	26.925.556	18.433.195	202.457.838
2009	137.099.315	2.408.870	20.129.645	17.841.473	177.479.303
2010	123.712.944	438.544	23.300.557	22.355.817	169.807.862
2011	149.888.709	1.639.369	28.420.753	24.325.987	204.274.819
2012	146.793.596	1.137.752	24.994.907	25.431.938	198.358.194
2013	155.817.026	1.307.711	22.586.746	33.135.411	212.846.894
2014	148.657.894	1.118.421	17.197.368	41.039.473	207.713.156

In BIH, the official statistical data on timber sales does not fully correspond to the NFI data (2006-2009) of the annual harvest. Table 3 shows the trend of timber production for 2006-2013. Timber sales solidified in 2013 after some bare in years 2009-2012, which might be explained by the global financial crisis and the regression of wood-processing industries in Europe. Furthermore, it can be shown that there is large discrepancy between harvested and marketed volumes. The reasons for this may be manifold, and are usually a conglomerate of issues:

- Incomparability of NFI statistical approach with market reports
- Incomplete reporting of harvesting and sales
- Private consumption and non-marketed wood, esp. fire wood
- Illegal logging and marketing

However, it can be concluded that although only 50 percent of the annual increment are used, it is less than 40 percent that is reported to be officially marketed.

Table 3: Production of timber per assortments from 2006-2013 (Agency of Stastistics BiH, 2007-2013)

Year	m^3							
	2006	2007	2008	2009	2010	2011	2012	2013
TOTAL	**4.104.333**	**3.752.936**	**4.010.888**	**3.429.025**	**3.614.899**	**3.500.351**	**3.796.369**	**4.024.171**
Coniferous	**1.749.530**	**1.591.946**	**1.722.003**	**1.395.745**	**1.577.825**	**1.580.277**	**1.763.822**	**1.944.451**
Logs	1.349.294	1.195.805	1.308.068	1.028.723	1.060.401	1.047.823	1.176.542	1.256.218
Mining wood	112.518	102.532	108.615	83.812	102.254	118.818	122.860	136.472
Other long coniferous wood	129.427	113.540	116.007	76.717	83.013	92.945	74.783	14.396
Cord coniferous wood	144.990	168.622	181.540	204.261	330.437	318.806	388.066	536.315
Coniferous firewood	13.242	11.447	7.773	2.232	1.720	1.885	1.571	1.050
Broadleaf	**2.354.803**	**2.160.990**	**2.288.885**	**2.033.280**	**2.037.074**	**1.920.074**	**2.032.547**	**2.079.720**
Logs	800.490	727.703	733.200	568.364	597.570	567.670	613.353	643.300
Mining wood	8.069	8.776	6.368	6.954	7.140	5.879	4.886	3.666
Other long broadleaf wood	12.180	14.621	13.170	13.100	16.355	13.599	17.344	15.941
Cord broadleaf wood	87.682	81.216	103.485	117.591	157.552	127.066	130.651	82.008
Broadleaf firewood	1.445.806	1.328.326	1.432.371	1.326.714	1.257.769	1.205.142	1.266.259	1.334.378
Other roughly processed wood	635	348	291	557	688	718	54	427

Data on officially registered timber production in Serbia are presented in Table 4. Analysis of the data shows that the volume of wood production in Serbia in the selected time period was pretty even. In the period from 2000 to 2012, the average value of wood production in Serbia was, according to the National Statistical Office, 2.58 million m³ of wood. Significant deviation from the fairly even production was recorded in 2001 when the total production was only 2.19 million m³, while the highest value of production of 2.94 million m³ was recorded in 200012. Some particular extremes in wood production haven't been recorded since 2002.

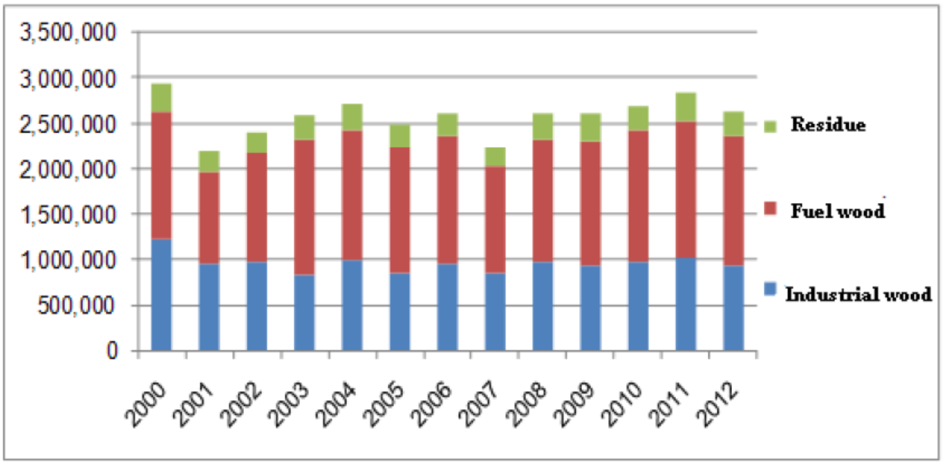

Figure 1. Wood production in Serbia in the period 2004-2012

Different types of sales of wood assortments are present on the wood market in Serbia (on the stump, by the stump, on the road, etc), which are expressed as "revenues from sales of goods" in a company's balances. Such an expressed ravenue contains the ravenue of other types of goods in a small percentage. For these reasons, in orfer to determine the value of other wood assortments sold on the roadside (the amount of 1.99 million m³), the calculation of the value of the sold wood in euros was done, based on the official price list of the PE "Srbijašume" and "Vojvodinasume" for 201283. The data was obtained showing that the total value of realized wood assortments, at prices on forest roadsides was €75.15 million. In the total value of wood assortments the fuelwood and pulp wood participated with 43.7%, logs with 34.4% logs for veneer and peeling participated with 16.9%. The share of fuelwood and pulpwood was less by 13,6% than the participation of these assortments in volume. Quite contrary, the value of logs for veneer and peeling was higher by 6,7%. By companies, the largest share had PE "Srbijašume", with 62.1% and PE "Vojvodinasume", with 27.7%.

Table 4: The value of the wood sold on the roadside, by assortment groups, in 2012 (Euros, source: Vasiljevic A. 2015)

Company	Total		Logs for veneer and peeling		Logs for sawmill		Other techn.wood		Fuelwood and pulpwood	
	€ * 10 ³	%	€ * 10 ³	%	€ * 10 ³	%	€ * 10 ³	%	€ * 10 ³	%
PE „Srbija-sume"	43,921	62.1	2,360	18.8	5,398	59.5	2,045	52.2	24,119	73.5
PE „Vojvodina sume"	23,388	27.7	9,990	79.7	6,661	25.7	844	21.5	5,894	18.0
National parks	5,972	7.6	59	0.5	2,849	11.0	1, 030	26.3	2,034	6.2
Others	1,871	2.7	131	1.0	965	3.7	0	0,0	776	2.4
Total	75.152	100,0	12.540	100.0	25.871	100.0	3 919	100.0	32.822	100.0

Source: Business reports of companies

4. WOOD INDUSTRY PRODUCTION VALUES

The overall significance of the wood industry sector, which has an important role in gross domestic product, employment and foreign trade, is considerably lower than its potential. The privatisation of major social enterprises for wood processing in some cases has not been completed and the use of these capacities is at a low level. The protection of interests is left to individual enterprises, or their associations which could lobby for their better market position through different kind of subsidies.

4.1. Croatia

In 2013, as shown in table 5, production of Croatian wood processing industry (primary and secondary wood products) has increased about 176 million EUR, or approximately around 33% compared to year 2009. The same trend was followed in export trends of primary and secondary wood products, with an amount of 333 million EUR in 2009 and 537 million EUR in 2013. On the other hand, in 2013 import values of wood processing industry products decreased about 23% in comparison to 2009. According to data of consumption per capita of primary and secondary wood products, it is evident that the highest amount was generated in 2009. In 2009 consumption per capita of primary and secondary wood products was 87 EUR, while the lowest amount was recorded in 2011. (69 EUR per capita). In other analyzed years (2010, 2012 and 2013), consumption of primary and secondary wood products per capita amounted 71 EUR.

Table 5. Production, export, import values and consumption per capita of Croatian wood processing industry from 2009 to 2013.

*According to Statistical Reports 1441 - Census of Population, Households and Dwellings (2011)

year	Production	Import	Export	Consumption
	EUR	EUR	EUR	EUR/per capita*
2009.	530.723.946	192.388.000	333.803.782	**87**
2010.	526.893.556	167.013.008	376.804.590	**71**
2011.	574.197.969	171.492.882	439.799.145	**69**
2012	616.453.978	150.573.239	449.816.970	**71**
2013	707.177.826	147.383.861	537.512.903	**71**

number of inhabitants in Croatia was 4.456.096

4.2. Bosnia and Herzegovina

According to available data for 2011 from the Agency for Statistics of BiH (BHAS) and the Chamber of Commerce of BiH, the domestic Wood processing industry can be declared as one of the most important and competitive of the production sectors of the BiH economy. This is illustrated by the fact that it is one of only three sectors in BiH that reported a foreign trade surplus of more than EUR 213,2 million supported by double digit growth in production, sales and export performance, which has resulted in a rise in its share of GDP, manufacturing and the employment structure. Moreover, in 2011 the WP industry saw 10.3 percent annually growth in terms of overall production volume that was almost double when compared to the dynamics of the whole of manufacturing at 5.6 percent annually. The rising production volume was fuelled primarily by a favourable external environment and rising foreign demand amongst the major trading partners (Euro-zone - primarily Germany). This resulted in a vigorous growth in export revenue of 14.7 percent annually up to EUR 381,2 million and amounted to 75 percent of the total wood processing revenue reported in 2011. With such a high and continued annual rise in its proportion of exports in terms of total production and sales the wood processing industry represents a substantial competitive advantage for further BiH economic development.

Through this dynamic wood processing attained an 8.9 % share of the total export of goods and 14.3 % of total manufacturing revenue in 2011 (compared to 8.8 % and 13.8 % respectively in 2010). Therefore, the share of the wood processing industry in 2011 in terms of GDP increased to 0.85 % in 2011 from 0.75 % in 2010. In addition, the structure of production, revenues and exports is becoming more favourable from year to year, with a higher proportion of production from segments with higher added value (Furniture and Seats, Wood Products and Prefabricated Houses). Estimated consumption of sawnwood in 2020 is 507 769 m3 (UNECE report 2012, B2 scenario).

Table 6: Main performance indicators of the wood processing industry in 2011 (FIRMA 2012: BiH industry outlook Wood & Metal Processing Sectors, 2012)

	2011					
	Sales (in million EUR)	percent share	Exports (in million EUR)	percent share	Employment	percent share
Sawmill products	235.4	6.6	141.3	3.3	-	-
Veneer	46.8	1.3	12.8	0.3	-	-
Joinery	24.5	0.7	24.78	0.6	-	-
Other wood products	29.02	0.8	7.85	0.2	-	-
Furniture	171.7	4.8	177.5	4.1	7,942	5.9
Prefabricated houses	3.3	0.1	14.89	0.3	-	-
Total WP	511.5	14.3	381.26	8.9	7,942	5.9
Total Manufacturing	3,578.06	100	4,299.94	100	133,707	100

4.3. Serbia

The continuous increase in the export of wood since 2000 (which was generated by foreign market demands) had an influence on the increase of import of the wood sector. The total balance of foreign trade of the wood sector became positive only in 2012, when the value of export was €6.3 million higher than import. Significant decrease in import values, and partly in export, was recorded in 2008, which matched the beginning of the global economic crisis on the wood market. In fact, the effects of the global economic crisis began to influence business activities in the wood sector in the second half of 2008. The decline in prices of wood assortments on the global wood market began by the end of 2008. According to (UNECE, 2009), small demand caused the prices of lumber to fall, where the price of softwood lumber dropped by 26%. As a consequence of the decrease in demands on foreign markets, the export in section 16 in the period 2008-2010 was decreased by 17.8%. In the same period was a reduction in imports by 33.9%. After 2010, there was an increase in exports, while the value of imports continued to fall slightly.

Based on information from Serbian Chamber of Comerce for 2014 wood processing industry without furniture recorded increase in export for 12,4% related to last year while export in furniture droped for 4,4% related to last year. Total export of wood processing industry and furniture in 2014 amounted around 460 000 000 USD. Surplus in export of furniture reached in 2014 around 128 000 000 USD. Domestic consuption of furniture is on the lowest level in last decade and producer are mostly oriented towards export. Estimated consumption of sawnwood in 2020 is 880 087 m3 (UNECE report 2012, B2 scenario).

5. CONCLUSION

According to Glavonjic et al (2008) primary wood processing, sawnwood and wood-based panels, and furniture production are important to most countries in the region, with Croatia and BiH being the strongest ones. These two countries are also strongest in exports for sawnwood, wood-based panels, and furniture. It is a common phenomenon that value-adding through downstream processing is low, and sawnwood and semi-processed parts dominate exports. The development of entrepreneurship in selected countries is limited by factors such as underdeveloped infrastructure; a lack of skilled labour; limited access to markets and to finance; a lack of investment support and low entrepreneurial potential. Rural development policies in the region which should assist the diversification of the rural economies are still inadequate and not in line with the EU rural development policy. The percentage of export products with higher value added is low, although the situation has changed positively in the past years. The applied technology in major systems is predominantly outdated, so that their products are mainly noncompetitive on the demanding foreign markets. The innovations of process and products are at a very low level, as well as quality standards, which need improvement. In general, the sector is characterised by very low efficiency. Recognized as an important subject in the value added chain of Croatian economy development success, wood industry sector was included as a one of very important drivers in Croatian Industrial Strategy (2014-2020). The Strategy consists instruments for rising competition in wood industry sector and measures for support industrial design, higher added value products (like furniture) and export.

Public forest enterprises have important influence in forest management and have a strong social role as employer. On another side, each country has sawmilling industry characterised by over-capacities and use of outdated technologies in many cases. Technological innovation and coordinated production clusters are needed to increase efficiency in the sawmill operations. The creation of an industrial biomass sector can be seen among the most promising fields for investments but needs respective strategic planning of resource and capacity needs, infrastructure and logistics. Wood pellets production and biomass- based heat production have became areas for future investment. Analysed countries show huge potential for wood mobilizations but needs investment in forest infrastructure and technology. Region is a net exporter of primary and secondary forest products. Production and sales of sawnwood is by far the most important product category, wood manufacturing and furniture production play also a significant role. However, there is a potential to generate domestic value-added (final) products in the processing industry based on quality raw material in selected countries. The wood-based sector will play significant role in future employment and growth of national economies.

REFERENCES

1. Anon (2006): Šumarsko gospodarska osnova područja RH (2006.-2015.)
2. Anon (2012): Croatian Bureau Of Statistics, http://www.dzs.hr/default_e.htm
3. Anon (2013): Agency of Stastistics BiH, 2007-2013
4. Anon (2013): Statistical yearbook of Serbia 2010. RZS, Belgrade Croatian forests Ltd, Bussiness Reports 2008 – 2014 www.hrsume.hr
5. Čavlović, J. (2010): First National Forest Inventory RH, MRRŠVG, Zagreb
6. Banković S, Medarević M, Pantić D, Petrović N. (2008): Nacionalna inventura šuma Republike Srbije
7. FAO (2011): Forest Resources Assessment (FRA). ISBN 978-92-5-106750-5, Rome, Italy 164p
8. FAO (2015): The Forest Sector in Bosnia and Herzegovina, EU funded project "Preparation of IPARD Forest and Fisheries Sector Reviews in Bosnia and Herzegovina"
9. FIRMA (2012): BiH industry outlook Wood & Metal Processing Sectors, 2012
10. Glavonjic, B. et all (2015): WISDOM SERBIA, FAO UN Rome
11. Glavonjic, B. (2008). Drvna industrija Srbije. Beograd: PWC.
12. Mantau et al. (2010): EU wood – real potential for changes in growth and use of EU forest, Final report, Hamburg, Germany
13. Motik, D., Posavec, S., Pirc Barčić, A., Bičanić, K., Moro, M., Perić I. (2013): Analiza i trendovi drva i drvnih proizvoda u Republici Hrvatskoj. Šumarski fakultet Sveučilišta u Zagrebu, 97 p.
14. MCPFE. (2012). State of Forests 2011 Europe's. MCPFE
15. Privredna komora Srbije (2015): www.pks.rs
16. UNECE Forestry and Timber Section (2012): GENEVA TIMBER AND FOREST DISCUSSION PAPER 59 ECONOMETRIC MODELLING AND PROJECTIONS OF WOOD PRODUCTS DEMAND, SUPPLY AND TRADE IN EUROPE Geneva, Switzerland
17. Vasiljevic, A. (2015): The Impact of wood market on Socio-Economic component of sustainable development of wood sector in Serbia, doctoral thesis, Univerzitet u Beogradu, Šumarski fakultet

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POTENCIAL CLUSTERS IDENTIFICATION FOR WOOD-PROCESSING ENTERPRISES IN SLOVAKIA

Erika Loučanová, Martina Kalamárová, Ján Parobek

ABSTRACT

The paper focuses on identifying the potential wood processing industry clusters in the Slovak Republic. This analysis applies methodology of localization coefficients identifying potential regions. Collected data are used for clusters formation. According to SK NACE the research systematically analyses enterprises concentration of the wood processing industry in different regions of Slovakia. Confrontation of the results shows dissimilarities among potential clusters of the wood processing industry according to regions differences.
Key words: cluster, innovation, wood-processing, SME.

1. INTRODUCTION

In the present period of ongoing tensions and chaotic changes, losing power by “mutual fights” is not useful to businesses. It is more appropriate to circumvent the "sharp clashes" with competitors and to join forces through the integration of enterprises in clusters. Enterprises can thus strengthen their own position either by cooperation or alliance. From the system point of view of modern management it is about the art of replacing “negative cooperation" by its counterpart, which is "positive cooperation" clustering (Loučanová et al., 2008) .

These patterns were studied in Japan, USA and UK by an American economist Michael Porter, who found out that the economic growth and technological development is often concentrated in several regions, in which sector- related companies, research institutions and education are concentrated. He calls such concentrations clusters and defines them as " ... geographic concentration of interconnected companies, specialized suppliers, service providers, enterprises in related industries and institutions in a particular sector that compete with one another but also cooperate " (Duman et al., 2009).

Agglomeration effects also contribute to the development of clusters. The so-called "Clustering of industries and companies " is based on external benefits of agglomeration and the common shares of companies concentrated in that area that jointly deliver them savings, encourage them towards introducing innovations as well as to the rivalry and competitiveness (Štofková, 2013).

The representatives of clusters in Slovakia gather in a common union called Union of Clusters of Slovakia in order to promote, consolidate and procure the common objectives in the economic system of Slovakia. It introduces to individual clusters a partner for communication not only at national but also international level in the field of cluster policy and clustering itself. Its aim is to support economic development and competitiveness of all Slovak regions through clustering tools. It covers the entire territory of the Slovak Republic and works at the national level in the preparation of strategic materials in cluster policy in Slovakia (Union of Clusters of Slovakia, 2015).

In Slovakia there are clusters, technological clusters:

- 1st Slovak engineering cluster, region of Banská Bystrica
- Automotive Cluster – west region of Slovakia, region of Trnava
- BITERAP Cluster, region of Košice
- Electrotechnical cluster – west region of Slovakia, region of Trnava
- Energy Cluster - west region of Slovakia, region of Trnava
- Cluster AT+R, region of Prešov
- Košice IT Valley z.p.o, region of Košice

- Slovak Plastic Cluster, region of Trnava
- Z@ict, region of Žilina

and clusters of tourism:
- Cluster of tourism – west region of Slovakia,
- Cluster LIPTOV – region of Žilina,
- Cluster ORAVA – region of Žilina,
- Cluster TURIEC – region of Žilina,
- Balnea Cluster, region of Banská Bystrica (SIEA, 2015).

Therefore, it is clear that the wood industry in cluster initiatives in Slovakia is not represented despite the fact, that it has a long tradition in Slovakia. Wood in Slovakia is a strategic renewable raw material. It is a source that Slovakia disposes of and connection to tradition of wood processing industry produces traditional industry in Slovakia (Šupín, 2011; Paluš, Šupín, 2004; Paluš et al., 2012).
For this reason, the aim of this paper is to identify potential cluster of wood processing sector in Slovakia at the regional level.

2. METHODOLOGY

Methodology is constructed by Šterbová et al. (2014) and Loučanová (2008). We used analytical and synthetic methods that connect approaches to the issue of innovation systems in the wood sector. Through the analysis of phenomena and processes we analysed the issue of innovations and innovation system, following the grouping and cooperation in the context of potential clusters in the wood-processing sector on regional level in the Slovak Republic.

The classification of enterprises in wood sector was based on the data collected and on the analysis of relevant information from the Register of Financial Statements of the Ministry of Finance of the Slovak Republic. We created a database of information through the following search criteria: 8 different regions of the Slovak Republic and numeric codes of subclasses, which consisted of enterprises according to the SK NACE (statistical classification of the character of their economic activities):
16100 Sawmilling and planing of wood
16210 Manufacture of veneer sheets and wood-based panels
16220 Manufacture of assembled parquet floors
16231 Manufacture of builders' carpentry and joinery
16232 Production of components for prefabricated buildings
16239 Manufacture of other builders' carpentry and joinery and other
16240 Manufacture of wooden containers
16290 Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting materials

We have not taken into account enterprises pulp and paper industry.

Based on the gained data we calculated the Localization quotient (LQ).

The formula for calculating the LQ modified for the number of enterprises by Porter (1998):

$$LQ = \frac{x_i / X}{y_i / Y} \qquad (1)$$

where:
LQ - localization quotient in the region,
X_i - number of enterprises in the wood sector in the region,
X - total number of enterprises in the region,
y_i - number of enterprises in the wood sector in Slovakia,
Y - total number of enterprises in Slovakia.

Clusters potentially exist in the regions, where groups of related industries with LQ higher than 1 are located. Based on this methodology subsequently, we identified the key regions suitable for the cluster in the wood processing sector (Šterbová et al., 2014).

3. IDENTIFICATION OF THE POTENCIAL CLUSTER OF WOOD-PROCESSING ENTERPRISES IN THE SLOVAKIA

The purpose of identifying clusters is to help national and local organizations and companies, public and private sector to determine the "focus" of existing or potential competitive advantages, which could be further and faster developed with a combination of public and private resources to achieve common goals.

Based on the database information, the Localization quotient was calculated (see. Table 1). Localization quotient with a value of 1 indicates the appropriate regions of potential cluster of wood processing industry in Slovakia.

Table 1 Localization quotient of Slovak region

Region		BB	BA	KE	NR	PO	TR	TT	ZA
LQ Wood processing sector - total		**1,01**	0,24	0,70	0,61	**1,76**	0,86	0,64	**2,38**
LQ by SK NACE to region / SK NACE		BB	BA	KE	NR	PO	TR	TT	ZA
16100	Sawmilling and planing of wood	**1,05**	0,33	0,60	0,48	**1,62**	0,68	0,32	**4,03**
16210	Manufacture of veneer sheets and wood-based panels	0,06	0,02	0,02	0,03	0,10	0,02	0,01	0,10
16220	Manufacture of assembled parquet floors	0,01	0,00	0,00	0,01	0,00	0,00	0,00	0,01
16231	Manufacture of builders' carpentry and joinery	0,19	0,09	0,10	0,20	0,59	0,15	0,12	0,43
16232	Production of components for prefabricated buildings	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01
16239	Manufacture of other builders' carpentry and joinery and other	0,17	0,19	0,17	0,23	0,75	0,19	0,34	0,43
16240	Manufacture of wooden containers	0,08	0,03	0,07	0,04	0,15	0,07	0,06	0,10
16290	Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting materials	0,43	0,22	0,43	0,34	0,85	0,43	0,29	0,57

Higher representation share of industry in the region than the state average (LQ) creates potential clusters. This survey determined the actual position of potential clusters of wood processing industry in Slovakia for the regions of Banská Bystrica, Žilina and Prešov.

It is likely that over time, these positions will get sharper and more specific contours of better understanding the nature of competitiveness of clusters, the opportunities clusters provide to their members and in the regions where social capital is concentrated. Social capital is very important for the formation of a cluster, given the necessary links between enterprises in the cluster and not only the concentration of businesses in the region. This will also affect the future concentration of enterprises of the wood industry in clusters.

Based on the localization coefficient, regions suitable for the location of the wood processing industry cluster are Prešov, Banská Bystrica and Žilina (Figure 2). As can be seen from the collected data, the main focus of these potential clusters is on the first-stage processing of wood.

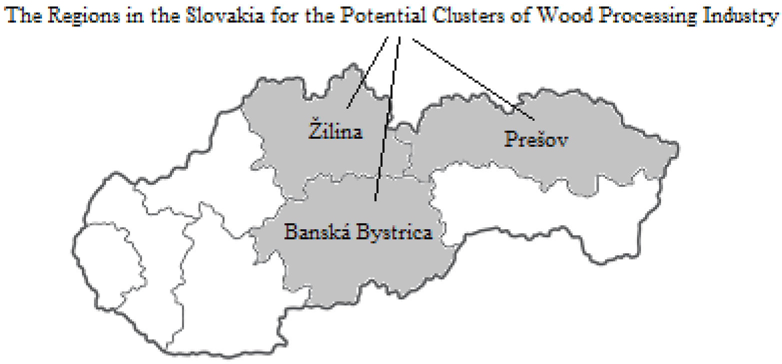

Figure 2 Localization of Wood-processing enterprises clusters

4. CONCLUSION

Continuous growth of competitiveness of Slovak industry is a necessary and important qualification for the successful application of enterprises in a global market. A possible tool for improving the competitiveness of DSP (from Slovak language Wood Processing Industry) enterprises in Slovakia is to join forces by integration of enterprises in the cluster of wood processing industry whose potential is identified in Nitra, Banská Bystrica and Žilina regions.

REFERENCES

1. Duman, P. et al. 2009. *KLASTRE NA PODPORU ROZVOJA INOVÁCIÍ : ANALYTICKÁ ŠTÚDIA* [online]. Bratislava : Slovenská inovačná a energetická agentúra, 2009. 35 s. Available from: <http://www.siea.sk/materials/files/inovacie/slovenske_klastre/Klastre-SIEA.pdf>.
2. Dzian M. 2014. PROSTREDIE ŠÍRENIA WOM NA SLOVENSKU V RÁMCI GENERÁCIE Y. In Globalizácia a je sociálno-ekonomické aspekty ´14. ISBN 978-80-554-0927-6. s. 89-95.
3. Loučanová, E., Zaušková, A. 2008. KLASTER AKO NÁSTROJ NA ELIMINÁCIU BARIÉR INOVATÍVNOSTI MALÝCH A STREDNÝCH PODNIKOV DREVOSPRACUJÚCEHO PRIEMYSLU. Zvolen : Technická univerzita vo Zvolene, 2008. 116 s. ISBN 978-80-228-1890-2.
4. Paluš, H., Maťová H., Kaputa, V. 2012. CONSUMER PREFERENCES FOR JOINERY PRODUCTS AND FURNITURE IN SLOVAKIA AND POLAND. In Acta facultatis xylologiae Zvolen : vedecký časopis Drevárskej fakulty. - ISSN 1336-3824. - Roč. 54, č. 2 (2012), s. 123-132
5. Paluš, H., Šupín, M. 2004. COMPETITIVENESS OF SELECTED CLUSTERS IN THE SLOVAK FOREST INDUSTRY. In The growth and developement in forestry and wood industry : scientific book. - Zagreb : University of Zagreb, Faculty of Forestry, Research Institute for Wood Technology, 2004. ISBN 953-6307-73-1, p. 17-20.

6. Porter, M. 1998. CLUSTERS AND THE NEW ECONOMICS OF COMPETITION. In Harward Business Review, Nov-Dec 1998. ISSN 0017-8012, Nov-Dec 1998, p. 25 -26.
7. Register UZ, 2015. [on-line] Registeruz, 2015. [cit. 23.04.2015] Available from: http://www.registeruz.sk
8. SIEA, 2015. [on-line] SLOVENSKÁ INOVAČNÁ A ENERGETICKÁ AGENTÚRA, 2015. [cit. 23.04.2015] Available from: https://www.siea.sk/klastre-na-slovensku/
9. Štěrbová, M. et al. 2014. THE REGIONAL INNOVATION PARADOXES OF FORESTRY CONTRACTORS FIRMS IN SLOVAKIA. In Investments to forests and forest based production : scientific book. - Zagreb : WoodEMA, 2014. ISBN 978-953-57822-2-3, p. 33-57.
10. Štofková, K. 2013. KONKURENCIESCHOPNOSŤ PODNIKOV V PODMIENKACH EURÓPSKEJ INTEGRÁCIE A GLOBALIZÁCIE. In: Pošta, Telekomunikácie a Elektronický obchod. 1 (2013) 71-74. ISSN 1336-8281.
11. Šupín, M. 2011. ANALÝZA VPLYVU GLOBALIZÁCIE NA SLOVENSKÝ DREVÁRSKY PRIEMYSEL V PRVEJ DEKÁDE 21. STOROČIA. In Marketing a obchod 2011 : vplyv volatility a interdependencie v svetovom hospodárstve na marketing a obchod. Zvolen : Bratia Sabovci, 2011. ISBN 978-80-89241-41-5, s. 282-286.
12. Triznová, M. 2014. MANAŽMENT VZŤAHOV SO ZÁKAZNÍKOM. Zvolen : Technická univerzita vo Zvolene, 2014. 86 s. ISBN 978-80-228-2640-2.
13. Union of Clusters of Slovakia, 2015. [on-line] ÚNIA KLASTROV SLOVENSKA, 2012. [cit. 23.04.2015] Available from: http://www.uksk.sk/

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THE POTENTIAL CLUSTERS AND REGIONAL INNOVATION PARADOXES IN THE FORESTRY SERVICE SECTOR IN SLOVAKIA

Martina Štěrbová, Erika Loučanová, Jaroslav Šálka, Hubert Paluš

ABSTRACT

The emphasis in the process of providing forestry services has been put on quality. The basic elements of success are the innovations that are the result of the institutional process. The ability of contractor firms to generate innovations currently depends on the ability to work and interact as a part of the innovation system. The basic functions of that innovation system in the forestry service sector are cooperation between the various actors, exchange of information and reducing uncertainty, management of conflict and risk. In the market of forestry services clustering is in its beginning and enterprises merge together and work as partners mainly on an informal level. The aim of the study is to identify the regional paradoxes within the enterprises providing services in forestry sector on the regional level in the Slovak Republic, in the area of potential clusters - innovation networks representing an effective system for promoting innovations based on the principle of synergistic effect.
Key words: cluster, innovation paradoxes, forestry services

1.THEORETICAL BACKGROUND

In recent years, the overriding role of forestry is associated with the provision of a wide range of services. These services are provided by a community of forestry contractors' consisiting mostly of small and medium-sized enterprises that don´t own and use forest lands, but only provide and ensure the full range of forestry services (bouriaud et al. 2011).

The emphasis in the process of providing forestry services has been put on quality. The basic elements of success are the innovations that lead to the use of specific technologies, which providers understand as their competitive advantage. A strong competition on the forestry service providers' side is partially forcing entrepreneurs to invest money in new advanced technologies. It is quite obvious that firms with modern technologies are able to obtain employment contracts (paluš et al., 2011).

However, innovations are the result of the institutional process, which means that the entrepreneur is not the only one who is responsible for the innovation activity of the company. The integration into the system of institutions that can support innovations is really important. The innovation systems represent a set of different institutions and actors who influence innovation processes in a given territory and they have been categorized into the national, regional and sectorial innovation systems. The innovation system of the forestry service sector has an influence on competition and cooperation, which is necessary for the implementation of innovation activities. The basic functions of that innovation system in the forestry service sector are cooperation between the various actors, exchange of information and reducing uncertainty, management of conflict and risk, creating new innovations, and their dissemination and use. It is divided into four levels: institutional, business to business (b2b), firm and personal levels (štěrbová et al., 2014).

The present time is typical for its permanent tension and chaotic changes. In these situations it is resonable to replace "negative cooperation" (fighting, rivalry, competition) by "positive cooperation" (cooperation, alliances, clusters), or the least to avoid competitive scrambles (neutral cooperation). However, it is assumed that cooperation with competitors may also partially include fights or "positive cooperation" may to change into the "negative cooperation" and vice versa after a period of time (Trnka, 2004).

Porter (1998) defines a cluster as *a „geographical proximate group of interconnected companies, specialized suppliers, service providers and associated institutions in a particular field, linked by commonalities and externalities, which together compete but also cooperate."*

In the market of forestry services clustering is in its begining and enterprises merge together and work as partners mainly on an informal level. These informally organised cooperations allow different information exchange on various degrees of institutionalisation. The Association of Entrepreneurs and Tradesmen Working in the Forestry Service Sector of the Slovak Republic has a characteristic function within the cluster and aims to create the best conditions for the development of small and medium-sized enterprises in the forestry sector in each region of the Slovak Republic. The association seeks to promote the professional and economic interests of its members in the course of their profession as well as ensuring fair competition between the economic entities. However, the actors from other sectors have also an important role (Zaušková et al., 2009).

In terms of innovation activities of the firms providing forestry services, participation of a firm in the cluster has a great importance and brings many benefits. By the constant contact with each other, companies are able to get very quickly a lot of information about evolving technologies, available parts, machines, new services and marketing concepts. There can be more enterprises working together in innovation creating process and they can also share the costs necessary for the development of new products and technologies. This creates strong networks between the firms and scientists, researchers and developers. There is a mutual inspiration and often in connection with the cross-cutting cluster "spill-over" effect, when technology from one field or industry can be used in supplementary or completely different industrial fields.

The aim of this work is to identify the regional paradoxes within the enterprises providing services in forestry sector on the regional level in the Slovak Republic, in the area of potential clusters - innovation networks representing an effective system for promoting innovations based on the principle of synergistic effect.

2.MATERIAL AND METHODS

We used analytical and synthetic methods that connect approaches to the issue of innovation systems in the forestry service sector. Through the analysis of phenomena and processes we analyzed the issue of innovations and innovation system, following the grouping and cooperation in the context of potential clusters in the forestry service sector on regional level in the Slovak Republic. We analyzed this issue by individual parts using the the descriptive method; we described their relationships to identify innovative paradoxes on the observed level.

The classification of contractor firms in forestry service sector was based on the data collected and on the analysis of relevant information from the Register of Financial Statements of the Ministry of Finance of the Slovak Republic. We created a database of information through the following search criterion - 8 different regions of the Slovak Republic. Based on the gained data (number of the contractor firms in forestry service sector in individual regions in Slovakia and the total number of enterprises in the regions and in Slovakia) we calculated The Coefficient of Localization (LQ). This is also known as the index of concentration, which measures the degree of concentration of the contractor firms in forestry service sector over a set of regions. The LQ coefficient is then the sum either of the positive or negative deviations of the regional percentage of firms in the given region from the corresponding regional percentage of all enterprises in this region. We identified the regions with LQ higher than the state average, to identify regions which play the key role in grouping of the contractor firms in forestry service sector.

Porter (1998) defines the formula for calculating the LQ modified for the number of enterprises:

$$LQ = \frac{x_i / X}{y_i / Y}$$

where:
LQ - coefficient of localization in the region,
X_i - number of contractor firms in the forestry service sector in the region,
X - total number of enterprises in the region,
y_i - number of contractor firms in the forestry service sector in Slovakia,
Y - total number of enterprises in Slovakia.

Regional clusters potentially exist in the regions, where groups of related industries with LQ higher than 1 are located. It indicates regions with a particularly large representation of selected enterprises. A value of 0 would indicate that the contractor firms are distributed very evenly over the region. A value of 1 indicates an extreme concentration of firms in one region within the country, but there can be more than one region with LQ higher than 1 in the same country. Subsequently, we identified the key regions suitable for the cluster in the forestry service sector.

Further on we focused on mapping the innovation activities of Limited Liability Companies in forestry service sector during the financial year 2012. We identified the regions with the highest and the lowest innovation activity in the field of investment innovations in this year. The assessment of innovation activities was based on the theoretical background of innovation, where innovation is defined as a quantitative or qualitative changes in the system of enterprise, relating to any area of its activity, that will benefit based on the assumption that entrepreneurs do not invest money in material equipment without subsequent benefit, so each one euro invested represents an investment into the innovations. This information about innovation investments was drawn from the Register of Financial Statements of the Ministry of Finance of the Slovak Republic. From the balance sheets published by various entities we found the value of assets for the financial years 2012 and 2011 and calculated the annual changes. This demonstrated the innovation activity in the category of investment innovations of these entities in the selected period. Our conclusions were based on the finding that the positive change demonstrated the positive innovation activity in the company. A negative change (assets were higheer in 2011 compared to 2012, the amount of accumulated depreciation exceeded the amount of capital investment in investment innovations) indivated that that the entity did not implement innovations.

To fulfill the objective of this work we finally used the method of comparing the value of investment in innovations of Limited Liability Companies within the individual regions and the concentration of these companies within the sector. The actual synergic effect of innovation networks - clusters, representing an effective system for promoting innovations, was observed by the integral indicator of pragmatic value of innovation activity within the regions, where these companies are located, and the concentrations of these companies in the sector, as well as the forest cover of regions. The final evaluation was done by summing and ordering the individual values.

3.RESULTS

There are totally 21,694 firms providing services in forestry in Slovakia. In the Slovak Republic most of the contractor firms is situated in regions of Prešov (PO) and Banská Bystrica (BB). This is connected to the fact, that these regions are characterised by the largest forest area in Slovakia. A relatively large number of firms can be also found in the regions of Košice (KE), Žilina (ZA) and Trenčín (TN). The fewest number of enterprises is present in the regions of Nitra (NR), Trnava (TT) and Bratislava (BA). This can also be attributed to the total area of forest land, which is the lowest in these regions of Slovakia (Table 1).

Table 1. The classification of firms in the forestry service sector according to regions of Slovakia

Region	BB	BA	KE	NR	PO	TN	TT	ZA
Number of firms	5 777	380	3 177	804	6 120	1 976	609	2 883

Based on these data the localization coefficient was calculated. It is used to indicate regions, where the groups of related enterprises (LQ higher than 1) or potential clusters in Slovakia within the individual regions can be found (Table 2).

Table 2. The coefficient of localization for different regions of Slovakia in the forestry service sector

Region	BB	BA	KE	NR	PO	TN	TT	ZA
LQ	2,42	0,09	1,32	0,31	2,19	0,92	0,28	1

Base on the LQ values shown in Table 2 we can determine the regions with the highest concentration of contractor firms and thus state that the regions of Banská Bystrica, Poprad and Košice can be considered as preferred potential regions for the creation of forestry contractors' cluster. The considerable potential for creating clusters is in region of Žilina too, where LQ assumes a value equal to 1. However, the coefficient of localization does not specify which of these regions has the highest mportance for the forestry service sector. It shows only the actual, static status of each sector.

In the next section we focused on the survey of investment innovations in Limited Liability Companies, as they are required to publish their financial statements (within their balance sheet, income statement and notes) for each accounting period. At the same time, this is the most preferred legal form of partnership in the forestry services sector in Slovakia.

The innovation activity in the field of investment innovations of Ltd. companies according to individual regions of Slovakia are illustrated in Table 3. The results show significant regional differences.

Table 3. Investment innovations of Limited Liability Companies by regions

Region	Value of assets (€)		
	Accounting period		Annual change
	2012	2011	
BB	35 716 277	33 808 277	**1 908 000**
BA	3 919 160	3 008 024	**911 136**
KE	20 245 995	20 846 969	**-600 974**
NR	10 343 729	10 550 791	**-207 062**
PO	32 356 435	30 305 171	**2 051 264**
TN	9 795 953	8 845 860	**950 093**
TT	6 537 300	6 767 908	**-230 608**
ZA	12 335 929	11 314 833	**1 021 096**
Total	**131 250 778**	**125 447 833**	**5 802 945**

As shown in Table 3, the highest amount of investment into innovations was spent by Ltd. companesies located in the region of Prešov and Banská Bystrica. The lowest amount was invested in the region of Košice, Trnava and Nitra.

To identify regional paradoxes within the enterprises of forestry service sector at the regional level of the Slovak Republic in the area of potential clusters (innovation networks representing an effective system for supporting innovations based on the principle of synergistic effect), the innovation activity was compared with the share of sector that enterprises operating in the region hold on the the LQ state average. These represent potential clusters; virtual innovation networks of effective system for supporting innovations (Table 4).

Table 4. Identification of regional paradoxes within the enterprises of forestry service sector

Region	BB	BA	KE	NR	PO	TN	TT	ZA
Innovation activity (mil. €)	1,908	0,911	-0,601	-0,207	2,051	0,951	-0,236	1,021
LQ of Ltd. companies	2,54	0,19	1,06	0,51	2,20	1,02	0,56	1,57

The identification of regional paradoxes within the enterprises of forestry service sector at the regional level of the Slovak Republic was based on the assummtion that the regions with the higher concentration of companies into innovation networks or clusters will be the innovation leaders and the highest amount of investment into innovations will be found here.

The values obtained for the region of Košice are remarkable, as on one hand, this region is considered as a strategic area in relation to cluster formation within the sector because of the existence of a group of related enterprises, however, on the other hand, there were negative values of investments into innovations (the lowest value among all 8 regions in Slovakia) in companies identified in this region during the observed period. In these companies the amount of accumulated depreciation exceeds the value of investment, so we can assume that investment innovations were not implemented by the companies during the selected period, or their character was not so extensive and the value of accumulated depreciation to previous investment innovations exceeded the value of capital invested into innovations.

The opposite situation was in the region of Bratislava, where despite of a very small concentration of enterprises of the sector, there was a high amount of capital invested into innovations per enterprise at average. In terms of the synergic effect of supporting innovations through innovation networks – clusters, this situation can be called as the “innovation paradox“. However, in the Bratislava region it is rather a regional specific resulting from the concentration of capital in Slovakia than the "innovation paradox". In relation to concentration of capital, there are also different rules applied in this region comapred to other regions in Slovakia.

The integral indicator of value was used to determine the value of the innovation activities of contractors in the forestry service sector. As shown in Table 5, information about concentration of selected companies, their innovation activity and the forest cover within the regions of the Slovak Republic were summarised in the matrix of multicriteria evaluation to quantify this indicator.

Table 5. Matrix of multicriteria evaluation

Region	Innovation activity (mil. €)	Rank	LQ Ltd. companies.	Rank	Forest cover	Rank
BB	1.9080	7	2.5400	8	0.4910	6
BA	0.9111	4	0.1900	1	0.3660	4
KE	-0.6010	1	1.0600	5	0.3960	5
NR	-0.2071	3	0.5100	2	0.1520	2
PO	2.0513	8	2.2000	7	0.4920	7
TN	0.9509	5	1.0200	4	0.4920	7
TT	-0.2361	2	0.5600	3	0.1570	3
ZA	1.0211	6	1.5700	6	0.5590	8
Character of criterium	+ 1		+ 1		+ 1	

The value of the synergic effect of innovation networks – clusters in forestry sector represents an effective system to support innovations. As shown in Table 6, the highest values occurred for the region of Prešov, Banská Bystrica and Žilina.

Table 6. Synergic effect of innovation networks

Region	BB	BA	KE	NR	PO	TN	TT	ZA
Integral indicator	21	9	11	7	22	16	8	20
Rank	2	7	5	8	1	4	6	3

4.CONCLUSION

In the latest years, there has been a business community created and significantly expanding within the forestry sector. This community consists of firms providing services in forestry. The first part of this paper deals with the actual situation of contractor firms in the forestry service sector in Slovakia. As for regional distribution most of the enteprises can be found in the region of Banská Bystrica, Prešov and Košice. These regions are considered as the key regions for potential clusters in the sector and suitable for the mapping of relations between contractor firms in forestry service sector based on the knowledge of the general laws of development and operation in this field, as well as general laws of behavior of clusters and innovation system. In general conclusion it can be concluded that public institutions at local, regional, national and transnational levels, as well as research and education, can be considered as the most important elements of the innovation system in the forestry service sector.

As Paluš et al. (2011) states, it is typical for the market of forestry service sector that innovatiion activities are significantly affected by specifics of forestry production, such as seasonal silvicultural operations, random accidental felling, etc. Innovations also affect the amount of specific investments and the conditions of their implementation. They are gradually becoming the main driver of success in many business sectors and activities. They represent a long-term source of profit, business success, competitive advantage, work on the future of the company, part of its strategic management, key process in companies (Košturiak, Chaľ. 2008).

Based on the results of this study, the most innovative companies were located in the region of Banská Bystrica, Prešov and Žilina. This strengthens the strategic position of these regions in relation of the cluster formation within the forestry service sector. The “innovation paradoxes“ were indetified within the region of Košice and Bratislava.

Acknowledgements

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REFERENCES

1. Bouriaud, I. et al. (2011): Policy and market-related factors for innovation in forest operationsenterprises. In: Weiss, G., (eds.). Innovation in Forestry – Territorial and Value Chain Relationships. CAB International, UK. p. 276-293.
2. Košturiak, J,. Chaľ, J. (2008): Inovace – vaše konkurenční výhoda!: Computer Press, 2008. 164 s. ISBN 978-880-25119-29-7.
3. Paluš, H., Kaputa, V., Parobek, J., Šupín, M., Šulek, R., Fodrek, L. (2011): Trh s lesníckymi službami. Zvolen: TU Zvolen, 2011. 45 s. ISBN 978-80-228-2334-0.
4. Porter, M. (1998): Clusters and the New Economics of Competition. In *Harward Business Review, Nov-Dec 1998*. ISSN 0017-8012, Nov-Dec 1998, p. 25 -26.
5. Trnka, F. (2004): Výzkum konkurenční schopnosti českých průmyslových výrobců, Zlín : Univerzita Tomáše Bati, Fakulta managementu a ekonomiky, 2004. 160 s. ISBN 80-7318-219-X.
6. Štěrbová, M., Šálka, J., Paluš, H., 2014: Inovačný systém v sektore lesníckych služieb. Acta Facultatis Forestalis Zvolen. 2014. zv. Roč. 56(1), 113-125. ISSN 0231-5785.
7. Zaušková, a., Loučanová, E., Sarvašová, Z., Fodrek, L. (2009): Inovačný governance a lesníctvo, In: Governance v lesníctve, Národné lesnícke centrum Zvolen. 2009. s. 156-202. ISBN 978-80-8093-086-8.
8. http://portal.statistics.sk
9. http://www.registeruz.sk/cruz-public/domain/accountingentity/search

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QUALITY MANAGEMENT IN WOOD PROCESSING INDUSTRY IN SLOVAKIA AND THE CZECH REPUBLIC

Pavol Gejdoš

ABSTRACT

The paper deals with the issue of building and certification of quality management systems in terms of wood processing industry in Slovakia (SR) and the Czech Republic (CR). It presents the results of the current status of the using of ISO 9000 standards in companies of the wood processing industry (WPI) in Slovakia and the Czech Republic, through which we can built the Quality Management Systems (QMS). It monitors the advantages and disadvantages of the QMS and their individual components in terms of wood processing industry, which should ensure higher efficiency in the whole sector. In the paper have been used methods of analysis and synthesis of data, correlation analysis and questionnaire investigation method. The main results are: too high a formality implementation of QMS, QMS has very little effect on achieving better economic results and costs reduction of the company, the reasons for the implementation of the QMS is to gain competitive advantage, obtain better contracts and many others.
Key words: certification, quality management systems, implementation, wood processing industry, Slovakia, Czech republic

1.INTRODUCTION

The term quality is still more and more used in professional practice and also in usual life because it is becoming the criterion according to which is decided about surviving or extinction of companies. Area of quality is one of the substantive components in the company because without quality goods and services, which firms offer or should offer, company cannot exist. Only expressive increasing of quality can guarantee the efficiency of production and competitiveness of the company. One way to increase the quality and performance of organizations is the implementation of ISO 9000.[6]

2.QUALITY MANAGEMENT BASED ON ISO 9000 IN SLOVAKIA AND THE CZECH REPUBLIC

The basis for the analysis of the actual implementation of QMS in the wood – processing industry (WPI) in Slovakia and the Czech Republic was the creation of a questionnaire, which consisted of several classification issues (industry sector, size of business, length of time on the market), whose purpose was to diversify the various types of business of WPI and questions in which respondents gave relevant answers to the asked questions (QMS length of implementation, reasons, benefits and negative aspects of the implementation process etc.). The questionnaire was sending out an electronic form to all companies operating in the market in both countries and whose contacts are available.
The information was collected electronically, then they were used scientific methods of analysis and synthesis of data which were then processed in Excel as well as assessed by correlation analysis of program Statistics.

The first classification issue a questionnaire investigation was the question about the industry in which it operates (Table 1).

Table1. The share of questioned enterprises in the sectors of WPI in SR and CR

WPI	SR	CR
	%	%
Wood industry	25 %	48 %
Furniture industry	66 %	43 %
Pulp and paper industry	9 %	9 %

Another classification of the questions raised in the questionnaire was the question of the size of the undertaking and provided that the characteristics of each group was defined only limit to the number of employees in the company. The data obtained are presented in table 2.

Table 2. The share of enterprises WPI in SR and CR by size of enterprise

Size of company	SR	CR
	%	%
Micro and small enterprises (under 50 employees)	76%	17%
Medium enterprise (51-250 employees)	20%	63%
Large enterprise (251 and more employees)	4%	20%

Other information that has been subject to review information on the length of exposure of companies in the market. The results are presented in Table 3.

Table 3. The share of enterprises WPI SR and CR by the length of time on the market

The length of exposure of companies in the market	SR	CR
	%	%
Less than 1 year	0 %	0 %
1 - 5 years	11 %	0%
5 - 10 years	7 %	9 %
Over 10 years	82 %	91 %

Another area that we were interested in was to give reasons why companies have decided to introduce QMS(Fig.1). As we can see from the graph fundamental differences between the two countries are mainly the reasons such as improving the quality of where this ground in Czech Republic favors almost twice as enterprises in Slovakia, the result is the same reason for such a company's competitiveness and market position.

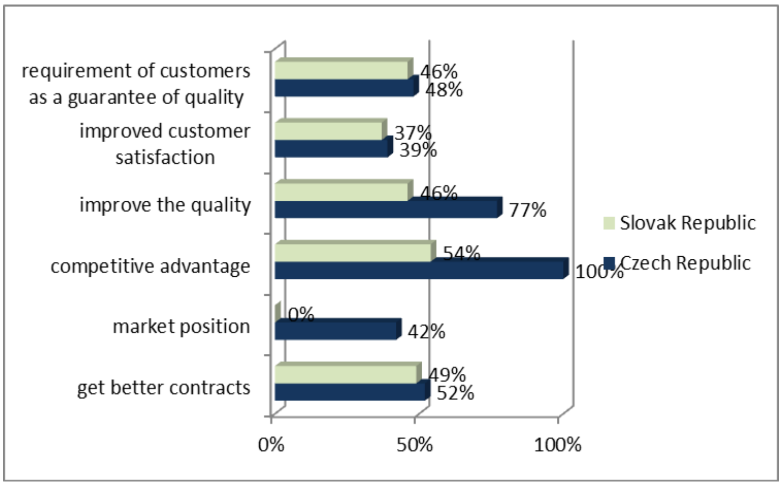

Figure 1. Reasons for the introduction of QMS in the wood processing enterprises in Slovakia and Czech Republic

Another issue concerns the benefits brought by the enterprises established and certified QMS. Identified benefits are presented in Figure 7.

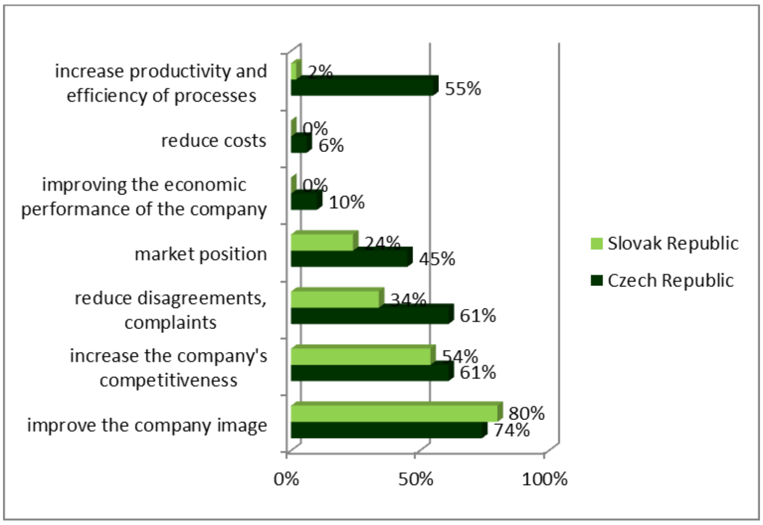

Figure 7. Benefits from the introduction of QMS in the wood processing enterprises in Slovakia and Czech Republic

The next part of the article presents the results of correlation analysis. According to the results of correlation analysis, where the value of the correlation coefficient reached 0.583, there is a statistically significant correlation relationship between the DSP industry in Slovakia and the implementation of QMS. This fact has further examined using one-way analysis of variance and we came to the conclusion that the undertaking of the timber industry is largely not implemented QMS, for the furniture industry enterprises, the situation is slightly better, where either have implemented QMS, or can be implemented in accordance with ISO 9000. In the pulp - paper industry, the situation is best which is documented by Figure 3, with 0 on the x axis represents the Wood industry, one - Furniture and 2- pulp - paper industry.

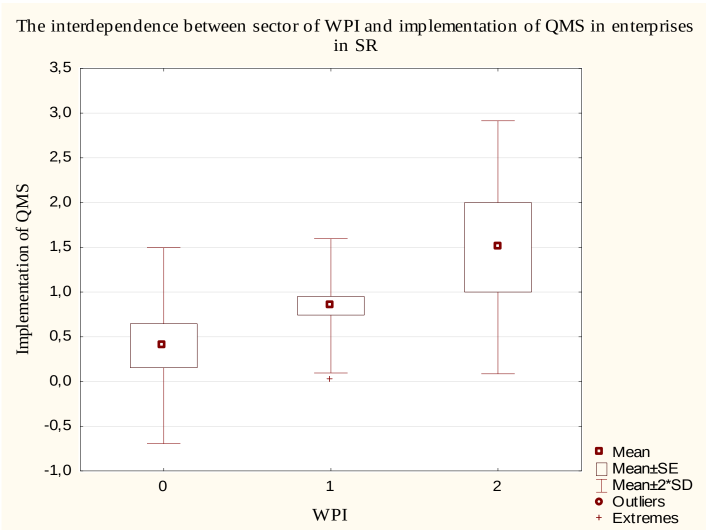

Figure 3. The interdependence between sector of WPI and implementation of QMS in enterprises in SR

Similarly, there is a statistically significant correlation between the length dependence of the implementation of the ICS and the DSP industry in Slovakia. Based on the value of the correlation coefficient of 0.569, we can say that the situation is very similar to the previous one, when companies of wood industry in the implementation of QMS declare the length of the application process most frequently in five months, Furniture 6-12 months and pulp - paper industry over 12 months . As a critical reason there seems to be mainly size of the undertaking and therefore demands the creation and building of QMS. Figure 4 shows the results, with 0 on the x axis represents the Wood industry, 1 - Furniture and 2- pulp - paper industry.

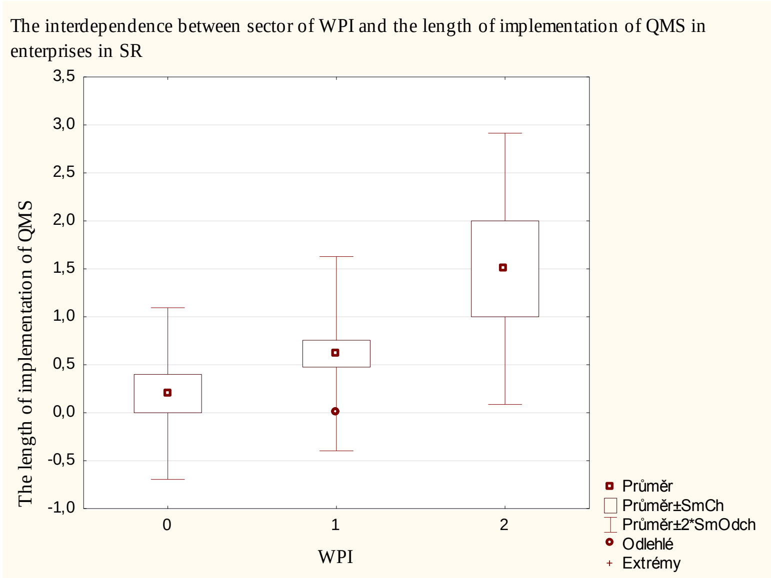

Figure 4. The interdependence between sector of WPI and the length of implementation of QMS in enterprises in SR

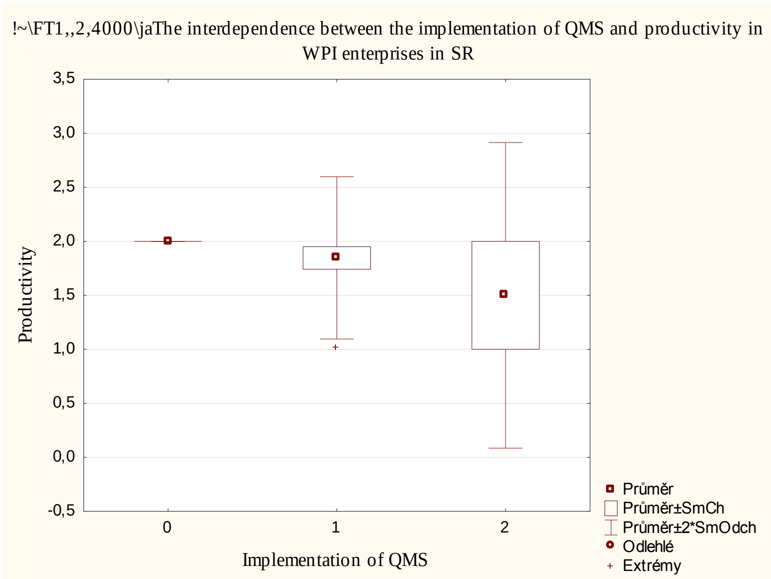

Figure 5. The interdependence between the implementation of QMS and productivity in WPI enterprises in SR

Figure 5 presents a statistically significant correlation relationship between the implementation of the QMS and the benefits for businesses in the form of an increase in labor productivity, with 0 on the x-axis means that enterprises fail to implement a QMS, 1 - implemented QMS according to ISO 9001 and 2 - have implemented QMS according to another standard. Correlation coefficient stood at 0.539 Thus, we can conclude that businesses in Slovakia have implemented QMS (either ISO or other standards) mainly indicated that they saw an increase of the indicator such as labor productivity.

Similarly to Slovakia, the individual responses to the questionnaire survey subjected to a correlation analysis of the results obtained from responses to the environment of Czech companies. In Figure 6 we can see a statistically significant correlation relationship between WPI and the length of implementation of QMS in companies of the Czech Republic, with 0 on the x axis represents the wood industry, 1- the furniture industry, and 2 - pulp - paper industry. The value of the correlation coefficient in this case was at 0,753 which clearly demonstrates that the wood industry enterprises were able to implement a QMS most frequently in five months, the furniture industry enterprises most often from six months to one year and businesses pulp - paper industry clearly over one year. These results are probably related primarily to the size of the firm that is the length of the implementation of significant impact.

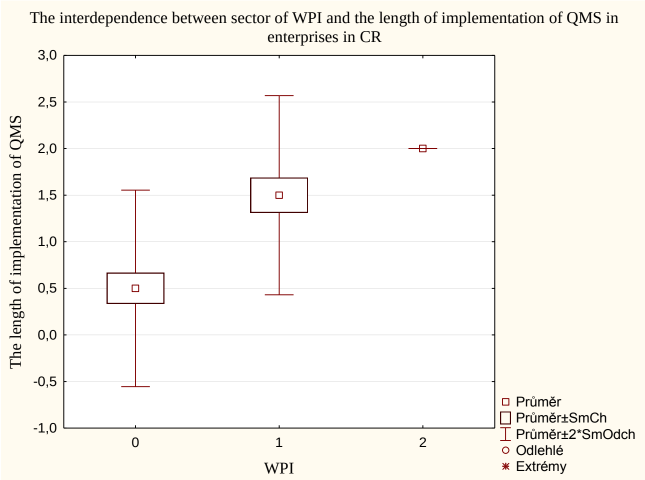

Figure 6. The interdependence between sector of WPI and the length of implementation of QMS in enterprises in CR

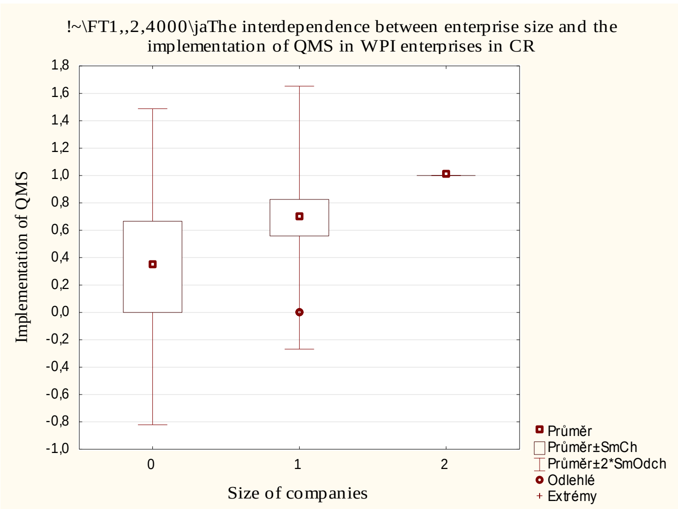

Figure 7. The interdependence between enterprise size and the implementation of QMS in WPI enterprises in CR

The last pair correlation dependencies that can be logically interpreted statistically significant correlation relationship between firm size and QMS implementation as demonstrated by Figure 7, with 0 on the x axis represents small business, 1 - median and 2 - large correlation coefficient is level of 0.525 which means that small companies reported the largest variance of responses, but it is obvious that they at least represented the implementation of QMS, medium-sized enterprises the situation is better, therefore, the number of enterprises that have implemented QMS is much larger, and the best are doing big business which clearly have implemented QMS.

3.CONCLUSION

According to our survey conducted on a sample of Slovak and Czech enterprises DSP we came to certain facts which can be summarized as follows.

In the case of Slovak companies, we arrive at the following fact:

- 96% of companies consider quality as an important aspect of the success of the enterprise,
- 73 % of companies have implemented QMS,
- the most frequently mentioned reason for the introduction of QMS is to gain competitive advantages and strengthen the competitiveness of the company , provide better further downstream contracts and the requirement of customers,
- enterprises accounted for the largest share of the furniture industry , micro and small enterprises and businesses that are on the market for over 10 years,
- frequently termed benefits of implementing a QMS certification is to improve the image of the company , then it is strengthening the competitiveness and increase sales,
- only 5 % of businesses had a problem of implementation and certification of QMS,
- 51 % of companies implement a system from 6 months to 1 year, while only 5 % said they took the introduction of several years.

Results of Czech companies can be summarized as follows:

- enterprises accounted for the largest share of the timber industry had a slightly lower proportion of companies furniture industry , businesses , and even large companies responded ,were mainly companies that are on the market for more than 10 years,
- 93 % of respondents consider quality as an important aspect of the success of the enterprise,
- 67 % of companies have implemented QMS , all have it implemented the ISO,
- the most frequently mentioned reason for the introduction of QMS is to gain competitive advantages and strengthen the competitiveness of the company , which identified all companies with established QMS , it was further improve the quality of its own products and improve their own operations,
- frequently termed benefits of implementing a QMS certification is to improve the image of the company , then it is strengthening the competitiveness and increase sales and lower production of non-conforming products,
- up to 39 % of enterprises reported that they had difficulties in implementing QMS
- 42 % of companies mislead SMK from 6 months to 1 year, but only 32 % of respondents said they mislead SMK several years.

Correlation analysis business answers from Slovakia and the Czech Republic confirmed that the size of an undertaking to the length effect of the implementation of QMS. Small and middle size enterprises can quickly implement a QMS, due to the smaller scale of individual activities necessary for successful implementation of QMS, less complex and extensive documentation and more. The analysis further showed that small and medium enterprises have implemented QMS in a much smaller number than for large enterprises, as there appear to be reasons for lack of funds, lack of knowledge about the need for building a QMS, nonexistent reason for their construction and more. In terms of classification of industries have implemented at least QMS businesses wood industry, followed by the furniture industry and pulp – paper industry. The reason can be classified mainly size of the company since it was established that the companies were mostly of wood industry in the category of small businesses.

REFERENCES

1. Gejdoš, P.,2009. Implementations of quality management systems into small and middle size woods enterprises in Slovakia In: Intercathedra 25, Poznaň,2009, s.37-38, ISSN 1640-3622.
2. Gejdoš, P. 2011. Budovanie a certifikácia systémov manažérstva kvality v podnikoch drevospracujúceho priemyslu na Slovensku. In: Zborník z medzinárodnej vedeckej konferencie Ekonomika a manažment podnikov 2011. TU Zvolen 2011, 92-97s, ISBN 978-80-228-2284-8.
3. Giltov, H., 2000. Quality management systems: A practical guide, St. Lucia Press, 2000, 283 s, ISBN 1-574-44261-9.
4. Hoyle, D., 2007. Quality Management Essentials, Elsivier Limited, 2007, ISBN 0-75-066786-9.
5. koštialiková, M. 2014 Budovanie a certifikácia systémov manažérstva kvality. Diplomová práca, TU Zvolen, Zvolen, 2014, 74s.
6. Lestyánszka Škůrková, K., Kudičová, J., 2011: The process capability study of pressing process for force closed.In: Vedecké práce MtF STU v Bratislave so sídlom v Trnave. Research papers Faculty of Materials Science and Technology Slovak University of Technology in Trnava. - ISSN 1336-1589. - Vol. 19, č. 30 (2011), s. 51-57
7. Mateides, A. a kol., 2006. Manažérstvo kvality, Bratislava : EPOS, 2006. 751 s. ISBN 80-8057-656-4
8. STN EN ISO 9000 Systémy manažérstva kvality. Základy a slovník. Slovenský ústav technickej normalizácie. Bratislava, 2006.

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QUALITY AND PROCESSES IMPRROVEMENT IN THE WOODEN CONSTRUCTION JOINERY PRODUCTION

Stanisław Borkowski. Renata Stasiak-Betlejewska

ABSTRACT

Information on the wooden windows quality is provided by customers and functioning of the production system was evaluated by employees. The complaints process results show that defects identified in the windows have been generated during milling, drying and loading (36%; 23% to 16%, respectively). Identification of processes concerning standardization has been evaluated by using the sixth Toyota management principle. The principle has been described in BOST method as set of seven factors importance determined by workers' opinion. It was highlighted, that documents standardization is identified as the most important standardization type, while the employment standardization is not required. Based on the survey results, there was introduced the checking obligation of the following issues: the turning tools status, the wood moisture after drying, windows packaging method. There was increased supervision of documentation, which is varied depending on the type of contract.
Key words: quality, process, BOST, standardization

1. INTRODUCTION

Product safety assurance system in Europe requires manufacturers and importers of equipment, machinery and any elements or products related to safety of obligation to implement only fully safety products in the market and to the general marketing. Safe product is known as machines and safety components that meet the standards harmonized with Directives 98/37/EC, 73/23/EEC and 2000/14/EC and 89/336 EEC [Liwowski, Kozłowski, 2007].

Assessment of compliance with the relevant requirements regarding safety and protection of health included in Directive 98/37/EC can be made by the manufacturers on their own or in cooperation with the appropriate unit from the outside [Borkowski, Rosak-Szyrocka 2009]. To enter possibility of the free import and export to EU markets, it is necessary uniformity norms and standards, which product is in charge. Creation of the European market forced the unification and creating rules that harmonize technical requirements for certain products. In the Member States, there is obligatory mark attesting conformity with the directives "New and Global Approach", which is called "CE". It is a form of the manufacturer's declaration that the product has been manufactured in accordance with requirements which relate to the protection of life, property, health and the environment. It is therefore required from the producer to oversee the entire production process and prepared the technical documentation and declaration of conformity, and if necessary submit product inspection, which is conducted by an independent entity a notification, which has the appropriate permissions needed for such a control [Michna, Naprstkova, 2012].

Quality improvement is a part of quality management directed towards continuous improvement and increase capacity to meet the ever-changing quality requirements. Process improvement applies to both products/services and processes for its implementation. This should be a continuous process leading to still setting new targets and finding new opportunities for improvement by conducting audits and data analysis conducted in the enterprise. Its consequence should be to carry out preventive and corrective actions in the company. Hence this should also lead to the upgrading of product quality, implementation of new innovations and lower production costs [Potkány et al. 2002].

The purpose of quality improvement should be corrective activities for the general organization and linked to the organization objectives. This applies in particular to improve customer satisfaction and improve the product quality. Maintaining an effective system of quality improvement is connected directly with an important factor which is teamwork [Stachova, 2012]. The quality management is affected by some factors such as: organization associated with the improvement of quality, quality improvement planning, the improvement effectiveness measuring, inspection of activities and implementation of the improvement process.

2. CHARACTERISTICS OF THE RESEARCH OBJECT AND RESEARCH METHODS

2.1. Characteristics of the research object

The analysis is the production of wooden single-arm windows in the S - system. Standard windows are made mostly from pine timber or oak lumber.

The S-Class combines traits of commonly offered window profiles with additional features. Structural changes in comparison to the previously manufactured windows allow for the complete elimination of visible defects associated with blocking glass slat at chute. It is necessarily a different side of the element, but in contrast to standard profiles is completely transparent and free of defects resulting from bonding the two components [Borkowski et. al. 2013; Hrovatin et al. 2013].

2.2. Characteristics of the research methods and research findings

To provide a high level of the product quality and safety in the wooden construction joinery production, the entire window production process has to compatible with the quality requirements and it must be designed so that the possibility of the emergence of possible nonconformities occurrence is so low as possible. One of the many and one of the simplest of tools that could be used for quantitative assessment and analysis of the production process of wooden windows is a control sheets. The sheets are most frequently used in the initial stages to identify quality problem during the control process. Owing to this tool data concerning the manufacturing process as well as after its completion [Borkowski S. 2004]. In the case of determining causes of nonconformities that occur during the windows production, control sheets allows collecting and organizing all collected data. Well-prepared control sheets should allow for individual data entry and its clear reading, the use in further analysis and expose the target [Borkowski S. 2004].

Designing of the control sheet consists of several stages. In the first stage study phenomenon is recognized. The control sheet, which was used in the company X, allows identifying defects that cause nonconformities in accordance with quality requirements set by the management. The next stages of proceedings are following [Łuszczak, Matuszek - Flejszman, 2007]:

– definition of data and determining its full names,
– determining research period and the place of data storing,
– elaboration of clear and simple-to-use form of the control sheet,
– save all the data obtained in the sheet,
– data counting.

On the basis of survey conducted among managers and employees of the complaint department, a list of 8 defects types found in the complaint related to wooden windows production was elaborated:

– damage during treatment carpentry,
– damage the paint coating,
– improper selection of glass,

– the color of fittings incompatible with the order,
– the use of defective blank,
– incorrectly located silicone layer,
– chipped glass,
– scratched handle.

After determining the types of defects it was decided that the information will be collected in the final stage of the manufacturing process prior to packaging. It was also established that the whole process of data collection covers the period of one year: January 2012 - January 2013. To facilitate the work, there was created a simple and functional control sheet which included: types of data defects, symbols of defects, rubrics allowing graphical representation of the number of defects on a given day and summing column.

The control sheet in a very readable and clear way illustrates the number and types of nonconformities occurring in the production of wooden windows within 4 working days (number of produced windows reached 45 items and 33 defects have been identified in the final product). Most defects can be removed and repaired without great prejudice to the finished product, however, it is an important time for the company. In the next stage, some data allow to create Pareto - Lorenz diagram. Pareto - Lorenz diagram is based on the empirical regularity according to which about 20% of the causes of a given phenomenon is responsible for about 80% of the often negative effects. It is the law of uneven distribution and allows finding causes responsible for the formation of nonconformities. For the purpose of analyzing the data collected and complaints on windows in 2012, which total market value was more than 100 000 PLN, accumulated 62 complaints. The various factors responsible for complaints and the frequency of its occurrence are shown in Table 1. They were previously ranked in terms of frequency.

Table 1. Number of complaints caused by individual production nonconformity in the analyzed company

SYMBOL	Defect	Number of complaints
N1	Damage during treatment carpentry	22
N2	Shortened dwell time in the dryer	14
N3	Damage during loading / unloading	10
N4	The use of defective material or semi-finished	7
N5	Error during installation	6
N6	Improper grinding treatment	3

Source: control sheets of company X.

The factor that most contributed to the fact that customers have decided to exercise their right to a two-year warranty was nonconformity N1 (damage during processing carpentry). Another important factor contributing to the increased number of complaints in the analyzed company is nonconformity N2 (shortened dwell time in the dryer). Improper grinding treatment was the reason for 3 complaints. The two main reasons constitutes 33.33% of the causes, that are responsible for 58.06% of all complaints identified in the wooden windows production in the analyzed period.

The damage of the window while processing at carpentry may be effect of carpenter error. It is often forced by the work in the carpentry department associated with the use of obsolete machines, such as thickening and milling machines. It caused that modernization of the machinery have been taken in the analyzed company with using European funds of the Regional Operational Programme of Silesia in 2007-2013. It made fundamental changes to the manufacturing process what contributed to increasing the competitiveness of the company. Reduced freshly painted windows dwell time in the dryer is a nonconformity that is associated with increased seasonal demand and insufficient drying surface. The damage during loading/unloading is the third nonconformity that caused complaints windows. It concerns mainly large-sized the windows, which are very heavy for loading and unloading. Applying defective materials or semi-finished products in the production results from improper inspection and approval of defective materials and semi-finished products for production. Errors caused by improper assembly and processing of grinding are the least involved in the formation of the complaint.

3. BOST METHOD IN THE PRODUCTION PROCESS IMPROVEMENT

Each production process, regardless of its type or variant must be carried out smoothly and in such a way that the products are characterized by the highest quality and meet customer requirements. One of the elements of quality improvement in the analyzed company is BOST survey, which objective is to identification of employees' opinions about specific types of standardization responsible for the product quality level. Workers of the analyzed company (number of respondents = 200) responded to various questions concerning the manufacturing process of wooden windows. Survey question concerns factors of E6 area: *What kind of standardization is the most important in ensuring the continuous improvement of processes in your company?.* There are 7 variants of answers (seven types of standardization): time of one task execution (CW), process (PI), documents (DO), workstation stores (MP), training (SN), the flow of information (PI), employment (ZA). This question was formed in accordance to Toyota principle that states: *Standard task as the basis for continuous improvement and empowering employees*. Obtained research results are shown in Figure 1.

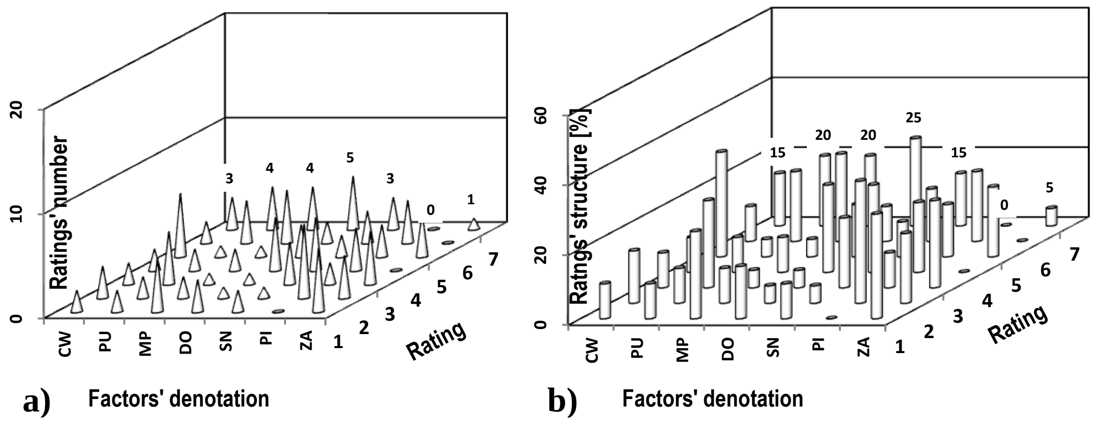

Figure 1. The spatial presentation of research results: a) the number of ratings, b) the ratings' structure. It concerns analyzed company.
Source: own interpretation based on the author's program of prof. S. Borkowski [Borkowski, S., 2012a, 2012b].

In Figure 1a research findings of BOST survey are presented in numerical form, while in Figure 1b - as a percentage. According to graphical data presentation (Figure 1), the most important factor in the production process it is a document standardization (DO) with the highest score represented by 25% workers' opinion.

The secondly important production factor is the process standardization (PU) and standardization of workstation stores (MP) that obtained the highest scores (ratings) indicated by 20$ of examined workers. The next two factors also received the same number of votes and it concerns standardization of execution time of one task (CW) and standardization of training (SN). The least important factor is standardization of employment (ZA), this factor has been assessed by 5% of respondents. The last place in the factors' importance hierarchy belongs to standardization of information flow (PI) that hasn't received any high rating. According to the respondents standardization of documents it is the most important element in the production improvement.

4. CONCLUSIONS

Each manufacturing company, regardless of size and type of production profile, points quality as the most important and essential factor. The aim of the quality management is to find inappropriate processes where failures occur and nonconformities are formed. Identification and quantification of consequences found failures and nonconformities can result in the corrective actions creating aimed to product quality improvement. Results of the quality level analysis within the entire organization activity should be implemented as the set of actions focused on the improvement of all identified processes in accordance to consumers and market requirements.

REFERENCES

1. Borkowski, S. (2012b): Toyotarity. BOST Method as the Instrument of Assessment Process Functioning according to Toyota Prinicples. Faculty of Logistics. University of Maribor. Maribor. pp.14 – 15.
2. Borkowski, S. (2012a): Toyota management principles in the questions. The research findings BOST. Wyd. PTM. Warszawa. pp. 34- 36.
3. Borkowski, S., Stasiak-Betlejewska, R., Jereb, B. (2013): Analysis and Evaluation of Factors Creating the Enterprise's Development. In: Improvement's Factors in Enterprises/Products Development. Monography. Editing and Scientific Elaboration Borkowski, S., Sygut, P., Faculty of Logistics, University of Maribor. Celje, 86-99.
4. Borkowski, S., Rosak – Szyrocka, J. (2009): Procedury uzyskiwania znaków jakości, Wydawnictwo Politechniki Częstochowskiej, Częstochowa.
5. Hrovatin, J., Prekrat, S., Berginc, J., Šernek, M., Zupančič, A., Oblak, L., Medved, S., (2013): Strength comparison of joints at window frames. Drewno, 56 (189): 128-135.
6. Liwowski, B., Kozłowski, R. (2007): Podstawowe zagadnienia zarządzania produkcją, WoltersKluwer, Kraków 2007.
7. Michna, S., Naprstkova, N. (2012): RESEARCH OF INTERNAL STRUCTURE INFLUENCE ON THE QUALITY OF THE SURFACE DURING LOADING IN THE CORROSIVE ENVIRONMENT. In: Engineering for Rural Development . 11th International Scientific Conference on Engineering for Rural Development Location: Latvia Univ. Agr, Fac Engn, Jelgava, LATVIA Date: MAY 24-25, 273-278
8. Potkány, M., Šatanová, A., Gejdoš, P. (2002): Manažérstvo kvality na základe noriem ISO 9000:2000 a environmentálne manažérstvo na základe noriem ISO 14000. In: Marketing and trade 2002, International Coloquium, Zvolen: TU Zvolen, 2002, 201-206.
9. Stachová, K. (2012): JOB PERFORMANCE EVALUATION AS BASE FOR ORGANISATION OPERATION IMPROVEMENT. In: Business and Management-Spausdinta. 7th International Scientific Conference on Business and Management. May 10 – 11, 2012, Vilnius Gediminas Tech Univ, Vilnius, LITHUANIA.

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ENVIRONMENTAL INFLUENCES AS FACTORS INFLUENCING BASIC QUALITATIVE CHARACTERISTICS OF WOOD PRODUCTS PLACED IN EXTERIORS – SURVEY RESULTS FOCUSED ON WOOD PLAYGROUND

Josef Novotný, Renata Nováková

ABSTRACT

In history and in the present it is a matter of course that wood represents a very important building material. As such it succumbs to various weather conditions. This is the reason why new technologies and materials are developed to reduce or even avoid the quality decrease of wood products. It is not always possible to use various chemical coats as they can significantly influence health. Therefore we made a research on the influence of weather on wood playground located in exterior and assessed the possibilities of securing quality of similar types of products.
Key words: Wood products, quality, wood playground, new technologies

1.INTRODUCTION

"They are our future ……", when using this phrase, it is clear that we are talking about the most important person in every parents´ life: his child. Today, in times of technology, electro technical gadgets and digitalized computer games, more and more parents prefer the so called return to nature. This approach is demonstrated by shopping for toys made of natural materials, as is **wood**. Before getting to the subject of our survey in more detail, letus point out that wood is a natural product with a significant polymorphism and a wide variety of outstanding characteristics, such as thermal insulation, acoustic insulation, high strength, good bendability, high bearing capacity and easy machine processing to name a few. Every piece of wood is unique. It contains bumps, splits and different color variations. Being a natural material, it evolves, expands and contracts depending on changes in temperature, humidity and climatic conditions. In a warm and dry environment it usually shrinks, in humid conditions, on the other hand, the wood expands. In a wood massif such processes do not occur evenly, thus causing clefts and even splintering. Those splits may take up different depth, wideness and length. We could say that those are present in virtually any type of wood, more often in round timber than prism. Many natural materials, including tree cells, contain bound water. Depending on the air humidity, this water is slowly excreted or absorbed, leading to changes in volume. For this reason the wood is saturated with impregnation solution through pressure procedure. The change of structure during drying causes an 8% contraction in width but only 0,3% contraction in length of the wood. Our survey aims to observe the influence of weather changes throughout seasons on wooden children's´ playgrounds.
The wood is becoming a very popular material for the construction of outdoor playgrounds. Those, as well as wooden swings, are preferably made of softwood and round timber (rather than prisms), due to financial reasons. While deciding on the selection of surveyed samples, we focused more on prism than round timber, though being aware of possible variations in key characteristics.

2.ENSURING QUALITY MANAGEMENT AND OBSERVATION OF SAFETY NORMS AT THE CONSTRUCTION OF WOODEN CHILDREN'S PLAYGROUNDS.

We notice a wide variety of domestic and foreign manufacturers of wooden playgrounds not only on the internet, but also on exhibitions and fairs. Based on their diversity and modularity evolves the price and flexibility at the final assembling of the playground. Many manufacturers declare a strong emphasis on quality and respect of technological and safety norms that are especially designed for wooden children´s playgrounds.

Figure No 1 Wooden playground

As already mentioned above, we focused our survey on those products, where the dominant material is wood, more precisely wooden prism. The prism usually contains less wooden mass from middle section of the tree than the round timbers, making them less prone to the occurrence of clefts and splinters. The weather conditions and temperature differences might however result in rough surfaces or splits, which is why it is necessary to check the wooden product regularly.

What types of checks do we recognize?
a) Routine visual check– the control enables discerning prominent sources of danger, that may have been caused by vandalism, wear or weather conditions, for example: danger caused by broken pieces.
b) Operational check –a more detailed control aiming to check the functions and stability of installation, especially in terms of wear. Operational check-ups need to be executed every 1-3 moths or as stated in manufacturer manual.

c) General yearly check– the control takes place no later than 12months after the previous control. Its objective is to ascertain the general level of security of the installation, its foundations and surfaces assessing the weather influences, traces of disintegration or corrosion and any changes in security level originating from performed reparations, additionally incorporated elements or replaceable parts.
It is very important to consider the whole lifespan of the installation as well as its individual parts. The checks must be carried out by an authorized person with certificate that would proceed in conformity with the manufacturer´s instructions.

Consequently, it is important to elaborate a “control schedule”. The schedule must reflect the local conditions and manufacturer´s instructions that may affect the frequency of checks. It should include a list of parts to be checked at different control stages as well as the method to be applied for the checking. Should the control return any significant defections that might threaten the security, it is necessary to eliminate them promptly. In such case the installation must be temporarily put of operation, in order to avoid its use during the reparation phase. To ensure a good maintenance, all fixating elements or foundations have to be safely stored.

How often should the controls be carried out?

In nursery schools with wooden playgrounds and garden installations the check should be realized 1 time a year.
In external playgrounds the check should be realized 1 time a year.
It is necessary to point out, that such yearly control has to be effectuated by an authorized person.

Apart from prescribed checks, the routine control should also include precautionary measures, in particular:

- Tightening of fixating elements
- Re-painting a re-processing of surfaces
- Maintenance of all shock-absorbing surfaces
- Greasing of bearings
- Marking of equipment in order to indicate the level of powdery-material filling
- Cleaning
- Maintenance of free areas

Respect of security norms plays an important role during precautionary proceedings and check-ups. We could say that well-functioning safety norms are designed to aid the development of safest possible playground while keeping its attractiveness, without lessening its entertainment value. The norms target elimination of risks that are unforeseeable for the children. At present there are several safety norms in vigor for this area, the essential being STN EN 1176/2009 Safety norm for the equipment of children’s playgrounds.

To support the facts described above, we decided to realize a proper experiment, whose objective was to test whether the meteorological influences can have a significant impact on the material that is a main constitutive element of children’s playgrounds – wooden prism. The outcome of our experiment in presented in a case study which is part of the paper.

3.THE IMPACT OF WEATHER ON WOODEN STRUCTURES

The study considers the influence of weather on degradation of wooden structures, protected by chemical coating, that are most frequently found on children’s playgrounds. For this purpose we selected two most typical meteorological variables: temperature and precipitations. Meteorological measuring took place at the meteorological station of University of Defense in Brno (Fig 2) equipped with standardized apparatus by Vaisala, represented by rain gauge and temperature sensor.

In order to assess the impact of weather we selected a pointed wooden prism 50cm long and 5cm wide (Tab. 1). The surface of the prism has been painted with 7 different types of coating designated for treatment and protection of wooden structures, each stripe 5 cm wide. In order to enable an inspection afterwards, the bottom part was left without paint. Table1 presents different types of applied chemical coating.

Fig 2 Wooden prism with protective coating (numbering from above) and Measuring site of meteorological station of University of Defense in Brno with planted wooden prism

Tab 1 View of different types of coating (from above), names of coating, colors of coating

Number of coating	Name of coating	Color of coating
1.	Sokrates	brown
2.	ETERNAL akrylat	white
3.	Bakrylex	black
4.	PRIMALEX lesk P 8190	red
5.	IMPRANAL Profi	Golden oak
6.	Dulux Universal lesk	black
7.	Dulux Universal lesk	white
8.	No chemical treatment	-

4.APPLIED METEOROLOGICAL DATA AND THEIR EVALUATION

Though the submitted time series is not very long, its range has been designed so as to cover different seasons, cold and warm likewise. The research period starts 1.12.2014 and finishes 25.5.2015, counting 177days.The weekly progress of temperature is demonstrated in figure 3. The blue line represents the weekly averages, the green line stands for weekly averages of minimal temperatures and the red line depicts weekly averages of maximal values. The chart shows that the temperatures oscillated intensely at the end of 2014 and beginning of 2015. This is apparent not only from the maximum and minimum curves, but also from the blue average temperature line. In spite of that, the average daily temperature merely fell under 0°C at the beginning of January and February. From February the temperatures rose in a relatively steady though moderate manner. However, only since mid-April the average weekly minimum temperature stays above the freezing point.

The figure 4 outlining the weekly rainfall clearly shows, that with the exception of the beginning of measuring period and a few days at the beginning and the end of January, the weekly rainfall did not exceed 5mm. In March the values in average leapt over this threshold. The weekly amounts increased distinctively beyond 10mm at the end of measuring period, peaking between 12.5.2015-18.5.2015 with 21mm of measured rainfall.

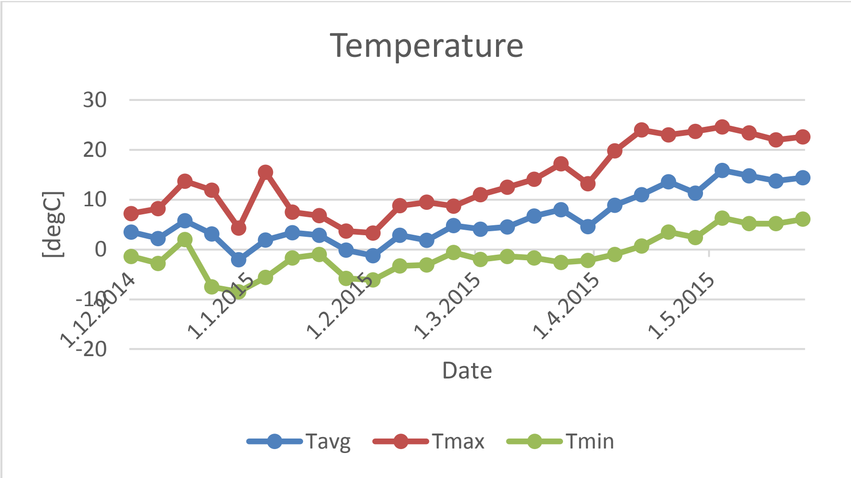


Fig 4 Course of temperatures measured in meteorological station of University of Defense between 1.12.2014 and 25.5.2015.Blue Tavg represents the weekly average temperatures, red Tmax represents the course of weekly maximum temperatures and the green Tmin line shows weekly minimal temperatures

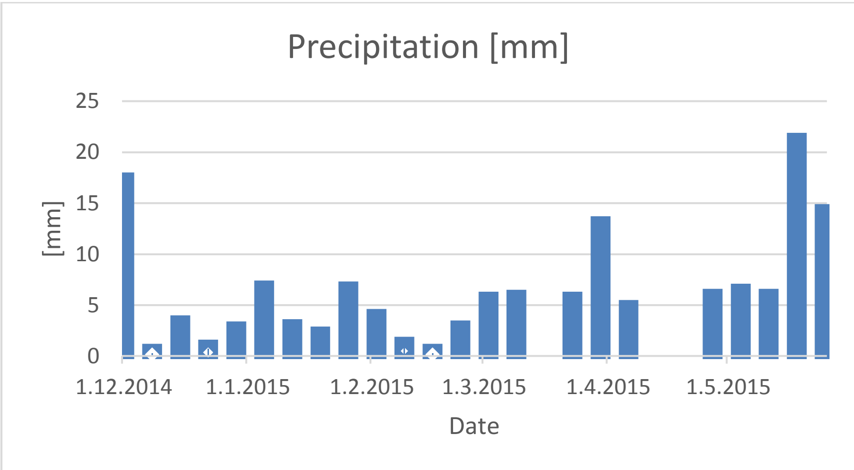


Fig 5 Weekly rainfall measured at meteorological station of University od Defense in Brno between 1.12.2014-25.5.2015

5.INITIAL RESULTS OF EVALUATION OF WEATHER-CONDITIONED IMPACT ON A WOODEN PRISM

A casual examination does not return any significant changes on the wooden prism. After a closer inspection a relatively highest degree of degradation is notable on the bottom part of the prism, which has been thrust in the soil. The part of prism located right above the ground level (8. stripe) presents a somewhat better condition, despite having been left unpainted, thus free of any chemical treatment or coating. At the first glance the other, chemically treated stripes, do not show any sign of degradation. The paint of 6th stripe (Dulux universal lesk – black) merely appears to have a reduced luster.

Consequently, it is evident that the period of the experiment is too short for weather to influence either the degradation of protective chemical coating or the examined wooden material in a more significant way. No extreme values of temperature or precipitation occurred during the experimental period.

It seems to be appropriate to subject the examined sample to a longer influence of weather, namely a more intense fluctuation of temperature combined with precipitation, in order to obtain more visible traces of degradation in the form of washing off of protective chemical coating. This would allow a clearer assessment of potential dangers related to the mentioned wash off issues in the domain of children's´ playgrounds.

6.CONCLUSION

In spite of our survey being limited in time, we came to some consequential findings. Those more or less proved the weather conditions to be among the fundamental factors influencing health and safety during manipulation and use of items produced in relation with children's playgrounds. Our paper highlights the importance of "control and maintenance schedules". Keeping track of any realized activities related to the object is an essential feature of safety management. Recommended documentation should include:

- Certification of inspection and testing, if necessary
- Maintenance and control manuals
- User manual, if necessary
- Keeper´s records, for example diary

Only if the recommended documentation complies with the norms in vigor can we pronounce the safety and health protection rules to be respected, and consequently declare a level of quality of the product – wooden children´s playground.

BIBLIOGRAPHY

1. Norm STN EN 1176/2009 – Norma bezpečnosti pre zariadenia detských ihrísk
2. http://www.garden-life.sk/

USE OF CROSS LAMINATED TIMBER (CLT) IN THE CONSTRUCTION OF MULTI-STOREY BUILDINGS AND ITS CONTRIBUTION TO MITIGATION OF CLIMATE

Predrag Sretenovic, Branko Glavonjic

ABSTRACT

The paper gives an overview of the research results in the use of cross laminated timber (CLT) for the construction of multi-storey residential and nonresidetial buildings in Europe and the world. The tallest building in the world named Forte and the tallest building in Europe - Stadthaus, Murray Grove present the most significant construction objects made of cross laminated timber (CLT). These multi-storey wooden buildings should present examples of good practice which could positively influence the growth and development of the construction industry in Serbia and countries in the Balkan region. The research included a brief overview of cross laminated timber market with special reference to the beginning of production and countries that are the dominant producers in this field. In addition, the research also involve the contribution of wood construction to mitigation of climate change. Unavoidable fire resistance of buildings made of of CLT was also the subject of the research in this paper. It referred to particular objects made of CLT in terms of period of time in which they may be exposed to fire, as well as possibilities for improving the properties of fire resistance through the use of other materials for its covering.

Key words: cross laminated timber (CLT), construction, buildings, fire, climate

1. INTRODUCTION

Application of modern and advanced technologies in wood processing has led to the improvement of utilization of raw materials in qualitative, quantitative and financial terms. Composite wood products such as cross laminated timber (CLT), glue laminated timber (GLT), laminated veneer lumber (LVL), beams of *I* profiles and many other products began to replace classic lumber made of spruce, fir and pine. In this way, the innovative composite products retained good characteristics of wood as the environmental material, greatly improving its mechanical properties and characteristics. In the past limiting factor for beams dimension was the raw material from which they were produced, but today its only production capacities and transport regulations for such long elements. In addition to the environmental advantages, wood has better insulating properties than steel and concrete, which is supported by the fact that it is 400 times better insulator than steel and 15 times better insulator than concrete. Taking into account these facts it is of great importance get to know with CLT used in structural purposes, primarily in the construction of multi-storey buildings made of wood. In addition to the fact that CLT successfully replace massive wood because of its superior properties, it is also used for purposes where the solid wood can't be applied because of its anisotropic properties and dimensional constraints.

2. SCOPE AND OBJECTIVE OF THE WORK

The main scope of research in this paper is the use of cross laminated timber (CLT) as the most important composite wood products intended for the construction of multi-storey residential buildings in Europe and the world. The main objective of the paper is market research of cross laminated timber in

Europe and Australia. In this sense, the research included the production of CLT with a clear designation of the most important countries but also companies that dominate the market. The indispensable segment of the paper which is of great importance for the production and installation of CLT are standards. Having in mind previously mentioned, besides the basic features of CLT, special emphasis was placed on its fire resistance which was very often a limiting factor for more intensive wood construction. The research of market flows led to the most important examples of good practice in which CLT was used for the construction of multi-storey buildings. The biggest contribution that can be achieved by building these objects, which are encompassed by the term *green building,* is linked to the reduction of CO_2 emissions into the atmosphere and mitigation of climate changes having in mind that it is about substitution of classic carbon-intensive building materials such as steel, concrete and aluminum.

3. MATERIAL AND METHODS

For conducting the research and understanding the elements that are set in the scope and objective of the paper, it was used the appropriate methodological base, which is largely composed of general research methods such as historical, analysis and synthesis, generalization, induction and deduction, while of special scientific methods were used normative.

The historical method was used in part of the paper in which was described the development of cross laminated timber in Europe with special reference to the beginning of its production. Methods of analysis and generalization were used for CLT market research in Europe, where in addition to the most important countries were included the biggest companies that produce CLT. In addition, methods of analysis and generalization were applied in the research of its use in the construction of multi-storey buildings in Europe and Australia. The analysis method was used for the purpose of comparative analysis of CO_2 emission and storage for four most important building materials. Synthesis as a general scientific method was applied in part of the paper relating to the share and types of individual materials which unifying into functional unit formes cross laminated timber. This enables to understand complex product (CLT) using its individual parts. Induction and deduction were used to derive the appropriate conclusions regarding the importance of cross laminated timber, methods and effects of use and contribution of this innovative wood products to mitigate climate change. For the research of certain standard provisions of EN 16351:2011 relevant for the production and testing of cross laminated timber in the countries of the European Union were used normative method. The primary data sources for these analyzes were used the official publications of the UNECE/FAO, as well as articles published in professional journals and relevant databases from the internet which names are listed in a separate part of the paper refers to the used literature.

4. RESEARCH RESULTS

4.1. Market analysis and basic characteristics of cross laminated timber (CLT)

Although the construction of classic wood houses dating centuries ago, in the construction of multi-storey wood buildings this is not the case. Their intensive construction became possible when the central European market launch the new product of innovative design and superior properties with high strength and dimensional stability - cross laminated timber (CLT). Its appearance is linked to Switzerland and early '90s and since 1996 it appears on the Austrian market, which is the largest European manufacturer of CLT today. This is corroborated by the fact that from 550,000 m^3 of CLT, which was produced in 2013 in Central Europe, 90% was produced in countries such as Austria, Germany and Switzerland. The participation of Austria in the production of CLT in 2013 on the central

European market was as much as 74%, while Germany had a share of 23%, and Switzerland 3% (Diagram 1). CLT production growth in 2013 was on average 20%, depending on the country (UNECE/FAO, 2014). Other European countries which produce smaller amounts of CLT are Czech Republic, Italy, Spain, Norway and Sweden.

There were 12 factories in Europe in 2012 for the production of CLT with total production of 3,000,000 m^2. From the aforementioned amounts 83.3% was produced in 6 factories (KLH = 700,000 m^2, Stora Enso = 500,000 m^2, Mayr-Melnhof Kaufmann = 500,000 m^2, Binderholz = 400,000 m^2, Finnforest Merk = 200,000 m^2 and 200,000 m^2 = Schilliger). This amount of CLT was sufficient to build 1.000.000 m^2 of new buildings (Smith S., 2012). Estimations from early November 2012 were that by 2015 will be reached the level of production of 1 million m^3 at the global level. However, it seems that this value will be exceeded, taking into account the sharp rise in the number of factories for the CLT production, particular in Canada, Australia and New Zealand (Taylor S., et al., 2013).

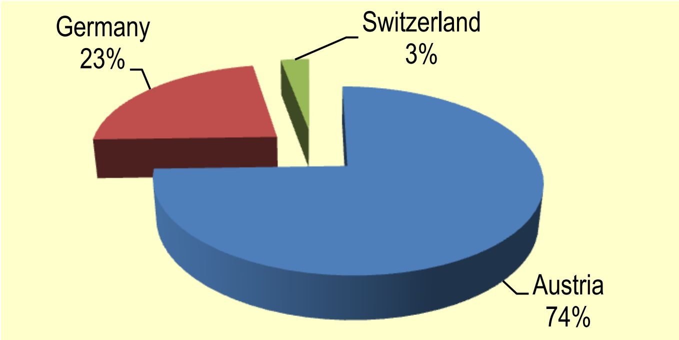


Diagram 1. CLT production in Central Europe
(Source: UNECE/FAO, 2014)

Cross laminated timber (picture 1) is made from multiple layers of solid wood laminated panels, which are built mainly of tangential elements 80 to 240 mm in width and 10 to 45 mm in thickness. From coniferous wood species spruce, pine and fir are used, while of deciduous species ash, beech and others. Finger joint is used for longitudinal connection of elements into lamellas, whereby the minimum joint distance between two neighboring parallel lamellas must be at least equivalent to 1/3 of their width. Mutual layers orientation is mainly at an angle of 90°, but sometimes may be at an angle of 45°. In terms of technological and production limitations, maximum dimension of the product is 16.5 × 3 m, while the transport restrictions enable dimension up to 30 × 4.8 m. The thickness of the final product ranges from 42 mm up to 500 mm, depending on its final purpose which depends on exploitation class 1 and 2. Strength classes in the longitudinal layers range from C24 - C30, while the transverse layers are mostly in the strength class C16 (max. C30). Their purpose is mainly for constructing walls and floors of wooden buildings (Leonardo da Vinci Pilot Project, 2008).

Picture 1. Five layer spruce CLT with grooves for stress reduction *(Sretenovic P. 2014. Germany)*

According to research by the German Institute for Construction and Environment (IBU) to produce 1 m^3 of cross laminated timber are consumed primary and auxiliary materials as shown in Table 1.

Table 1. Consumption of materials for the production of 1 m^3 of cross laminated timber

Material	[kg/m^3]	[%]
Wood	430.19	87.5
Water	51.62	10.5
Melamine-Urea-Formaldehyde adhesive	6.88	1.4
Polyurethane adhesive	2.46	0.5
Emulsion Polymer isocyanate adhesive	0.49	0.1
Total	**491.65**	**100**

Source: Institut Bauen und Umwelt (IBU), 2014; Original

For the production of 1 m^3 of cross laminated timber primary energy sources such is electrical energy (kWh 116.56), gasoline (0.01 L), propane (0.09 kg + 0.69 L), heating oil (0.45 L), natural gas (1.28 m^3) and biomass (9.53 kg in the dry state) are consumed, while from auxiliary materials hydraulic fluid (0.04 L), lubricants (0.04 L) and packings (0.46 kg). Table 2 gives an overview of fire reaction classes for cross laminated timber of all types according to prEN 16351:2011.

Table 2. Classes of reaction to fire for cross laminated timber

Product	The lowest average density[c] (kg/m^3)	Minimum overall thickness (mm)	Class[b]
Cross laminated timber	380	40	D-s2, d0
Cross laminated timber for flooring	390	20	D_{FI}-s1

Source: *prEN 16351. 2011. Timber structures - Cross laminated timber – Requirements*

Remarks:
- *Cross laminated timber products exclusively made of wood layers in accordance with this standard.*
- *Applies to all species and adhesives covered by this European Standard.*
- Class as provided for in Table 1 of the Annex to Decision 2000/147/EC.
- *Conditioned according to EN 13238.*

On the other hand fire resistance of CLT is determined by the standard EN 13501-2 and it shall be declared by the corresponding class R in one of two ways:
- An appropriate test method specified in standard EN 13501-2 and
- calculations for example according to EN 1995-1-2.

4.2. The most important examples of multi-storey buildings constructed with CLT and their contribution to climate change mitigation

Cross laminated timber (CLT) allows very fast construction of multi-storey buildings. This is primarily enabled with high-capacity technology used for its production but also highly sophisticated CNC machines used for processing and cutting according to defined shapes and dimensions. Having in mind that wood is much lighter than steel and concrete the manipulation at the construction site is simplified and also further cutting and finishing can be done with standard tools and machines. Thus, the product delivered on site is quickly installed in the appropriate place depending on the position, thanks to its high finalization degree.

Emission of carbon - dioxide in the atmosphere is increasing year by year. Goals to reduce its emission, which among others are defined by the Kyoto Protocol, now may be replaced by those which aspired to maintaining CO_2 emissions at present levels, ie. preventing its further increase. Only upon stopping the growth of CO_2 emissions can be talked about the set goal, which primarily relates to the reduction of carbon emissions in the future. This can be confirmed by data on CO_2 emissions into the atmosphere due to the fossil fuels burning of at least 6.3 billion tons annually, of which 22.2% is absorbed by the plants (1.4 bilion tons) and 27% by the water resources on the planet (1.7 bilion tons). This means that annual amount of CO_2 that remains unabsorbed amount to 3.2 billion tons (Ministry of the Environment, Government of Japan, 2004). According to experts Donald Kennedy and Brooks Hanson concentration of CO_2 in the atmosphere is now higher than at any time in the last ten million years, which cause a serious concern (D. Kennedy, B. Hanson, 2006). According to UN figures, the average CO_2 emissions in the EU-25 is about 8.5 tonnes per capita annually (GRID - Arendal, 2008).

Having in mind previously mentioned it can be concluded that wood has an important role in reducing CO_2 emissions into the atmosphere. This also confirmes one of the important wood properties such as absorption of CO_2 through photosynthesis and storing in the wood fibers. It is well known that every 1 m^3 of wood increment stores 0.9 tons of CO_2, and in the same time release about 727 kg of oxygen (European Wood Factsheets, 2004). If we add to this the amount of 1.1 tonnes of CO_2 saved by substitution of carbon-intensive materials (concrete, steel, aluminum ...) with wood, it leads to savings in CO_2 emissions of even 2.0 tons/m^3 of wood.

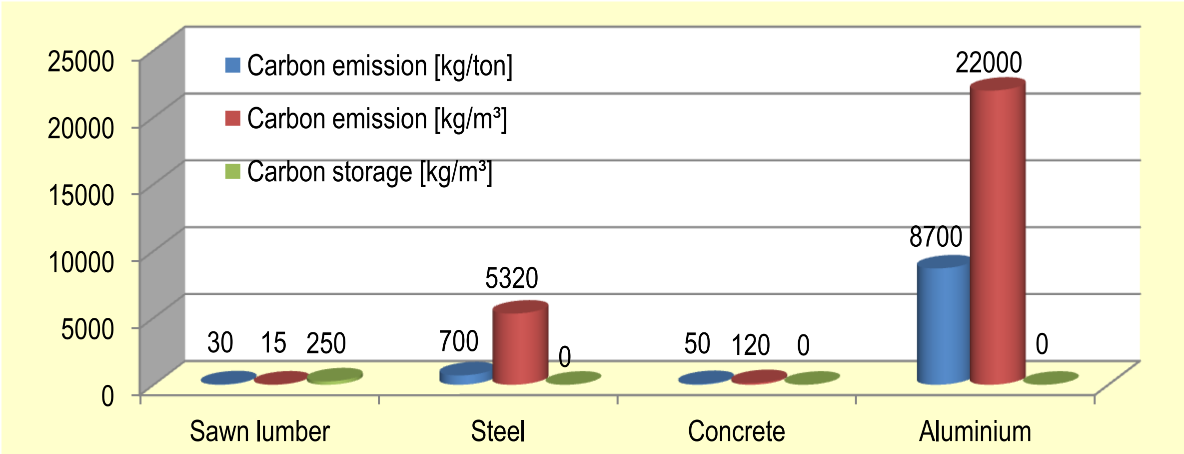


Diagram 2. Carbon emission and storage (retention) of four most important building materials (Source: *Australian Government, 2004)*

In the total amount of chemical elements in wood carbon has a 49% share, so it can be concluded that 1m^3 of wood absorbs 250 kg of carbon (Diagram 2). Diagram 2 shows that wood is the only material that has the ability to storage carbon, ie. it is the only material where the difference between emission and storage is negative value. The fact that carbon - dioxide after felling the trees and their processing into the final product remains in the wood until the end of its life cycle is of great importance. Even then, when wood no longer can be used in the manufacture of certain products, it can be used for combustion and heat generation. In this way wood release the same amount of CO_2 that was absorbed during the process of photosynthesis and retained during the entire life cycle of the product. In this sense, it can be concluded that the use of wood is CO_2 neutral, which is corroborated by the fact that even the most primitive use as a fuel also has CO_2 neutral impact.

On the other hand in the production of construction materials such as steel, concrete, aluminum and others large amounts of energy is consumed in order to obtain a final product that is ready for installation. In that proces a significant amount of CO_2 is released, which as the most negative consequence has the creation of the greenhouse effect and global warming increase. Among all gases that cause the greenhouse effect carbon dioxide is the most common with 77% share, of which 57% comes from burning fossil fuels, 17% from deforestation and forest exploitation, and the remaining 3% comes from other sources (GRID - Arendal, 2008).

4.2.1. The highest residential wood building in the world – Forte

Austria is among the world leaders in the production of cross laminated timber (CLT). That is confirmed by the fact that one of the largest factories for CLT production named "KLH" has produced structural elements for the highest residential building currently in the world. The name of the building is "Forte" and it is located in Melbourne, in Australia (Picture 2). The building has 10 floors with 23 apartments and a total height of 32.17 m. Works on the construction site were started in February 2012, and the installation of the CLT panels lasted from June to August of the same year, while the facility in December was fully completed. From the above mentioned it can be concluded that the period of installation CLT panels is relatively short primarily due to a high degree of prefabrication. The investment amounted to 11 million dollars (Lend Lease, 2013).

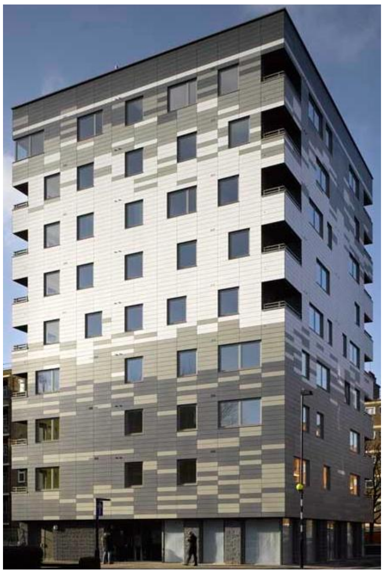
Picture 2. Finished CLT building Forte
(www.thomsonrealestate.com.au)

The quantities of materials used in the construction of this building are remarkable, so consumed timber volume amounted to 485 tons, which is equivalent to 759 pieces of CLT panels which are installed. Steel angles were used as connecting elements for CLT panels in total quantity 5,500 pieces, and wood screws were spent in the total amount of 34,550 pieces. By building this residential object from CLT, 761 tons of CO_2 were stored. To this value of stored CO_2 it is necessary to add the amount of CO_2 that would be emitted if an equivalent object of concrete or steel was built, so it can be concluded that the savings in carbon emissions are 1,451 ton. These savings in CO_2 emissions are comparable to the amount of CO_2 that would be saved if the 345 cars were excluded from traffic for a period of one year. In addition to the savings in CO_2 emissions, construction of this building made of wood also influenced on savings in water consumption in the amount of 7,700 m^3. (Lend Lease, 2013). From all the above mentioned it can be concluded that there is no green building without cross laminated timber (CLT), so it can be considered as the main generator of CLT demand, and therefore consumption.

In terms of building regulations in Australia, construction of wooden building larger than 3 floors was not possible. In this sense, it should have been solved one of the most important tasks such as ensuring the fire resistance of the object, which is usually placed in the foreground. Therefore it was necessary to find an alternative solution in the form of fireproof plasterboard panel which was used to cover the CLT walls and ceilings and thus fulfills the requirements of the standard AS1530 - part 4 which refers to fire resistance of bearing elements in the construction of Australia. In addition to previously mentioned, the fire resistance is further improved through the installation of five layer CLT panels in thickness 128 mm for walls and 148 mm for floors. These panels have two layers more than is structurally necessary, so it can be concluded that with appropriate dimensioning additional fire resistance can be achieved. In addition to the above mentioned, it is important to point out that the properties of the incorporated materials are largely predictable, as it is burning rate of CLT which is 0.7 mm/min. Beside those properties, also were investigated acoustics, resistance to abiotic and biotic factors because each of the above is of great importance for the exploitation of building (Lend Lease, 2013).

4.2.2. The highest residential wood building in Europe – Stadthaus, Murray Grove

Until Forte building in Melbourne was finally finished, Stadthaus Murray Grove in London was the tallest residential building in the world made of wood. It was completed in 2009 and with its nine floors held the record in this area for three years (Picture 3). Installation of CLT panels made of spruce lasted nine weeks, and on these jobs worked four professional workers and one supervisor. From the above mentioned it can be concluded that the time of panel installation was very quick if we take into account the number of workers who worked on the installation. This has been largely contributed by the fact that CLT panels were custom made. All openings and holes in the CLT panels such as those for windows, doors, plumbing and electrical installations were done in the factory, so this contributed to its faster installation. CLT panels supplier was the Austrian company KLH like for the building Forte, which produce panels in three qualities: 1. Non-visual quality in which mechanical and physical properties are important, but not the aesthetic having in mind that they are not built-in on visible positions. 2. Industrial visual quality in which by the mechanical and physical properties, aesthetic properties are also important because they are built-in on visible positions. 3. Domestic visual quality is intended for installation in living spaces (Timber Research and Development Association, 2009).



Picture 3. Finished CLT building Stadthaus, Murray Grove (*www.e-architect.co.uk)*

It is important to note that 926 m^3 of wood were used for building this object, which means that the amount of stored carbon is 186 tons. On this quantity of stored carbon its necessary to add 124 tons of carbon which would be emitted in the case that reinforced concrete was used for construction. This building has 29 dwellings, and in their interior there is no beams or pillars that could break uniformity in any sense, which is achieved by using CLT materials. (Timber Research and Development Association, 2009; www.klhuk.com).

The use of cross laminated timber for the construction of this building largely made it sustainable in terms of environmental protection. Using CLT materials significantly reduced energy consumption during construction on site, but also energy in the future exploitation having in mind that it is a low-energy building. It is also important that at the end of the life cycle (cycle of exploitation) building can be relatively easy to demolish and to recycle the remaining material. It is interesting to note that by the building envelope and elevator shaft which are made of wood, the building facade is made of wood too. Specifically, for this purpose was used 5,000 boards in dimension 1200 × 230 mm, and the ecological side highlights the fact that for their production were used 70% of recycled material.

Stadthaus Murray Grove is inevitably tested to fire resistance, where the CLT panels showed superior properties. In this respect they may be exposed to the combustion up to 60 minutes, and if they are protected with plasterboards resistance is increased to 90 minutes. Insulating properties of the CLT walls in thickness 128 mm can be shown through thermal resistance (U) which amounts 0.13 W/m²K with only 100 mm of insulation (Timber Research and Development Association, 2009).

5. CONCLUSIONS

In the global market increasingly actual and present are environmentall friendly and energy efficient buildings for which construction are used various types of innovative composite wood products. The most important composite product that enabled the construction of multi-storey buildings made of wood is cross laminated timber. From the above stated it can be concluded that the construction of multi residential buildings greatly affects the increase of consumption and consequently intensification of CLT production.

Research has shown that Austria is a world leading manufacturer of CLT which exports to the European market, but also to other continents such as Australia, North America and Asia. It can be concluded that on the global market is present clear upward trend in the production and consumption of CLT, which is confirmed by the statistical data mentioned in the paper, as well as with world examples of multi-storey buildings made of CLT. Excellent fire resistance of CLT made it reliable product even when it comes to the most stringent criteria set by the relevant European and Australian standards. In this sense, the fire resistance of 60 minutes can be achieved with five-layer CLT, and if it is covered with plasterboard this time is increased by 50%, so it can be concluded that allegations of poor fire resistance of these buildings are not based on relevant sources of information.

The impact on the reduction of CO_2 emissions into the atmosphere by using CLT as a building material is clearly proven by the representative examples of multi-storey buildings in Europe and the world. Direct savings in CO_2 emissions which amounts hundreds of tons per constructed object are achieved through its retention in the wood fibers by the end of the product life cycle, and indirect savings are achieved through substitution of traditional construction materials such as concrete, steel and aluminum. From the above stated it can be concluded that the ultimate effect of cumulative savings in CO_2 emissions is very important for reducing global warming, ie. reduce greenhouse gases, especially if we have in mind the requirements defined by the Kyoto Protocol signed by Serbia. Previously mentioned is of great importance for the intensive use of innovative composite wood products, primarily cross laminated timber (CLT) in Serbia, which should be an important strategic goal of construction and wood processing industry. These products as environmentally friendly materials should encourage the wood processing industry to improve and develop products with added value. When the rules and regulations in Serbia harmonize with requirements of the European Union can be expected to intensify the wood construction with the gradual substitution of concrete and steel.

It is believed that cross laminated timber is not only the product that enables wood construction, but the whole construction sector provides new opportunities and opens new horizons. This is primarily related to the multi-storey residential and commercial buildings, so the CLT may be the initial trigger for the intensification of building with innovative composite wood products in the cities. It is also considered that wood construction may represent a new milestone in the economic sense, particularly in terms of competitiveness of cross laminated timber compared to reinforced concrete, masonry and steel structures.

From all the above mentioned it can be concluded that there is no green building without composite wood products, including multi-storey residential and commercial buildings without use of an innovative composite material CLT.

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REFERENCES

1. Australian Government (2004): Forest and Wood Products Research and Development Corporation. Timber as a Sustainable Building Material. Timber in environmentally sustainable development.
2. European Wood Factsheets (2004): Wood products as carbon stores.
3. GRID-Arendal (2008): United Nations Environment Programme publication.Kick the Habit- A UN Guide to Climate Neutrality.
4. Institut Bauen und Umwelt - IBU (2014): Studiengemeinschaft Holzleimbau e.V. Cross-laminated timber (X-Lam). Environmental product declaration in accordance with ISO 14025 and EN 15804.
5. Kennedy, D., Hanson, B. (2006): Ice and History. Science, vol 311.
6. Lend Lease (2013): Forté. Creating the world's tallest CLT apartment building.
7. Leonardo da Vinci Pilot Project (2008): Handbook 1 - Timber Structures.
8. Ministry of the Environment, Government of Japan (2004): The Goal in Addressing Climate Change.
9. prEN 16351 (2011): Timber structures - Cross laminated timber – Requirements
10. Taylor, S., Wilson, P. (2013) The use of cross-laminated timber in high-density affordable housing and the potential to manufacture this engineered timber product in the Dumfries & Galloway region. CIC-Start Feasibility Study
11. Timber Research and Development Association (2009): Stadthaus, 24 Murray Grove, London. Eight storeys of apartments featuring cross-laminated timber panels.
12. www.klhuk.com
13. UNECE/FAO (2014): Forest Products Annual Market Review 2013-2014. Forestry and Timber Section, Geneva, Switzerland.
14. Smith, S. (2012): Timber Structures (material, design & case study). University of Cambridge.

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THE TEST OF THE CORPORATE CHARACTER SCALE ON TWO COMPANIES

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ABSTRACT

In this paper the usability of the Corporate Character Scale is tested in the conditions of the Slovak republic on two well-known companies IKEA and Möbelix which sell furniture. We tested the Corporate Character Scale mentioned in Davies et al (2004) and Whelan and Davies (2007). This scale consists of seven dimensions of corporate personality: Agreeableness, Enterprise, Competence, Chic, Ruthlessness, Informality and Machismo. Respondents were asked to agree or disagree with the items of the scale. The results are two profiles and the recommendations for further research.
Key words: corporate character scale, corporate personality,

1. INTRODUCTION

Turbulent and significant changes in the political, social and economic areas are reflected in the use of domestic renewable resources. Wood production has a long tradition in the Slovak Republic. (Paluš, Šupín, 2004) The domestic wood processing industry in the Slovak Republic is the major customer of the products of the forestry sector (Parobek and Paluš, 2008; Kalmárová et al., 2014). Timber production tries to adapt to rapidly changing market conditions and the requirements of wood processing sectors that vary over a relatively short period of time (Parobek et al., 2014). In our papers we test the Corporate Character Scale method on two retailers with furniture. Today, successful companies realize that the measure of success in the market is a satisfied customer (Loučanová et al., 2014) and the customer with a positive attitude towards the company. Customers create a picture (image) about the company and it is necessary for the company to know this image.

Davies et al. (2004) developed The Corporate Character Scale method to measure the image and the identity of the company by asking respondents to imagine that the company come to life as a person. We attempted to apply a holistic approach to an enterprise; the organisation is seen as a human being with the body and soul, identity and personality. In the real world it is impossible to work with the company as with a living being that's why we are using a metaphor. To characterise the corporate personality traits we recommend to use The Corporate Character Scale mentioned in Davies et al., (2004) and Whelan and Davies (2007, p. 139). This scale consists of seven dimensions of corporate personality: "Agreeableness, Enterprise, Competence, Chic, Ruthlessness, Informality and Machismo" (Whelan and Davies 2007, p. 139, Davies et al. 2004) (see table 1). These seven dimensions consist of 49 items, which reflect the human personality traits. The respondents had to rate each item on a Likert-type scale (from 1 – strongly disagree to 5 – strongly agree). This scale was created for business companies, but it can be used in non-profit organisations Ahonen et al. (2008). Keller and Richey (2006) in their work explain corporate brand personality and they describe corporate personality traits in three dimensions: "heart (passionate and compassionate), mind (creative and discipline) and body (agile and collaborative)". "These dimensions reflect three distinct sets of personality traits that can guide employees in the organisation and influence how the company will be viewed by others." (Keller and Richie, 2006, p.76) We mentioned this work because it follows up on corporate identity mix which is described in Balmer and Soenen (1999) (Soul, Mind and Voice). In our opinion, holistic approach to a company or organization can open space for revealing and developing new methods which can help managers, researchers etc. The enterprise is made up of individuals and groups. That's why we think that we can see an enterprise as a human being.

Table 1: The Corporate Character Scale: Dimensions, Facets and Items (Davies et al. 2004, p. 136)

Dimension	Facet	Item
Agreeableness	Warmth Empathy Integrity	Friendly, pleasant, open, straightforward Concerned, reassuring, supportive, agreeable Honest, sincere, trustworthy, socially responsible
Enterprise	Modernity Adventure Boldness	Cool, trendy, young Imaginative, up-to-date, exciting, innovative Extrovert, daring
Competence	Conscientiousness Drive Technocracy	Reliable, secure, hardworking Ambitious, achievement oriented, leading Technical, corporate
Chic	Elegance Prestige Snobbery	Charming, stylish, elegant Prestigious, exclusive, refined Snobby, elitist
Ruthlessness	Egotism Dominance	Arrogant, aggressive, selfish Inward-looking, authoritarian, controlling
Informality	None	Casual, simple, easy-going
Machismo	None	Masculine, tough, rugged

2. METHODS

To test the usability of the corporate character scale developed by Davies et al. (2004, 2007) we selected two well-known companies IKEA and Möbelix. We translated 49 items from the scale from English to Slovak language and we prepared the questionnaire. Respondents were asked to imagine that these two companies came to live as human beings and to rate their personality on a Likert-type scale. The respondents rated 49 items on the scale from 1 - strongly agree, 3 - Neither agree nor disagree (neutral answer, the midpoint of the scale) to 5- strongly disagree. The sample consisted of 285 respondents. The sample of respondents was not random, we used a snowball sampling technique. Face to face interviews were made with our 285 respondents. Respondents were selected according to their knowledge and experiences with IKEA and Möbelix. We used the weighted average score on the 5-pointing rating scale for both companies. For facet from the Corporate Character Scale, we used also mode and weighted average.

3. RESULTS

The sample (N=285) consisted of 57.9 % women and 42.1 % men. More than 86 % of the respondents were under the age 51. As for economic status more than 53 % were employees, more than 22 % were students and more than 14 % were entrepreneurs. More than 52 % of respondents have lived in the city.

Figure 1 presents the profiles for both companies and table 2 presents the results for facets from Corporate Character Scale. IKEA scores well on the four dimensions Enterprise, Agreeableness, Chic and Competence (as for facets for these dimensions see table 2). Möbelix scores higher than IKEA on these dimensions. Möbelix scores close to midpoint (2.76) of the scale on the Chic dimension. Dimensions Ruthlessness and Machismo have the highest scores for both companies (from 3.52 to 3.66), these scores are on the "not agree" side of the scale. As for dimension Informality score for IKEA is higher (2.6) than score for Möbelix (2.52). In general IKEA has lower scores in every dimension except dimension Informality.

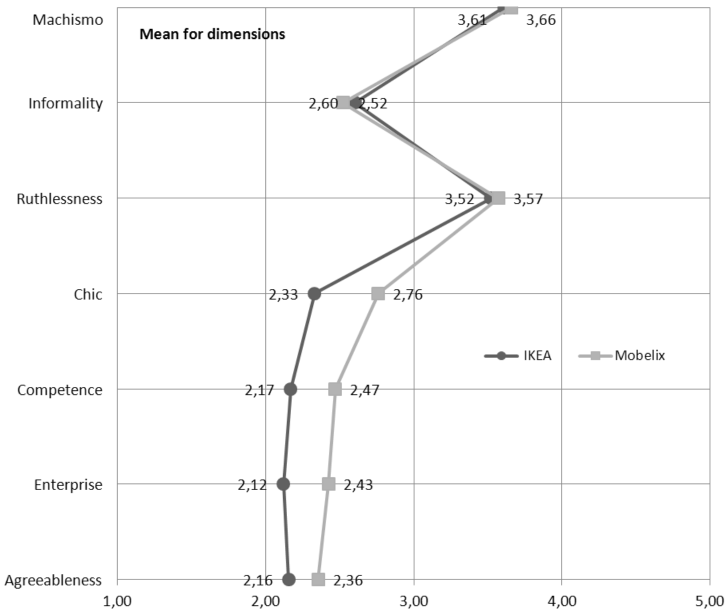

Figure 1. Profile for IKEA and Möbelix

Table 2. Modes, average scores and rounded means for facets (IKEA and Möbelix)

Dimension	Facet	Mode IKEA	Mode Möbelix	Mean IKEA	Mean Möbelix	Rounded mean IKEA	Rounded mean Möbelix
Agreeableness	**Warmth**	1	2	**1,90**	2,13	2	2
	Empathy	2	2	**2,23**	2,43	2	2
	Integrity	2	2	**2,33**	2,50	2	**3**
Enterprise	**Modernity**	2	2	**2,03**	2,30	2	2
	Adventure	1	2	**2,03**	2,42	2	2
	Boldness	3,2	3,2	**2,44**	2,62	2	**3**
Competence	**Conscientiousness**	2	2	**2,15**	2,44	2	2
	Drive	2	2	**2,08**	2,45	2	2
	Technocracy	3,2	3,2	**2,33**	2,54	2	**3**
Chic	**Elegance**	2	2	2,00	2,45	2	2
	Prestige	2	2	2,11	2,57	2	**3**
	Snobbery	3,4,5	5,3	3,16	3,51	3	**4**
Ruthlessness	**Egotism**	5	5	**4,00**	**4,01**	**4**	**4**
	Dominance	3	3	**3,03**	**3,13**	**3**	**3**
Informality	**None facet**	3	3	2,60	2,52	3	3
Machismo	**None facet**	3,4,5	3,4,5	**3,61**	**3,66**	**4**	**4**

4. DISCUSSION

From the profile of IKEA (see figure 1) we can see that IKEA scored highly on the dimensions: Enterprise, Agreeableness, Competence and Chic. As for dimension Enterprise, IKEA is seen as up to date, modern, trendy, imaginative, innovative, young and daring. According to Davies et al. (2004) Agreeableness is the most important dimension. The items of this dimension with the highest score are: friendly, pleasant, open, concerned, agreeable and trustworthy. As was mentioned in Whelan and

Davies (2007) this dimension can be considered the best predictor of customer satisfaction. The dimension Competence was at the third place in IKEA profile. Competence is the second most important factor, which influences customer satisfaction (Whelan and Davies 2007). IKEA is seen as ambitious, reliable, hardworking, secure, achievement oriented, technical and also leading and corporate. Chic dimension is associated with prestigious organizations. In the condition of the furniture industry in Slovakia, IKEA is considered Middle-class retailer and its merchandising and whole offer including services is at the very high level in comparison with the other retailers. We speculate that Chic dimension and the items from this dimension with the highest score such as stylish, elegant, prestigious, exclusive, refined, but not too snobby (score at 3.64) is related to some items from dimension Enterprise (modern, trendy, innovative and young). Interesting is that dimension Informal has score 2.6, which is close to neutral point of the scale. According to Davies et al. (2004) IKEA emphasize their informal corporate culture in their advertising but dimension Informal has score 2.6, which is close to neutral point of the scale. We think that our respondents do not consider IKEA to be more informal as Möbelix. Möbelix has profile, which is quite similar as profile of IKEA. We want to point out the dimension Chic (2.76). This score is close to the midpoint of the scale (neutral point). So we assume, our respondents do not consider Möbelix be very Chic. In our opinion, the difference between these two organisations, as for their personality, is more significant.

We assume that respondents don't recognise the small differences among translated items from the scale or do not have enough experiences with them to assess their personality. The main aim of this study was to test the corporate character scale in Slovak condition. During interviewing our respondents we have revealed that respondents considered being quite difficult to imagine that organisation is a real person and they had some problems with some items on the scale.

As for future research, we decided to discuss the items from the scale and their translation to Slovak language again. Also, we decided to test this scale again on IKEA and Mercury Market (furniture retailer) according to recommendations from our respondents.

REFERENCES

1. Ahonen, M, Juntunen, J, Autere, V, & Saarinen, T. (2008) The Corporate Character Scale in the Finnish Military Context. Australian & New Zealand Marketing academy Conference ANZMAC, December 1st - 3rd, 2008, Sydney, Australia.
2. Balmer, J. M. T., & Soenen, G. B. (1999). The Acid Test of Corporate Identity Management™. *Journal of Marketing Management*, *15*(1-3), 69–92. doi:10.1362/026725799784870441
3. Davies, G., Chun, R., da Silva, R. V., & Roper, S. (2004). A Corporate Character Scale to Assess Employee and Customer Views of Organization Reputation. *Corporate Reputation Review*, *7*(2), 125–146. doi:10.1057/palgrave.crr.1540216
4. Kalamárová, M., Parobek, J., Loučanová, E., Trebuňa, P. (2014). COMPETITIVENESS EVALUATION OF THE SLOVAK FOREST INDUSTRY. In *Position and role of the forest based sector in the green economy : proceedings of scientific papers*. - Zagreb : International Association for Economics and Management in Wood Processing and Furniture Manufacturing - WoodEMA, 2014. ISBN 978-953-57822-1-6, p. 58-62. VEGA 1/0387/13.
5. Keller, K. L., & Richey, K. (2006). THE IMPORTANCE OF CORPORATE BRAND PERSONALITY TRAITS TO A SUCCESSFUL 21ST CENTURY BUSINESS. *Journal of Brand Management*, *14*(1/2), 74–81. doi:10.1057/palgrave.bm.2550055
6. Loučanová, E., Parobek, J., & Paluš, H. (2014). Identifikácia požiadaviek Slovenských zákazníkov na úložný nábytok na základe modelu KANO. *Acta Facultatis Xylologiae*, *56*(1), 109–117.
7. Paluš, H., Šupín, M. (2004): COMPETITIVENESS OF SELECTED CLUSTERS IN THE SLOVAK FOREST INDUSTRY. The growth and developement in forestry and wood industry. Scientific book. Zagreb, Croatia, 2004. ISBN 953-6307-73-1. p. 17-20

8. Parobek, J., Palus, H., Kaputa, V., & Supin, M. (2014). ANALYSIS OF WOOD FLOWS IN SLOVAKIA. *BIORESOURCES*, *9*(4), 6453–6462.
9. Parobek, J., and Paluš, H. (2008). MODELLING OF WOOD AND WOOD PRODUCTS FLOW IN THE SLOVAK REPUBLIC. In:A Europe a Wood Processing Strategy : Future Resources Matching Products and Innovations, Ghent University, Belgium, pp. 93-99
10. Whelan, S., & Davies, G. (2007). A COMPARATIVE STUDY OF THE CORPORATE REPUTATION OF IRISH VERSUS BRITISH RETAILERS: LESSONS FOR RETAIL BAND PRACTICE. *Irish Marketing Review*, *19*(1/2), 37.

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IMPORTANCE OF BRAND MANAGEMENT FOR WOOD SECTOR DEVELOPMENT

Ivan Ambroš, Darko Motik, Danijela Domljan, Andreja Pirc Barčić

ABSTRACT

Spačva basin in Vukovar-Srijem County is the largest integrated complex of low land oak forest in Europe (Klepac, 2000) with 96% of world-famous Slavonian oak. Brand strategy will be important part of regional strategy and region branding with brand management team and formal brand building system. Development of consumer brand vision by implementing brand strategy will position superordinate umbrella brand of Slavonian oak in consumers' minds creating a strong platform for subordinate companies' brands and finished products brands. This thesis focuses on importance of brand management for wood sector development in Vukovar-Srijem County.
Keywords: Brand management, wood industry, forestry, regional development

1. INTRODUCTION

According to the Global Competitiveness Index in 2013/2014, Croatia was ranked at 75 place on the scale which consisted of 148 countries, while according to the same source for the period 2014/2015 is the 77th out of 144 countries. Going forward, Croatia will need to foster the efficiency of its market for goods and services. As Croatia will move into the innovation-driven stage of development in the coming years, it will need to start putting measures into place that incentivize and enable companies to innovate more. Currently, its businesses' capacity for innovation is low according to business executives, although research institutes are assessed more favourably (53rd) and the country's patenting rate is moderately strong (36th).

In the majority of Croatian companies investment in image, marketing, design and development of new products, hence the complete brand, takes unsystematic. Worldwide, both external and internal perceptions of the brand are important (De Chernatony and Segal-Horn, 2001). Furthermore, brand investment activities should result in a cost-effective market position as well as a brand positional advantage. The link to a cost effectiveness position is based on Aaker's (1992) suggestion that as the brand generates loyalty, other marketing costs can be reduced. Competitive advantage is based on reputation (brand), innovation and architecture (internal and external relationships such as relationships with customers and competitors and within the organisation that constitute the market-oriented behaviour captured by market orientation (Kay, 1993).

Modernization of all segments of Croatian wood industry is a prerequisite for increased competitiveness, finished products production growth and export orientation. Especially for the survival on already conquered markets, while the rest of the developed world has almost reached the limit of technological development, increasing productivity by finding new models, organizations and promotions of their own brands. Production programs current structure of domestic furniture industry, with some exceptions, is lagging behind in the development of new products, rational usage of production materials and technological equipment that can't guarantee any improvement in productivity or product quality (Domljan et al., 2005).

Cooperation between science and industry is essential because only such relationship can increase productivity and competitiveness of the Croatian economy and enable the development of innovative and technological solutions in all sectors of the economy. Aim of such cooperation is the development that will functionally connect scientific research resources with other parts of the social and economic system which will create the conditions for the new technologies and innovation of new products, production processes and services in accordance with the concept of sustainable development and competitiveness on the global market.

In Vukovar-Srijem County wood processing and furniture manufacturing has an important role and according to Motik and Pirc (2011) investments in a recognizable brand Slavonian oak certainly presents a significant success both in the local and at the state level. Branding management, innovation, design and product development as sources of advantage of business organizations are considered as necessary mechanisms for accomplishing superior performance and competitive advantage of wood industry sector based on Slavonian oak in Vukovar-Srijem County and also of the whole Croatian wood industry sector in domestic and foreign markets.

2. BRAND – BRANDING - BRAND MANAGEMENT

There appear to be few differences between services branding and product branding in terms of the concepts and definitions employed (Dall'Olmo Riley and de Chernatony, 2000). Brand is a name, term, symbol or design, or their combination, with the intention of identifying merchandise or services of a sole vendor or a group of vendors and differentiating them from those of competitors (***, 2009). A strong brand sends signal of quality and high expectations and also, create strong thoughts and emotions in the customer's awareness (Kuhn and Alpert, 2009.) Additionally, branding is the process of creating, planning and communicating the name and identity aimed at managing one's own image and reputation. Branding has emerged as a significant feature of contemporary marketing strategies and is now considered a key organizational asset (Kotler, 2000). According to Assael (1993) consumers rely on previous consuming experiences when attempting to select a product to satisfy their present needs. Meaning that pleasant past experiences is highly conducive to consumers associating benefits to a brand. Conclusion can be that a central function of branding, is its ability to negate the need for a consumer to seek out information when a need or a want has been recognized, but rather, lead him to a brand that has been satisfying in the past (Assael, 1993).

Brand positioning involves establishing keybrand associations in the minds of customers and other important constituents to differentiate the brand and establish (to the extent possible) competitive superiority (Keller et al. 2002).The final source of competitive advantage considered here is brand investment. Brand names or brand equity are often considered to be important resources which the firm possesses (De Chernatony and Segal-Horn, 2001). Aaker (1992) suggests that brand equity contributes to firm value through loyalty, awareness, perceived quality, and other brand assets. Aaker (1992) noted that it can be expensive to achieve a brand that provides a firm with a competitive advantage. Brand investment may suffer if organizations concentrate on short-term profits through price reductions and other sales promotion activities that generate more immediate and easily measurable results. It appears then that to generate a competitive advantage based on the brand, organisations need to invest in the brand. Additionally, innovation and market orientation are valuable reminders that the two primary functions of any firm are to create and keep customers (Drucker, 1974). Brand management represents the other marketing activities of the firm (product, service quality, price, promotion) and is particularly important given the intangible nature of services (Berry, 2000).

3. CURRENT SITUATION AND SWOT ANALYSIS OF CROATIAN WOOD SECTOR

Wood industry is an important segment of Croatian economy and especially Vukovar-Srijem County whose forest area makes 28,7% of its territory (*** 2014a). Achieving 10% of Croatian overall export, wood industry demonstrated its potential for growth not only on regional level, but also on national level.

STRENGTHS: Available high quality basic raw materials; Accession of the Republic of Croatia into the EU (market of 500 million people); Export orientation and coverage of import by export (especially export of raw wood and wooden semi-manufactured goods); Long industry tradition in the sector and large number of sector experts; Existing wood-processing capacities; Developed horizontal sectors (ICT and Creative industry); FSC certificate is advantage in comparison to other countries of South-East Europe; High positive net rate of new start-ups into the manufacture of furniture.

WEAKNESSES: Inadequate vertical and horizontal integration of wood-processing sector; Weak bargaining power of the wood-processing industry and strong bargaining power of basic raw material supplier; High intensity of rivalry, especially in the low-profitable areas of the wood-processing industry; Export of high quality raw material; Imports of furniture higher than exports; Old technology and low value added of wood-processing sector (poor structure of manufacturing industry – low level of finalization); Poor work productivity and high cost of manufacturing; Labour market not harmonised with commercial needs (lack of competencies); Inadequate networking between public, private and scientific and research sector; Underdeveloped infrastructure for technology transfer and commercialization of innovation; Inadequate investment in research and development in comparison to EU average and the remaining manufacturing industry; Underdeveloped supporting industries (manufacturing of machines, equipment and supply materials); Non-existence of joint distribution and sales value chain in the wood processing industry; Poor market positioning and sub-optimal utilization of potential for branding of traditional and autochthon wood products; Inadequate investment in promotion of the sector as a favourable investment destination.

OPPORTUNITIES: Trend of usage of wood as ecological and renewable raw material; Tendency to encourage green Public procurement tends; Higher demand for eco products at the developed global markets; Possibility to use the structural funds as instruments of cohesion EU policy and regional supports; Smart sector specialisation of Croatia; Development and internationalisation of competitiveness clusters; Multi-sectorial connection of wood-processing with the ICT, construction and tourist sector; Decrease of production costs through using the renewable energy resources (using the bio mass) and effective energy management; Gaining skills and life-long education; Strengthening industry excellence and development of national and EU sectorial and technological platform; Utilisation of KET3 technologies such as nano-technologies in developing new products; Availability of new technologies related to production process and logistics (intelligent packaging, e-logistics) and relationship with customers (e-trade); Development of products in accordance with customers' needs, providing designing and furnishing services; Investing into the development and design implementation in order to develop domestic brand of wood industry; Defining value chain sector and including it into global value chains; Opening up new market opportunities.

THREATS: Globalisation of the world market; Global financial crisis; Price competition of low quality products from Asia; ‘Grey’ market in manufacturing furniture; Severe EU regulations for wood sector Timber Regulation (01.01.2013); Rise of the energy cost at the global market (*** 2014c)

4. WOOD INDUSTRY IN VUKOVAR-SRIJEM COUNTY

Biggest income from export activities in wood sector in Vukovar-Srijem County of Wood processing (C16) and Furniture manufacturing (C31) is from floors and construction joinery (C16.23). Comparing to 2013, income raised 32%. Total income from export in wood sector in Vukovar-Srijem County of Wood processing (C16) and Furniture manufacturing (C31) from 2013 to 2014 grew 7% (*** 2015a).

Table 1. Income from export activities of Wood processing (C 16) and Furniture manufacturing (C 31) sector in 2013. – 2014.

Business activity	**Income from export (in 1000 kn)**		**Index 2014/13.**
	2013.	2014.	
16.10	9.359	7.578	81
16.23	73.299	96.778	132
16.24	0	0	-
16.29	77.012	66.273	86
Total of wood processing (C 16)	159.670	170.629	107
31.01	0	0	-
31.02	0	0	-
31.09	1.160	1.438	124
Total of Furniture manufacturing (C 31)	1.160	1.438	124
Total in Vukovar-Srijem County (C 16 + C 31)	160.830	172.067	107

Source: FINA; HGK; author's analysis

Table 2. Import/export ratios for Wood Processing (C 16) and Furniture manufacturing (C 31) in Vukovar-Srijem County in 2013 and 2014.

		2.013 (in 000 kn)	**2.014 (in 000 kn)**	**Index 2014/13**
Export	VSŽ C16+C31	160.830	172.067	107
Import	VSŽ C16+C31	6.499	17.346	267
Index import/export		4,0	10,1	

Source: FINA; HGK; author's analysis

Import for wood sector in Vukovar-Srijem County was in 2013 only 4% of the export. In 2014 it was 10,1% (*** 2015b). This statistics approve wood sector as export oriented sector. Reasons for that are big demand and good position on the market of finished products from Slavonian oak. Brand marketing strategy could bring additional high added value, raising export, new investments, jobs opening and wood sector development.

5. THE STRATEGY OF BRANDING THE SLAVONIAN OAK

Wood sector in Vukovar-Srijem County and the region has capacity of strategic development sector, despite still non-existing strategies on national level in July 2015 like Smart Specialisation Strategy, Regional Development Strategy etc. (*** 2014a). Slavonian oak is recognized as high quality wood material by the world, sector itself as well as buyers of final products. Slavonian oak from Spačva basin is even more appreciated because of its superb characteristics. These facts contribute to Slavonian oak brand platform establishing, strong enough to support place branding, final products branding, cluster branding and national wood sector branding.

Figure 1. Superordinate brand of Slavonian oak and subordinate brands of wood companies and finished products

Application of Triple Helix concept is crucial for wood sector development (Ambroš et al. 2015). Important part of the university-industry-government link is strong collaboration between public and private sector in supporting regional umbrella brand of Slavonian oak offering possibilities to government authorities for place branding and region branding.

5.1. Place branding and region branding

Tradition in wood processing, existing resources of quality raw material, significant percentage of forest territory and biggest integral oak forest in Europe with 96% of famous Slavonian oak are strong foundation for place branding and region branding (Ambroš et al. 2015). Establishing umbrella brand of „Slavonian oak" could identify the Vukovar-Srijem Cuonty as green county, with sustainable bio-economy, renewable energy sources, protecting natural environment, humans health and in conclusion desirable place to live and work in. Sustainable forestry and wood industry demands sustainable brand management strategy, having in mind high standards of environment and nature protection. Touristic destinations of hunting lodges Spačva and Kunjevci in Spačva basin forest managed by Croatian forests, protected special forest reservation Lože, magnificent several centuries old protected rear wood species of oak trees, natural sights of rivers Spačva and Virovi together with Museum of Forestry with regional importance, located in Bošnjaci make great touristic potentials which are not used enough.

Capacities of the County, counties departments and companies, touristic offices, cities, municipalities including every single inhabitant should actively support implementation of region branding strategy. Combined with an effective marketing campaign, regional brand can serve as source-identifier for consumers. Regional brand identify goods originating from a specific territory, region or locality within that territory with reputations for unique qualities. Branding can help producers develop consumer loyalty, which can lead to long-term and sustainable competitive advantages. Researchers found that geographic location is an important component of wine pricing (Schamel, 2000; Bombrun and Sumner, 2003) and that geographic origin has high importance for consumers of other food products (Wolfe and McKissick, 2001; Hayes and Lence, 2002). Additionally, design of new products stemming from traditional values and heritage of the local environment creates value-added products and services (Domljan et al., 2005).

5.2. Possibilities of cluster branding and sector branding

Wood Cluster „Slavonian Oak“ was founded in 2010 gathering companies from wood sector and those who promote wood sector, initially from Vukovar-Srijem County. In Wood Cluster “Slavonian Oak” wood-processors produce many finished and semi-finished wood products with overall low level of marketing and branding, except biggest company Spačva Ltd. who is becoming regional leader in finished products orientation (*** 2015a).

Place of origin has ability to add value to the product as part of brand management. This umbrella branding strategy of Slavonian oak can develop platform for new sub brands and individual brands in wood industry and forestry. Deciding factors for successful umbrella brand management and regional brand strategy implementation are coordination and connection between internal and external brand management. Existing capacities of Wood Cluster “Slavonian Oak” and Vukovar-Srijem County Development Agency Hrast Ltd. can offer adequate level of communication and coordination necessary for internal management of all stakeholders actively implementing Slavonian oak brand management strategy. Start-ups will benefit from the cluster reputation and brand to enhance their own business, while large corporations will want to facilitate innovation and perhaps come up with new business models and ideas.

6. CONCLUSIONS

Important part of brand management in wood sector development is region branding. Identifying a product based on its origin is an ideal way for high quality raw wood material of Slavonian, to be differentiated and recognized.

Potential benefits are not only restricted to wood sector, but also to tourism and food sector on regional and national level. Regional brand of sustainable and green county based on Slavonian oak has the power to gather all sub-ordinate brands under its umbrella brand, at the same time fitting well under superordinate national Croatian touristic brand of desirable destination for vacation.

After region branding, next step will be national sector branding. This means that Slavonian oak and especially Spačva forest as location with highest quality of raw wood material can be promoted from the national authorities – giving benefit to entire Croatian wood sector and their final products which have the origins in tradition values and heritage of Slavonian oak.

REFERENCES

1. Aaker, D.A. (1992): THE VALUE OF BRAND EQUITY, Journal of Business Strategy, Vol. 13, No. 4, 27-32.
2. Ambroš, I., Miškulin, I., Žalac, G. (2015): APPLYING TRIPLE HELIX CONCEPT TO DEVELOP WOOD SECTOR IN VUKOVAR-SRIJEM COUNTY, Interdisciplinary Management Research XI, Opatija, 860-868.
3. Anholt, S. (2007): BRANDING PLACES AND NATIONS, Brands and Branding, Profile Books, London.
4. Assael, H. (1993): MARKETING PRINCIPLES AND STRATEGY, New York: The Dryden Press
5. Berry, LL (2000): CULTIVATING SERVICE BRAND EQUITY, Journal of the Academy of Marketing Science, Vol. 28, No. 1, 128–37.

6. Bombrun, H. & Sumner, D.A. (2003): WHAT DETERMINES THE PRICE OF WINEW, Oakland: University of California, Agricultural Issues Center.
7. De Chernatony, L., Segal-Horn, S. (2001): BUILDING ON SERVICES' CHARACTERISTICS TO DEVELOP SUCCESSFUL SERVICES BRANDS, Journal of Marketing Management, Vol. 17, 645-69.
8. Domljan, D., Grbac, I., Motik, D., Radović, R. (2005): RAZVOJ NOVIH PROIZVODA U FUNKCIJI IZVOZA DRVNOG SEKTORA – BRAND DRVNOG SEKTORA, studija, Sveučilište u Zagrebu Šumarski fakultet, MPŠVG, Zagreb, 1-235.
9. Drucker, P.F. (1974): MANAGEMENT: TASKS, RESPONSIBILITIES, PRACTICES. New York: Harper & Row.
10. Hayes, D. J., & Lence, S.H. (2002): A NEW BRAND OF AGRICULTURE? FARMER-OWNED BRANDS AND REWARD INNOVATION, Iowa Ag Review 8 (4).
11. Kay, J. (1993): FOUNDATIONS OF CORPORATE SUCCESS, Oxford University Press, Oxford.
12. Keller, K. L., B. Sternthal, A. Tybout. (2002.) THREE QUESTIONS YOU NEED TO ASK ABOUT YOUR BRAND, Harvard Business Review, September Vol. 80, No. 9, 80-89.
13. Kerry, K., Alpert, F. (2009): APPLYING KELLERS BRAND EQUITY MODEL AND B2B CONTEXT LIMITATIONS AND EMPIRICAL TEST, Griffith University.
14. Motik, D. and Pirc, A. (2011): MARKET RESEEARCH OF FURNITURE AND OTHER WOOD PRODUCTS. University of Zagreb, Faculty of Forestry, Zagreb, 1-68.
15. Kotler, P. (2000): MARKETING MANAGEMENT, Millennium Edition, US: Prentice Hall.
16. Schamel, G. (2000): INDIVIDUAL AND COLLECTIVE REPUTATION INDICATORS OF WINE QUALITY (Policy Discussion Paper #0009), Adelaide, S.A., Australia: University of Adelaide Centre for International Economic.
17. Wolfe, K. & McKissick, J. (2001): AN EVALUATION OF THE "GROWN IN GEORGIA" PROMOTION (CR-01-39), University of Georgia, Center for Agribusiness and Economic Development.
18. *** (2009): The American Marketing Association, http://marketing.about.com/cs/brandmktg/a/whatisbranding.htm
19. *** (2011): ŽUPANIJSKA RAZVOJNA STRATEGIJA VUKOVARSKO-SRIJEMSKE ŽUPANIJE 2007. – 2013, Vukovarsko-srijemska županija, Vukovar
20. *** (2014a): INFORMACIJA O STANJU GOSPODARSTVA VUKOVARSKO-SRIJEMSKE ŽUPANIJE, Upravni odjel za gospodarstvo Vukovarsko-srijemske županije, Vukovar
21. *** (2014b): THE GLOBAL COMPETITIVENESS REPORT 2014–2015: Full data edition. (Prof.Klaus Schwab, ed.), World Economic Forum Geneva.
22. *** (2014c): CROATIAN WOOD COMPETITIVENESS CLUSTER STRATEGY AND OPERATIONAL PLAN 2014-2016, Identification No: EuropeAid/127604/D/SER/ HR,1-75.
23. *** (2015a): ANALIZA POSLOVANJA PODUZETNIKA PO ŽUPANIJAMA I PODUZETNIKA RH U 2014. GODINI, FINA, Zagreb 7. srpanj 2015.
24. *** (2015b): ANALIZA PODUZETNIKA NA PODRUČJU VUKOVARSKO-SRIJEMSKE ŽUPANIJE, Hrvatska gospodarska komora Županijska komora Vukovar, Vukovar, srpanj 2015.
25. *** (2015c): INFORMACIJA O POSLOVANJU UPRAVE ŠUMA VINKOVCI, svibanj 2015. Hrvatske šume d.o.o. Zagreb, Uprava šuma Podružnica Vinkovci
26. http://www.dzs.hr (Accessed: 20-06-2015)
27. http://www.ec.europa.eu/eurostat (Accessed: 20-06-2015)
28. http://www.fina.hr (Accessed: 21-06-2015)
29. http://portal.hrsume.hr/ (Accessed: 21-06-2015)
30. http://www.visitvukovar-srijem.com/ (Accessed: 20-06-2015)
31. http://www.vusz.hr/ (Accessed: 20-06-2015)

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A TEMPORAL VIEW OF U.S. VALUE-ADDED WOOD PRODUCT MANUFACTURERS AND CERTIFICATION: 2001, 2007 & 2014

Richard Vlosky, Cagatay Tasdemir, Rado Gazo, Daniel Cassens

ABSTRACT

Forest certification is a voluntary mechanism, which has emerged as due to concerns with sustainable management of forest resources. The primary objective of certification is to confirm that management of a specific forest area conforms to standards set by third party organizations such as, Forest Stewardship Council (FSC), Sustainable Forestry Initiative (SFI) and Program for the Endorsement of Forest Certification (PEFC). In addition to forest management, most certification schemes also provide chain-of-custody certification (COC) along with their regular forest certification process. The main purpose of COC's is to ensure that certified product is being processed in accordance with the guidelines and rules of specific certification program throughout the supply chain, from forests to the final consumer, by tracking and monitoring the material as it is formed into a pre-decided end item such as upholstered furniture, kitchen cabinets or wood flooring materials. This study examines COC as used by furniture and other value-added wood product manufacturers in the U.S. over three periods: 2001, 2007, and 2014. Overall, the understanding of certification and its use by this sector have increased over the past 14 years. In addition, certification is expected to increase in the future.

Keywords: Certification, United States, Wood Products, Value-Added, Temporal

1. INTRODUCTION

According to the Global Forest Assessment Report of FAO (FRA, 2010), approximately one third of the world's total land area is covered by forests, which equals to 4 billion hectares. About 93% of the world's total forest area is natural forests whereas 7% is formed by planted forests. Top five forest-rich countries are reported to be Russian Federation, Brazil, Canada, United States of America and China. It is also stated in the same report that 13 million hectares of area worldwide has been affected by deforestation between the years of 2000 and 2010. A vast majority of such deforestation occurred in tropical countries, whereas most developed countries follow a stable or increasing trend in terms of forest areas (FRA, 2010; FSC, 2015; Espinoza et al. 2013).

Forest certification is a voluntary mechanism, which has emerged as function of concerns in modern society associated with sustainable management of remaining natural resources in 1960's (Espinoza et al. 2012 and 2013; Vlosky et al. 2009; Chen et al. 2010). On the other hand, Marx and Cuypers (2010) defined the certification as "… Informational tool that structures market interactions." Based on their findings, the authors argued that alleviated levels of deforestation have very little to do with forest certification initiatives due to the fact that certification is only as effective as intended if certain level of development is achieved in that specific country while appreciating significant potential of certification programs (Marx and Cuypers, 2010).

1.1 Overview of Certification

Forest certification has had a noticeably positive trend in the last two decades. According to the UNECE/FAO, 28.3 % of global round-wood supply is coming from certified forests, which approximately equals to 501 million m³. In previous studies, it was stated that certified forest area in the world reached 320 million hectares and, this accounted for 13% of managed forests in 2008 while it was approximately 122 million acres as of mid-2002 (Vlosky et al. 2003 and 2009). Sustainable Forest Initiative (SFI), American Tree Farm System (ATFS), and Forest Stewardship Council (FSC) are the major forest certification systems around the world. PEFC endorsed standards, namely, SFI, ATFS and CAS have certified 154 million ha forest area, 59% of total certified area globally, in North America as of end of 2014 (PEFC, 2015). The breakdown of numbers for each organization by region is as follows; FSI has certified forest area of 24.4 million ha in U.S., 80.3 million ha in Canada; CSA has 40.8 million ha certified forest area in Canada while ATFS has a relatively smaller certified forest area, 8.6 million in U.S., when compared to those of other certifiers (PEFC, 2015). The growth of PEFC certified area around the world is reported to be 207.9 million ha from 2004 to 2014 (PEFC, 2015). FSC, one of the major independent certifiers in North America, FSC has certified 69 million ha of forest in the U.S. and Canada, and 187 million ha worldwide as of April 2015 (SFI, 2014; FSC, 2015). Recent studies examined costs of forest certification in South and North America, involving systems in U.S., Canada, Brazil, Argentina, and Chile, revealed that median average cost of certification ranged from $6.45 to $39.31/ha per year for land areas smaller than 4,000 ha while median cost for large land areas, 400,000 ha or bigger, were in between $0.07 and $0.49/ha per year (Cubbage et al. 2009; Moore et al. 2012). Moreover, FSC also reports that number of Chain of Custody (CoC) certificates issued to various companies processing wood products in the U.S. and Canada increased to 5013 recently. It was reported to be around 4012 in the last quarter of 2014 (FSC, 2015). In the global level, CoC certificates of FSC increased by 85% from 2009 to 2015. On the other hand, SFI had more than 2800 certified chain of custody locations by the end of 2013 as function of 251 CoCs in U.S. (SFI, 2015; PEFC, 2015). Figure 1 shows the generalized flow of certified products from the forest to end-users.

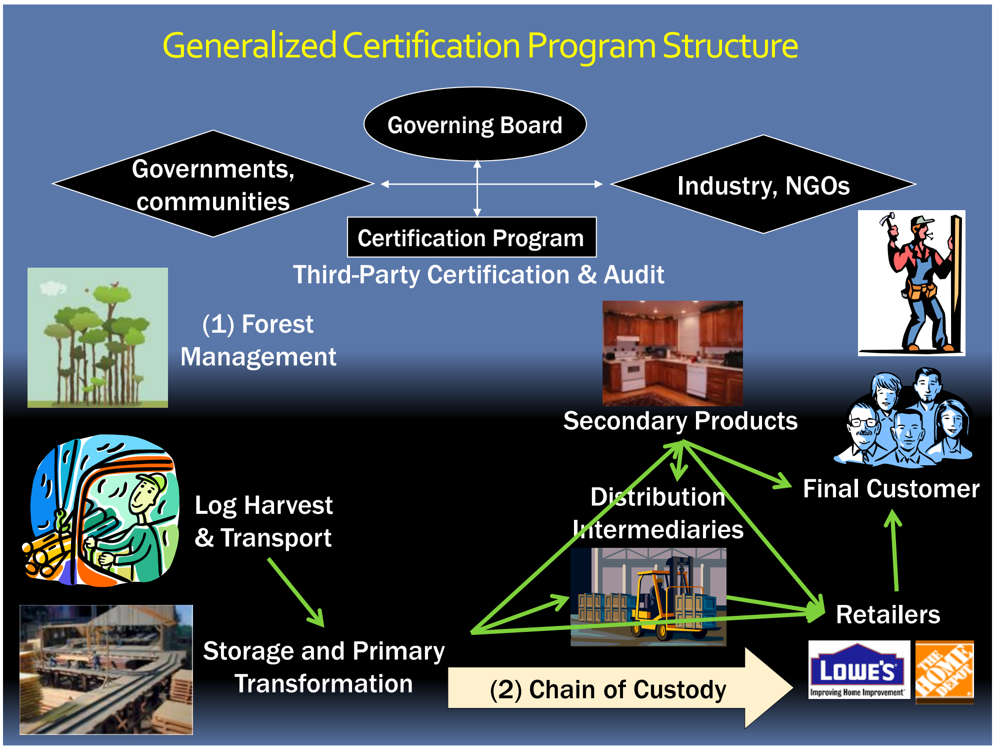

Figure 1. Generalized Certification Program Structure

1.2 Certification in the U.S. Value-added Wood Sector

Although several studies focusing on certification concepts have been conducted during the past years, there is limited information on certification of the value-added wood products industry. Vlosky and Ozanne (1998) conducted a study to have a better understanding on U.S. wood products manufacturer perceptions of certified wood products and concluded that larger manufacturers have higher interest than smaller-scale manufacturers in becoming more environmentally oriented and it is further stated that main concern of all respondents is reported to be costs associated with certification process (Vlosky and Ozanne, 1998). In a more recent study, Vlosky et al (2003) concluded that manufacturers of wood products industry are reluctant to pay premiums for certified raw materials (Vlosky et al. 2003). Another past study addressing the impacts of SFI and FSC certification in North America found out that a vast majority of disadvantages brought up by organizations participating in the study are cost related and the public, social and forestry issues of both programs were not perceived as crucial as cost issues (Moore et al. 2012). Furthermore, research by Michael et al. (2010), analyzing executive perceptions of adopting an environmental certification program in kitchen cabinet industry, discussed that executives who haven't adopted any environmental certification schemes may either be lacking knowledge on challenges and benefits associated with certification or have misperceptions misguiding them about such systems (Michael et al. 2010). This paper builds on survey-based research conducted in 2002 and 2008 by presenting a momentary snapshot analysis of certified wood products perception of companies serving in wood products industry and their participation level in any kind of certification by exploring conceptual and factual differences from company to company within the scope of well-known certification schemes, concepts and executive preferences.

2. METHODOLOGY

In 2002, 2008 and 2015, we conducted studies to identify value-added wood industry perspectives and participation in certification and to see what has changed in the industry. The data are presented for the previous years (the years that respondents were asked to report on). In 2002 and 2015, we used paper-based surveys sent by various associations to members (including AWI, BIFMA, KCMA, and the National Association of Store Fixture Manufacturers (NASFM)) to their members. These associations required anonymity for their members and as such, controlled the mailing of the surveys. Hence, only one mailing was sent. The associations did include a cover letter encouraging the recipients to participate in the studies. The 2008 study was web-based and anonymous. We worked with associations to send survey link to members of five national associations: Association for Retail Environments (A.R.E.); Architectural Woodwork Institute (AWI); Business and Institutional Furniture Manufacturer Association (BIFMA); Kitchen Cabinet Manufacturers Association (KCMA); and the National Hardwood Flooring Association (NHFA). In addition, the link was published in Wood & Wood Products magazine.

3. RESULTS

Due to the methodologies used, we cannot determine response rates for the studies. In addition, although the same sector was surveyed, respondents are likely different for each period and response rates vary as well. Following are some highlights from the research. First, as seen in Figure 2, The understanding of forest management and chain-of-custody certification has risen dramatically over the study periods.

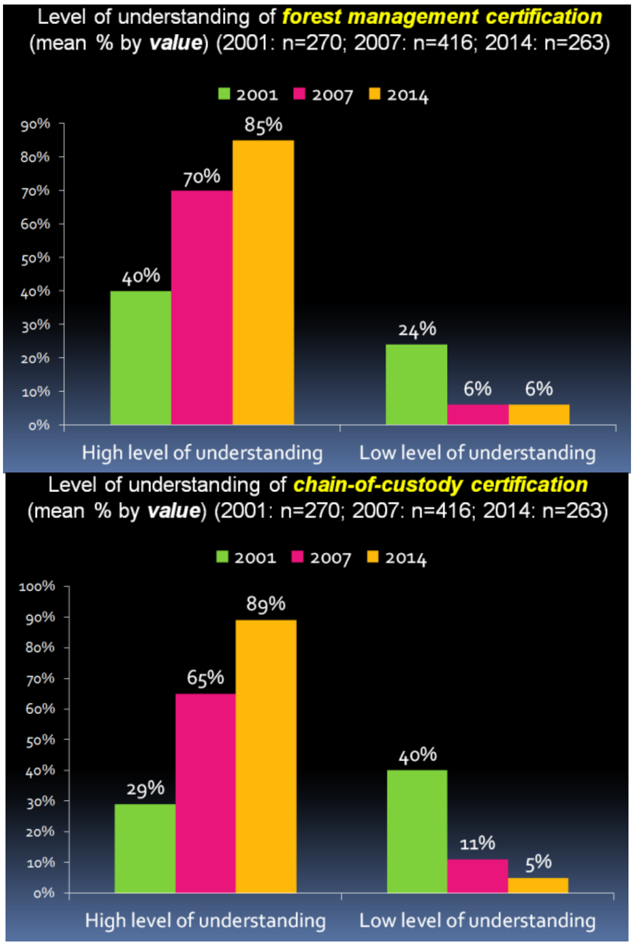

Figure 2. Level of Understanding for Forest Management and Chain-of-Custody Certification

In addition to the level of understyanding for certification in general, the percent of respondents that sell/sold certified wood products increased significantly as well, increasing from 8 percent in 2001 to 61 percent in 2014 (Figure 3).

.Figure 3. Percent of Respondents that Sell Certified Wood Products

In addition, over the study period, the percent of wood products raw materials purchase costs increased by 136 percent and the percent of company sales revevenue fir certified products increased by 120 percent (Table 1).

Table 1. Costs and Sales of Certified Wood Raw Materials and Products Sold (Means)

Costs and sales of certified wood products (means)	2001	2007	2014
Approximately what percentage of your wood products purchase costs in were attributed to certified wood products?	14%	20%	33%
Approximately what percent of total company sales value was from certified products?	10%	21%	22%

4. CONCLUSION

The purpose of this study has been to provide a quantitative assessment of the landscape for certification in the U.S. value-added wood products industry over time. The study suggests that certification continues to be an important component of doing business issue for this sector. Certification awareness, understanding, and participation have increased significantly from 2001-2014. Finally, respondents plan to continue to sell certified wood products over the three time periods (97 percent of respondents in 2001 and 2008 and 98 percent in 2014).

REFERENCES

1. Chen, J., Innes, J.L., & Tikina A. (2010). Private cost-benefits of voluntary forest product certification. International Forestry Review, 12(1), 1-12.

2. Cubbage, F., Moore S. T., Henderson, T., & Araujo M. (2009). Costs and benefits of forest certification in the Americas. Natural Resources: Management, economic development and protection. Paulding, J.B. (ed.). Nova Publishers, Hauppauge, NY.
3. FRA. (2010). Global Forest Resources Assessment Report 2010 – Main Report. Food and Agriculture Organization of the United Nations, Rome, Italy.
4. Forest Stewardship Counci (FSC)l. (2015). 2014 FSC Market Info Pack. Retrieved on 05.05.2015 from: https://ic.fsc.org/market-information.345.htm
5. Espinoza, O., Buehlmann, U., & Dockry, M. (2013). Status of forest certification. International Scientific Conference on Hardwood Processing (ISCHP 2013).
6. Espinoza, O., Buehlmann, U., & Smith, B. (2012). Forest certification and green building standards: overview and use in the U.S. hardwood industry. Journal of Cleaner Production, 33(2012), 30-41.
7. FSC. (2015). Forest Stewardship Council. https://us.fsc.org/
8. Marx, A., & Cuypers, D. (2010). Forest certification as a global environmental governance tool: What is the macro-effectiveness of the Forest Stewardship Council?. Regulation and Governance, 4, 408-434.
9. Michael J.H., Echols, A.E., & Bukowski, S. (2010). Executive perceptions of adopting an environmental certification program. Business Strategy and the Environment, 19, 466-478.
10. Moore, S.E., Cubbage, F., & Eicheldinger, C. (2012). Impacts of Forest Stewardship Council (FSC) and Sustainable Forestry Initiative (SFI) forest certification in North America. Journal of Forestry, 110(2), 79-88.
11. PEFC. The Programme for the Endorsement of Forest Certification. (2015). PEFC Global Statistics: SFM & CoC Certification. Retreived on 05.05.2015 from: http://www.pefc.org/about-pefc/who-we-are/facts-a-figures.
12. SFI. 2015.Sustainable Forest Initiative. SFI 19th Future Forest Annual Progress Report. http://www.sfiprogram.org/files/pdf/2014-sfi-progress-report-spreads/.
13. Vlosky, R., Gazo, R., Cassens, D., Perera, P. (2009). Changes in value-added wood product manufacturer perceptions about certification in the United States from 2002 to 2008. Drvna Industrija, 60(2), 89-94.
14. Vlosky, R.P., Gazo, R., & Cassens, D. (2003). Certification involvement by selected United States value-added solid wood products sector. Wood and Fiber Science, 35(4), 560-569.
15. Vlosky, R.P., & Ozanne, L.K. (1998). Environmental certification of wood products: the U.S. manufacturers' perspective. Forest Products Journal 48(9), 21-26.

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RETURN OF INVESTMENT INTO MARKETING ACTIVITIES IN ORGANIZATIONS FOCUSED ON WOOD-PROCESSING INDUSTRY

Renata Nováková, Vladimír Ovsenák

ABSTRACT

An important condition for survival of organizations active in wood-processing industry in global competitive environment is not only to produce a hight quality product. It becomes essentially important to advertise the product. The investments into marketing communication represent important financial expenses which are often influenced by factors such as market entry or decision on marketing programme. The later is about the possibilityhow to adapt one´s marketing mix to local conditions. The content of the article defines various problem areas which can be included in setting the communication strategy in wood-processing industry. We will also point out two extremes regarding decisions on marketing programme and we will focus on two different practice exaples which will confirm our theory.

Key words: Return of investment, marketing, wood-processing industry, communication strategy

1 INTRODUCTION

One of the most watched indicators in any industry are economic indicators. Economic literature may be encountered with more breakdowns, whether synthetic indicators or analysis, or indicators of performance and efficiency, etc. The basic performance indicators are also profitability indicators. We know indicator of return on sales, profitability and the return on investment. For us it will be subject to review indicator of return on investments, namely return on investment in marketing communication activities in organizations that are engaged in the woodworking industry. Before we begin, however, dealt with this topic in detail, we should summarize the marketing tools of the marketing mix under 6 and their chosen activities. These can be found in the following table:

Tab 1. Marketing tools of marketing mix 6P and their selected activities:

product	price	place	promotion	people	processes
Quality, features, name, packaging, service, guarantee	List price, discounts, allowances, credit conditions, costing, pricing	Distributors, vendors, locations, inventory, transport, storage	Advertising, sales promotion, public relations, direct marketing, direct sale	Before and after sales support servis,	Monitoring, quality assurance, customer complaints, identifying customer needs

(Source: www.cim-co.uk, www.homebasedbusiness.sbdc.com.au)

A new trend is that the top managers in organizations operating in the woodworking industry, are starting to increasingly require that marketing plans processed and in terms of financial impact and marketing investments that have been assessed as'. other types of investment. In marketing it is sometimes very difficult to precisely quantify the financial effects. The reason is that the indicators should be relevant to the assessment of the effectiveness of marketing activities can be established on the basis of immeasurable characteristics so. attributes. In practice, there is often tension and confusion on the operation of marketing tools to target group and effective terms.

We need to mention that the transition from independent indicators of a causal chain brought fundamental new insights in terms of efficiency and control. Models that these relationships can accentuate assess the impact of marketing strategies and tactics right on the executive level, t. j. the level of implementation. It determines the most profitable way of marketing action tools within a single marketing event. At the same time, however, can create forecasts model the impact of those measures on connecting variables indicators such as. development of the market share or customer attitudes and so on. In business practice, but, unfortunately, there are very few case studies and expert opinions, which would be strictly devoted effectiveness of strategic and tactical marketing decisions. If we can define these factors, we were able to predict and long-term financial performance of organizations active in the woodworking industry.

2 MARKETING SPECIFIC INDICATORS FOCUSED ON INVESTMENTS KNOWN FROM PRACTICE

Theory and practice is currently known about 60 different marketing measurement indicators, their level of knowledge and use is very low. In our contribution appoint at least basic groups according to their focus areas and applications:

a) Indicators reflecting the share of selective perception, position the product in the mind of customers, market position, such as: an indicator of customer perceptions, market share, competitive analysis, and so on.

b) indicators aimed at the field margins and profits, such as development of sales, cost structure and profitability developments.

c) indicators focused on product management and product portfolio, such Indicators tracking execution, respectively. percentage measurement of the effects of product strategy at the stage of testing the product in the growth phase, the effects of measuring brand value and so on.

d) indicators focusing on customer profitability, such as measurement and the expression of customer value for organizations operating in the woodworking industry, the effects of building relationships with customers and so on.

e) indicators of sales and management of distribution channels, such as indicators of the organization and performance of vendors, selling connectivity to the material interest coverage indicators distribution and logistics indicators.

f) indicators of pricing strategies such as indicators of price sensitivity and price optimization indicator pursuing setting prices to maximize profits and so on.

g) indicators focusing on the area of sales promotion, such as price promotional terms such as coupons, rebates and price compensation.

h) indicators focusing on the area of advertising media and indicators associated with Internet communications such. measurement range of advertising coverage and efficiency, along with measuring the extent of interventions, frequency and creating the impression. Modeling customer response to advertising, specialized indicators for internet communication and advertising campaigns.

i) indicators aimed at linking marketing activities and corporate finance - complex indicators on the financial evaluation of marketing programs.

j) indicators designed to use as the main indicators of market opportunities, challenges and financial performance. It is an area of the new approach to gauge indicators often referred to as "X-ray parameters".

3 CHARACTERISTICS OF RETURN (PROFITABILITY) AS THE PRIMARY CRITERIA FOR ASSESSING THE EFFECTIVENESS OF MARKETING ACTIVITIES

In a study of IBM (TASR report dated 17.10.2011) was very relevant information:

"The primary criteria for assessing the effectiveness of marketing activities in 2015 - marketing ROI"

Marketers are therefore becoming increasingly addressed return indicators in marketing activities. But it is, as already mentioned above, quite difficult, because it is not always clearly structured indicator and credibility of the relevant data could be also discussed, as not all indicators have a specific character. However, where should marketers interested in creating a global view of the return on invested funds in marketing in organizations working in the woodworking industry, they could use a methodology consisting of the construction, use and evaluation indicators that have professionals from literary sources can know. Among those essential it includes, for example **Indicator of customer capital.**

These indicators are very closely linked and customer profitability indicator (ROC - Return on Customer).

This is influenced by three main factors:

a) profit
b) competitive advantages
c) creating value for internal operations

Just for comprehensive information, we have also noted that such profitable customer is an entity which over time creates a revenue stream flow in excess of costs incurred in obtaining the customer's sales and operating.

PR managers use indicators designed to assess the effectiveness of advertising:

Effectiveness of advertising = fulfilled target of advertising / advertising target path x 100

Rate of return on investment ROI (Return on Investment) is the indicator, which is known from practice, but they marketers indicate that depends largely on the input data, which can often be irrelevant nature. Therefore, the indicator of profitability of investments in PR activities and advertising spending are merely indicative and must be strengthened even more by other indicators, which makes a comprehensive view on the effectiveness of marketing investments.

ROI = Sales / Investment in PR activities
ROI = Sales / advertising investments

Rate of return on marketing spend - Return on Marketing Expenditure (ROME):

- **ROME = increase profitability / increase in marketing expenses**

or

- **ROME = increase revenues - expenses increase / increase in marketing expensesv**

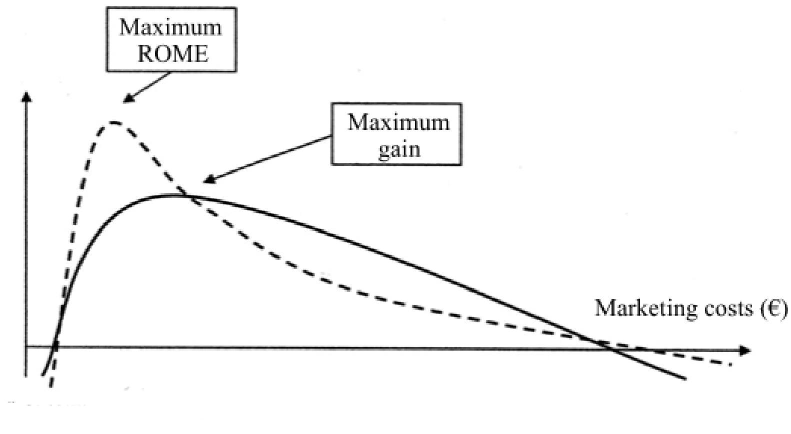

Fig 1 Rate of return on marketing spend
Source: processed by author Ambler, 2003

Special portfolio matrix developed for its internal needs of the company Diageo - the graphic representation of the efficiency and effectiveness of marketing communication is then as follows:

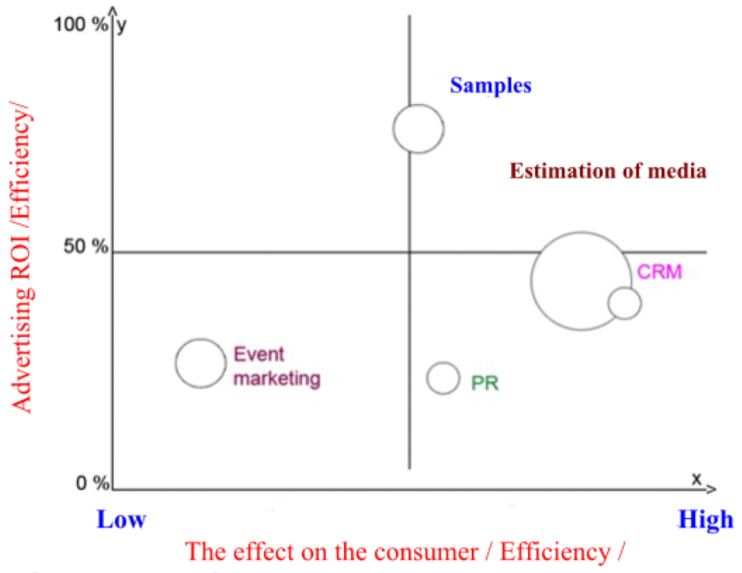

Fig 2 Efficiency and effectiveness of marketing communication
Source: processed by author Malcom, 2003

Based on the solutions of grant tasks VEGA we dealt with we, the topic and, following extensive analysis we have made a proposal for new ratios on the quality level, these indicators accentuated level of profitability indicators and their links to the defensive and offensive communication and quality costs and the new structure . An important indicator of yet unknown, which is our know-how is an indicator of profitability communication with customers. Construction of indicators, as well as other connection and explanations provided as follows:

$$ROQ = \frac{P}{QC} \qquad QC = CRD + CD + CO$$

$$ROI = \frac{P}{CRD}$$

$$ROC = \frac{P}{CC} \qquad \text{while } CC = CD + CO$$

Legend:
ROQ - indicator of profitability quality
P - profit (profit)
QC - quality costs (Quality costs)
CRD - costs of research and development, taking into account the time factor
CD - the cost of defensive communication
CO - cost of an offensive communication
CC - the cost of communication with the customer
ROC - profitability of customer communication

$$ROQ = \frac{P\left(\frac{QC}{TC}\right)}{QC} > 1 \qquad ROIA = \frac{P\left(\frac{CRD}{TC}\right)}{CRD} > 1$$

$$ROC = \frac{P\left(\frac{CC}{TC}\right)}{CC} > 1 \qquad ROC = \frac{L\left(\frac{CC}{TC}\right)}{CC} < 1$$

Legend:
ROQ - the proportion of quality costs on the profit - profitability quality
TC - total costs
QC - the cost of quality
ROIA - the share of innovation activities in generating profit
ROC - the proportion of the cost of communicating with customers in generating the profits if the numerator P, if numerator is L (loss) to the fraction of the cost of communication with customers in case of of loss reporting
P - earnings
L – loss

4 CONCLUSION

Most of the world marketers realize a fundamental shift in communication with customers. The challenges are primarily social networks, but it is questionable how to handle such an important turning point in consumer behavior in the wood industry. The survey, which we mentioned in our article (IBM study) confirmed the change in the evaluation criteria of marketing. Two-thirds of managers surveyed (from 1700) reported that marketing ROI already in 2015 becomes the primary criterion for assessing the effectiveness of marketing activities. The problem, however, remain relevant numbers and gaps in the analytical record of the individual cost items related to the subsequent comments profitability indicators. A very important reason why you need to follow the marketing specific indicators is that their value is an important source of information for organizations active in the woodworking industry, and this can through them and during the measurement process accurately inform what the main impacts will be determined in the woodworking industry customer value and value the organization as a whole. Marketing Specific indicators help to monitor over time the connection between strategy and financial performance of organizations active in the woodworking industry.

BIBLIOGRAPHY

1. Fíbrová, J., Šoljaková L, : Hodnotové nástroje řízení a měření výkonnosti podniku. 1. Vyd. Praha: ASPI, a.s. 2005. 263 p. ISBN 80-7357-084-X.
2. Oreský, M.: Hodnotenie efektívnosti marketingu - východiská tvorby a uplatnenia merných ukazovatelov v marketingu = Evaluation of the marketing effectiveness - the basis of measurement and application of indicators in marketing. In: Vedecké state Obchodnej fakulty. Bratislava : Vydavateľstvo EKONÓM, 2011. s. 1-13. ISBN 978-80-225-3326-3.
3. Grantová úloha VEGA č. VEGA 1/0107/11: Manažérstvo kvality v oblastiach nepokrytými normami ISO na systémy manažérstva kvality
4. Ojurovič, R., Moro, M., Šegotič, K., Grladinović, T., Oblak, L.: Analysis of the investment in wood processing and furniture manufacturing entities by key factors of competitiveness. Drvna industrija, 2013, 64 (2), p. 131-137. ISSN 0012-6772.

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THE IMPACT OF PARTICIPANTS' STANDPOINTS IN USAGE CHAIN ON THE INCREASED USE OF WOOD AND WOOD PRODUCTS

Aida Kopljar

ABSTRACT

The main objective of this study is to explore market perception and analyse wood and wood industry as a basis for increased wood consumption in the Republic of Croatia. The present research involves end users and businesses. It aims to establish models of increased wood consumption which can be applied on the territory of Croatia and which, according to the strategic document 'Paper and Wood Processing Strategy', will ensure the growth, development and increased profitability of wood-based industries. This paper is the first attempt to explore this issue and analyze the application of the Strategy. Survey data will be analyzed and processed in order to examine the current model, as well as define a new and acceptable model of increased wood consumpton in practice. The purpose is to prove the hypothesis which assumes that the current model of wood and wood product consumption is unsatisfactory in terms of sustainability, competitiveness, climate change and the impact of economic crisis in the respective fields. A new model of increased wood consumption will be proposed in accordance with the results of this research.
Key words: Market research, the perception of wood and wood products, wood consumption, increased use of wood.

1. INTRODUCTION

The development of processes and products with high added value and extensive replacement of non-renewable materials with wood are the biggest potential of the wood sector. Forests are, along with water, the most valuable natural renewable resources and a great national treasure. Croatia has a significant amount of raw material; 48% of the national territory consists of forests and forest land, that is, more than 2 million acres is forested. Each year about 80% of total growth is cut down and the growing stock is constantly increasing. Forests in Croatia are natural in 90% of cases and have FSC certification, which confirms that the forest is managed according to strict environmental, social and economic standards. Croatia has a very rich tradition in wood processing, and its origins are the three essential elements: forest cover of the country, belonging to the European Economic trends and traditions in crafts. Given the fact that the increased use of wood in the long run results in the strengthening of the domestic market of wood products, creating jobs and contributing to the competitiveness of the sector through strategic investment and boosting association with political support, the sector will be in a position to significantly increase the use of wood while preserving other important forest functions. In doing so, creating and product design are relevant, in order to meet the needs of present and future consumers and that the same products can be recycled. The wood sector has to work within the regulatory framework, in which competition plays a key role, and it is necessary to supplement that framework with communications, with aims to familiarize society with the benefits that wood and wood sector brings to current and future generations.

The aim of the research of end users was to determine the standpoint of Croatian population concerning the wood industry in Croatia and to understand the perception of Croatia's population; and different materials for the construction and furnishing. The main objectives were to determine the preference of certain materials when buying furniture and other interior parts, to determine which elements affect the purchase of furniture and other interior parts, establish familiarity with manufacturers of furniture and other wood products, and perceiving the campaigns with the forests and wood topic. This paper is, in fact, the assessment made in order to define the key factors, challenges and opportunities, which will encourage the use of wood and wood products.

2. PROBLEMATICS AND RESEARCH AIMS

Application of the increased use of wood model, just like any other novelty bears challenge, uncertainty and discomfort, and sometimes resistance to certain interest groups, either in companies or in certain traditionally inert structures within government institutions. Such resistance, in particular a lack of understanding of the usefulness of introducing a renewable and ecological material, for example wood, often reverses already achieved results that have been accomplished by great commitment and effort, mostly by individuals or small groups of experts. The innovative nature of the activities is that they are often risky, with many uncertain costs of implementation of the idea into the potential product, process and / or business, and questionable final business results (Christensen, 1997). Among scientists, there is the opinion that innovation is a complex phenomenon, but with major differences between sectors (Pavitt, 1984; Storper, 1997; Malerba, 2005) and largely depends on the level of interaction of different participants in different spatial environments (Smith, 2000). The research on innovations and innovative activities specific to the wood industry are not particularly present among the scientific research (Stendahl and Roos, 2008). Recent studies suggest[10] that investments in this sector have a high multiplication effect on the creation of new value and employment.

In communication and marketing, it is important to understand your target audience. Generally, people have a very positive attitude towards forests and wood. In addition, the relationship between humans and forests, and also wood, greatly determines their feelings and emotions. However, the wood sector is often faced with a strong prejudices-delusions may be so deeply rooted that they often indicate the underlying problem of change and require long-term efforts of communication based on the correct understanding of what people really believe. German sociologist Niklas Luhmann[11] has shown that the psychological factors that determine whether communications fail or not are often seriously neglected. The adequate information often is not enough. Effective communication is a process based on the two-way information. Together with the report of the *Europeans and their forests*, published by the MCPFE and UN FAO / ECE Forest and Communicators Network in 2003, it is the most comprehensive insight into public perceptions regarding forests, wood and wood products.

In arrangement with the public nothing can fail, without public acceptance nothing will succeed.[12]

There is no doubt that the phrase of Abraham Lincoln is more relevant today than ever. Nevertheless, who is the public? What should be agreed with it? What does it not accept? The answers to these questions are crucial, especially if we want to be accepted by the public and succeed in the market.

3. METHODS

In the analysis of the subject a standardized procedure for collecting data in a unique and equitable manner from all units involved in the study was administered. The following methods were used: quantitative analysis, qualitative analysis, descriptive analysis, interviewing method, χ2-test and

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[10] Dhubhain, A.N. i dr. (2008), „Ekonomik Impact of Forestry and Wood Products Industry in Ireland“, Socio Economic Aspects, Vol 57, No 4.

[11] Niklas Luhmann (8. prosinca 1927 - 6. studenog 1998) bio je njemački sociolog i istaknuti mislilac u sociološkoj teoriji sustava. Luhmannov se sustav teorija fokusira na tri teme, koje su međusobno povezane u cijelom njegovu radu: 1. *Teorija sustava kao društvena teorija* (Systems theory as societal theory), 2. *Komunikacija teorija* (Communication theory) i 3. *Evolucija teorija*)

[12] Ewald Rametsteiner, Roland Oberwimmer i Ingwald Gschwandtl; Forest Communicators Network (FCN), UN-FAO/ECE, Europeans and Wood – What Do Europeans Think About Wood and its Uses?, 2003.

Bonferoni *post hoc test*.[13] The collected data were analyzed and presented in tabular and graphical display and numerically. Certain variables were measured using Five-point Likert scale, with some claims of certain variables ranges from 1 to 5 were listed, where the number 1 meant 'I do not agree' or 'I strongly disagree' and 5 meant 'I completely (fully) agree' or 'it is very important'; the respondents defined the degree of satisfaction or importance they assign to these statements. Furthermore, certain measurements were defined in the way that the specific statements were defined in the form of yes / no questions. Some questions were taken from similar studies, but were adapted to the problematics and aims of this study. Data from the questionnaires were entered into a Microsoft Excel spreadsheet (database), in the first part for the records, and in the second part the database was used to store all the answers of all respondents, accompanied by coded survey variables. The research method among end users was quality research conducted by telephone interviews. The study included 517 subjects (marked N) aged 15 to 60 years. The first group consisted of subjects aged 15 to 35, who have bought or have participated in the purchase of at least one of the eight pieces of furniture, while the participants in the second group were those aged 36 to 55. The sample was representative of the population of Croatia with regard to the county, age and gender. The testing was conducted on Croatian territory.

4. RESULTS AND DISCUSSION

The study included 517 people from 15 to 60 years of age. The sample was stratified by county, gender and age groups and the structure of the sample according to the variables gender, age, education, region and the average monthly household income. Most of the respondents (89%) agree that the Croatian wood industry should not be let to foreigners. More than half of the respondents agree with the fact that the wood industry is significant and promising sector in Croatia and that it can help Croatia in the current crisis and recession.

Respondents evaluated four construction materials - wood, concrete, PVC and particle boards, with respect to 13 different characteristics and were supposed to determine to which material are best suited for. Wood was estimated as the material to which all studied characteristics are found most appropriate. Wood is largely perceived as a natural and comfortable material, environmentally friendly, warm, traditional, and with good appearance. However, wood is also rated as old-fashioned material in the largest number of responses. Concrete is a material that is largely perceived as safe, reliable and timeless, and PVC was perceived as fashionable material, the material in the trend (Fig. 1).

The perception of these four materials among the youngest respondents is the most diverse concerning the average of the population. Namely, there is a greater proportion of those who perceive concrete as safe material, important for the future, timeless, warm and long-lasting. They perceive wood as a reliable and timeless material in the smallest amount, and largely perceive PVC as a modern material. At group discussions the most common association of subjects related to WOOD were warmth, durability, natural materials; PVC - window, door; PARTICLEBOARD- cheap, furniture, sawdust; LAMINATE FLOORING- cheap, easy setup, quickly gets dirty, difficult to maintain; PARQUET - quality, heat, high price.

In addition to evaluating those materials according to the different features they were evaluated with respect to the material characteristics. The highest proportion of respondents perceived wood as a renewable material, with good thermal conductivity, durable, and as a material that requires a short construction period. More than 80% of respondents perceive concrete as a fire resistant material, while the PVC in the minds of the respondents is mainly connected to water resistance and ease of maintenance. Particleboard is seen as the most convenient material (Fig. 2).

[13] Elektronic Statistics Texbook, Tulsa, OK: StatSoft. http//www.statsoft.com/texbook/

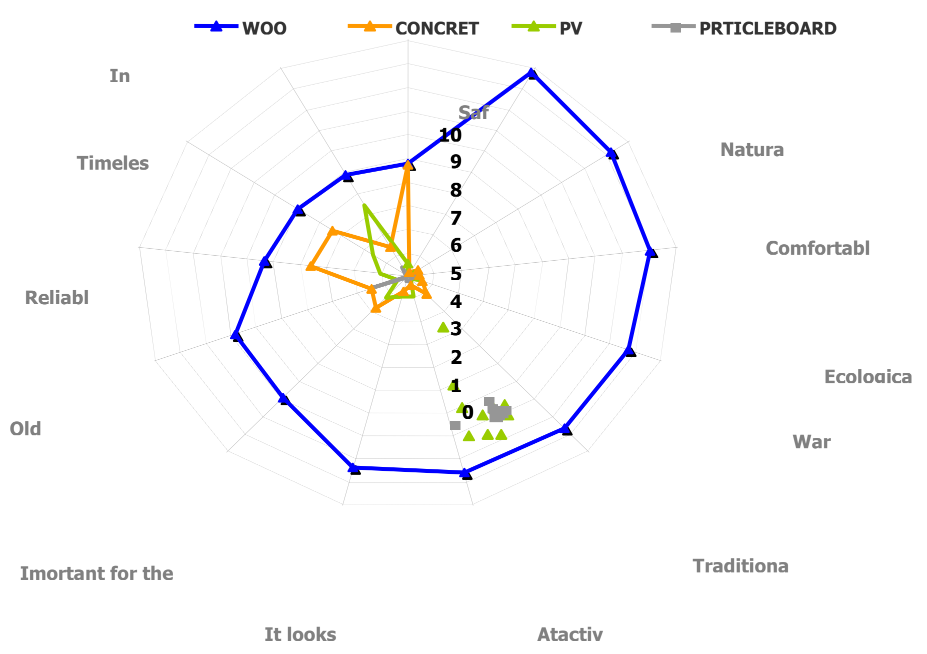

Figure 1. The standpoint of respondents on the use of different materials for the construction and furnishing

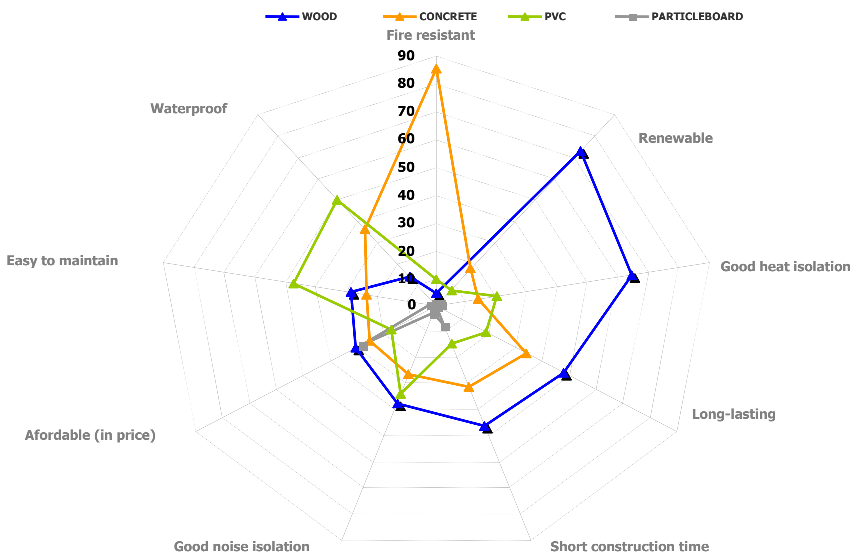

Figure 2. The standpoint of respondents according to the materijal characteristics

In a situation where the prices of all materials are equal, most respondents prefer wood as a material for all six tested furniture or interior parts. Wood is the preferred material for tables, wardrobes and doors. Apart from wooden wardrobes, 17% of Croatian respondents love particleboard wardrobes, while 16% preferred the PVC doors. 80% of respondents prefer wooden kitchens, while 23% of them love the kitchen made of particleboards. ¾ of the respondents love wood floors, and about 1/3 would choose laminate flooring. The smallest proportion of respondents prefers wooden windows (despite the preference of wood in other pieces of furniture), while 46% prefer PVC windows (Fig. 3).

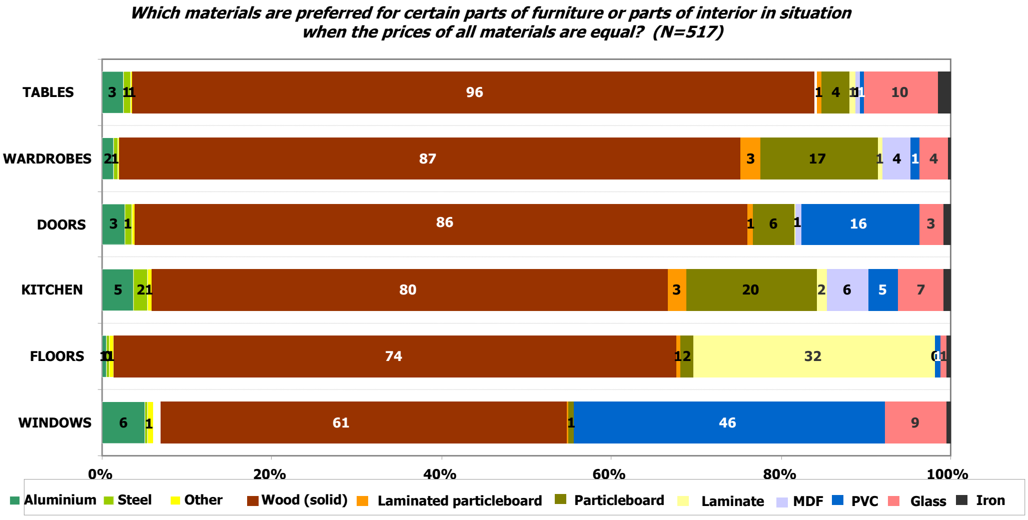

Figure 3. Standpoint of respondents on the choice of materials in a situation where the prices of all materials are equal

The respondents evaluated Croatian wood furniture and wood products by the degree of their agreement with the statements provided. Within five offered statements, more than 70% of respondents agreed that the Croatian wood furniture has quality, and 60% that Croatian wood furniture and wood products have good design. More than 40% of respondents consider the Croatian wood furniture accessible, while 27% have the opposite opinion. 40% of them think that the Croatian wood furniture is competitive in the export market, while 29% of respondents do not share that opinion. Respondents have separated opinion on the prices of Croatian wood furniture. Namely, 29% of respondents agree with the statement that the Croatian wood furniture has a good price, 31% disagree with this and 35% are undecided (Fig. 4).

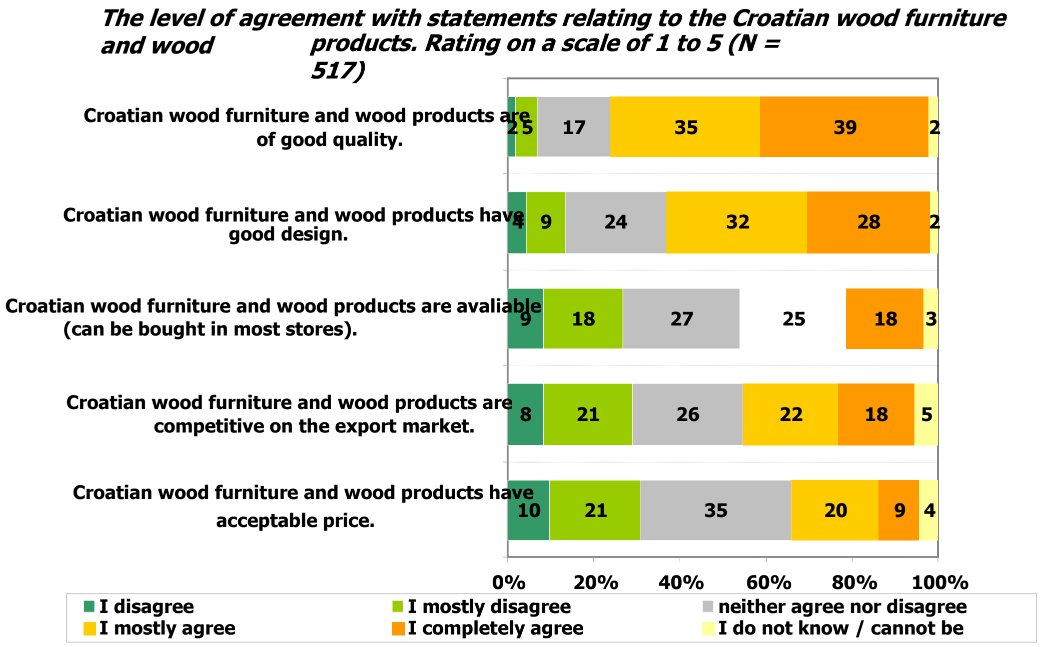

Figure 4. The agreement with statements relating the Croatian wood furniture and wood products

Subjects were asked to choose between the dwelling houses built of wood and those built of brick / concrete, provided that their prices are equal. Slightly more than half of respondents (56%) would rather choose a house of brick / concrete, and 40% of a house made of wood. 4% was undecided. More often than the average of population a house of brick / concrete chose people from Dalmatia (70%) and those from Slavonia (63%), while the house of wood cgose people from Lika, Kordun and Bania (60%). Similarly, the house of brick / concrete is more attractive to younger people (78%), and the house of wood is more attractive to elderly (53%).

Most of the younger respondents in groups, wooden house associated with a holiday home, cottage or something romantic. Brick / concrete house is safer and requires less additional work. Wooden house is less resistant to the winds ("the wind can blow it away like tornado in the United States"), isolation of wooden house does not provide trust, and the problem is that the wooden houses are adequate only in certain environments, like Podravina, Gorski Kotar and Zagorje, and are not adequate in Dalmatia and Istria. For 1/3 of the respondents (30.3%), health is the main reason why they chose the houses of wood for living. Besides being healthier, the wooden house is warmer, more natural, and it is more modern, more beautiful. These are the most common reasons for choosing wooden dwelling houses. In addition, respondents who choose the house of wood find that it has better isolation, better quality and more environmentally friendly (Fig. 5.).

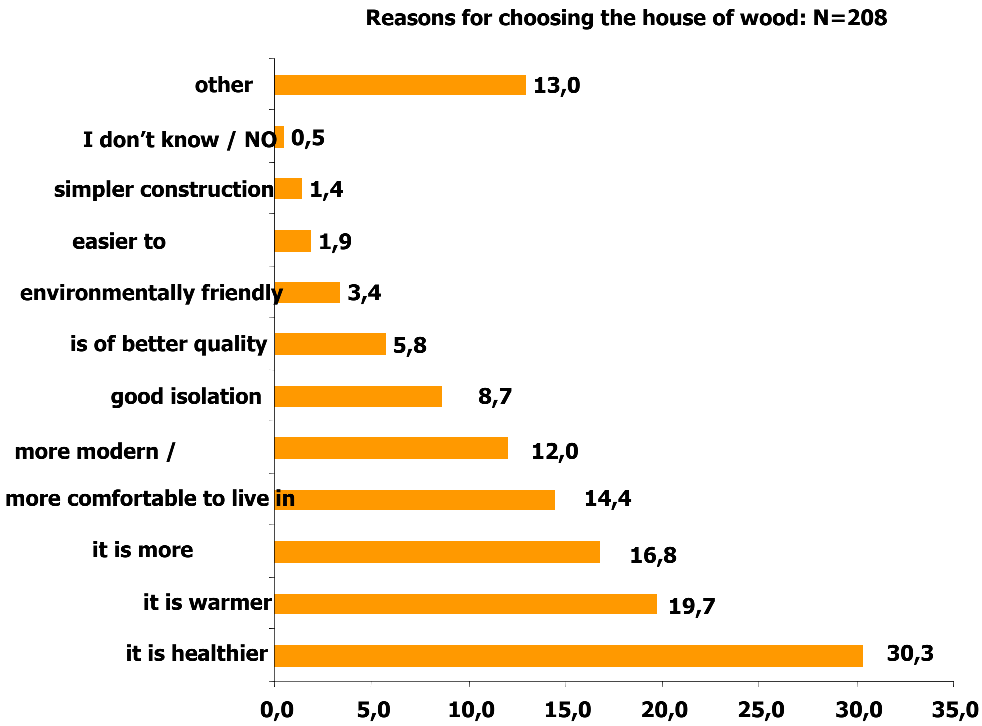

Figure 5. Reasons for choosing the wooden house

5. CONCLUSION

Based on the data obtained in this research, which are processed in this paper, the following can be concluded:

- ✓ Wood is percieved as a natural and renewable material, comfortable, environmentally friendly, warm, traditional, and acceptable, with good appearance, good thermal conductivity, and as durable material that requires short construction period. The most important criterion in the selection of wood is the quality. Domestic floorings are better than foreign and domestic manufacturers are selected for the origin of the product, quality, flexibility and proximity.

- ✓ Wood is preferred as a material for the construction of tables, wardrobes, doors, kitchen, floors and windows, and durability is the most important when purchasing these products. For house building wood is preferred due to the health, warmth, naturalness, comfort, environmental components, resistance to earthquakes and better isolation.
- ✓ Information on products respondents gather by visiting shops and comparing products and prices, but awareness of wood as a material in construction is low. Citizens of Croatia have a wrong perception of the share of export of wood raw material, and are of the opinion that education on forests and wood should be implemented in the youngest child's age. Certificates indicating the origin of the product are important, but the examiners do not recognise them, and they do not differ the manufacturers from sale point. The flaw of our manufacturers is poor design and lack of professionalism, and foreign manufacturers are chosen for good design, reasonable price and the lack of local products.
- ✓ The wood industry should not be left to the foreigners, and the opening of the furniture shopping center with exclusively Croatian products is a welcome idea.

REFERENCES

1. Bečić, E. i Dabić, M. (2008): Analiza ulaganja poslovnog sektora Republike Hrvatske u istraživanje i razvoj. *Revija za sociologiju*, 39 (1-2):69-84.
2. CEI-Bois: Memorandum of the Woodworking Industries to the European Institutions, Brussels, November 2004
3. CEI-Bois, Vision (2030): A technology platform initiative by the european forest-based sector *innovative and sustainable use of forest resource*
www.forestplatform.org/easydata/.../ftp/.../FTP_Vision_Document_2030.pdf
4. Jan, D. i dr. (2005): Razvoj novih proizvoda u funkciji izvoza drvnog sektora – brand drvnog sektora. Operativni plan, Sveučilište u Zagrebu, Šumarski fakultet, Zagreb.
5. European Commission Commission of the European Communities, european governance a white paper, COM(2001) 428, http://ec.europa.eu/governance/white_paper/en.pdf (20. svibnja 2010).
6. European Commission (2006): Innovation in the National strategic Reference Frameworks.http://www.google.hr/#hl=hr&biw=1280&bih=830&q=European+Commission%2C+2006%2C+Innovation+in+the+National+strategic+Reference+Frameworks&aq=f&aqi=&aql=&oq=&gs_rfai=&fp=a8f62731b87ed6bc (13. listopada 2009).
7. Forestry Strategy', COM (2005) 84 final, Brussels, March 2005 Euroconstruct, 2005 *(http://www.euroconstruct.org)*
8. FSC (2009) FSC reflected in scientific and professional literature – Literature study on the outcomes and impact of FSC certification. FSC Policy Series No. 2009 – P001, editors Karmann, M. i A. Smith, FSC International Center.
9. Porter, E. Michael (2009): Konkurentska prednost, Masmedia, Zagreb (2):49-71

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OUTSOURCING OF MARKETING SERVICE IN ORGANIZATIONS PRODUCING WOOD PRODUCTS

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ABSTRACT

The traditional goal of outsourcing was the cost reduction. Nowadays outsourcing allows organizations to concentrate their financial and management resources on activities connected with value production. We can say outsourcing is no longer an operational issue only. It is becoming an important part of key-decision making of the top management. The organizations producing wood products, mainly those smaller ones, usually do not have sufficient capacities to provide a complex portfolio of marketing service. However, to resist the competitive forces, the main reasons of small organizations producing wood products which result in omitting some marketing activities and benefits and risks of such decisions for the whole organization.
Key words: Outsourcing, marketing service, wood products, small organizations

1.INTRODUCTION

Reduction of costs was the traditional goal of outsourcing. Nowadays outsourcing allows organizations active in wood processing industry to concentrate their financial and management resources on activities connected with value production, i.e. focus on the core of their activities. Outsourcing is no longer an operational issue only. It is becoming an issue of the top management. If we imagine that without marketing and proper product advertisement the companies are no longer able to succeed in wood processing industry, it is necessary for them to start dealing very intensively with the question if it is or it is not effective for them to outsource some marketing services. Thus the main aim of our paper is to provide basic information that should be taken into consideration when making decisions. As the range of products in wood processing industry is varied, we have narrowed the scope of our interest to the furniture industry. The reason for doing so is open European space where only the best can dominate. Nowadays it is the Polish and Italian producers who are the biggest competition for our producers. The Scandinavian company IKEA has also a very stabile position. The portfolio of marketing communication tools used in this environment can vary in structure and importance. It is due to criteria such as the size of furniture producing company, the specificity of the products offered or financial budgets invested into marketing communication. In the research, which we carried out in the past, we found out that small businesses mostly do not create reserve funds that would cover the costs for intensive and strategically oriented marketing communication. Some activities are done rather intuitively or the traditional forms of communication are used. However, they necessarily do not have to correspond with the new trends in communication. The reason for that is generally the lack of knowledge or absence of an expert who would be able to monitor and provide all the activities in the whole range. Thus, there is a lack of capacities, both material and financial ones. The biggest deficiency might be e.g. competent marketing worker who would be able to manage all activities to good purpose. Here is the space for outsourcing of some marketing activities. It can be partial or complex. Before we start dealing with outsourcing in marketing services in companies producing wood products, in our case it is furniture, it is interesting to have a closer look at the history of outsourcing, basic criteria in the decision-making process about outsourcing and its (dis)advantages for a company.

2.HISTORY OF OUTSOURCING AND BASIC CRITERIA OF DECISION-MAKING PROCESS ABOUT ITS USE

Outsourcing, similarly to other marketing tools, has its historical development. Without being complex, we could divide the whole development into three basic phases:

- During the 50´s of the last centuries big businesses set aside mainly offices such as security and security services, printing, logistics, etc. and the "make or buy" decisions were transferred to service businesses.
- At the beginning of the 80´s the businesses set aside not only the offices but mainly whole processes. The reason for that was the growing pressure on cost reduction due to growing competition, new technological, information and communication techniques as well as faster reaction time.
- The third phase has started in the 90´s of the last century. It was marked mainly by focus on the core of activity, growing combination of strategic and cost considerations as well as an offer of professional performances and technological possibilities. Nowadays the outsourced services focus on highly specialized activities and these are provided by professionals in particular area.

Outsourcing of business and marketing activities has become a tool allowing the management to focus on more effective competencies and key areas in entrepreneurship. Practice shows examples where various forms of outsourcing lead to reduction and costs savings up to 20 – 50 %, to higher flexibility and growth of market share and competitiveness.

Basic criteria of decision-making process about outsourcing:

Decision, which activities to set aside from our processes is not easy. It has some disadvantages, which will be described later. If we want to make our decision which activities to outsource more effective, we have to follow the sequence of steps:

Step 1 – Exact specification of activities creating the core of company´s activity and setting aside activities which do not belong to the core and can be externalized.

Step 2 – Level of productivity (comparison of lower and higher productivity of business segments with the service of suppliers, possibly hidden costs).

What are the main reasons to remove business processes in organizations focused on production of wood furniture?

- Pressure to reduce costs
- Insufficient performance quality
- Business size
- Strategic management
- Providing own capacities
- Shift of risk upon the service provider
- Gaining access to top professionals in particular area
- Better flexibility
- Stronger focus on service
- Elimination of power relations and establishing partner relations with outsourcing consumers
- Transformation of fixed expenses into variable

Before the top management approves crucial decision whether it will or will not outsource marketing services, it should summarize all benefits and risks of such a decision.

3.BENEFITS AND RISKS OF OUTSOURCING IN BUSINESSES PRODUCING WOOD PRODUCTS – FURNITURE INDUSTRY

Benefits of outsourcing:

a) Reduction of costs for externalized activity
b) Efficiency improvement of the externalized activity
c) Focus on strategic activities of a business
d) Management improvement and restructuring of externalized activity

Risks of outsourcing:

Business loses control over sources, activities and employees, risks relate to:

- Insufficient performance
- Dependence on provider
- Loss of experience and competencies
- Social risk
- Dependence on partner – difficult change of partner
- Qualitative risks
- Motivational problems with service provider
- More difficult control
- Outflow of competencies and know-how

Classification of outsourcing by:

- Features of external holders of functions
- Features of outsourced functions
- Goals and partners
- Number of external holders – single, multi outsourcing
- Placement of holders of functions
- Access to outsourcing

In the introductory part of our paper we state that outsourcing is part of strategic management and thus should be included in basic strategic documents such as marketing strategy of a business producing wood products. Strategic analysis of functional areas is then integral. It consists of following steps:

- Defining functional areas to be outsourced
- Defining the boundary "business – provider" and provider´s requirements
- Selection of provider
- Transformation of requirements
- Management of the relationship

To be able to provide all activities we require from the external partner, we have to contract these relationships. With outsourcing we can rely upon three basic types of contracts:

- Classical – standard, simple and short-term contracts – outsourcing relates to less important activities
- Neo-classical – complex and long-term – outsourcing relates to important strategic tasks
- Relation-related – less formal and complex – their main objective is to define goals and relations between a provider and outsourcing consumer – often called a partnership

In bibliographical sources we can find also other terms. They either condition the term of outsourcing or the other way round. Among these terms are: ***insourcing or re-insourcing.*** It is an opposite process to outsourcing– inclusion, or take-over of a business function which once belonged to the activities of a business.

Term BPO – Business process outsourcing:

- Applied in big multi-national businesses

- Removal of support processes for business and marketing and their purchase from an external service provider
- Applied mostly in countries where labour is cost effective and where there is a sufficient amount of qualified workers
- It is a product of international globalization and development of information and communication technology

Term BTO – Business transformation outsourcing:

- It is a programme aiming to change the operational mode of a company, uses outsourcing for fast, sustainable and radical changes in business performance
- Advantage is in reduction of time when accessing a market, more innovations by using the access to world sources and the use of experience and branch knowledge to improve the competitive advantage and better risk management.

4.CONCLUSION

To sum up, current trend shows that majority of businesses in Slovakia producing wood products outsource marketing activities. The reason for that is the effort to achieve the highest efficiency and professional provision possible. The study based on the sample of 20 small businesses producing wood furniture helped us to profile following examples of outsourced services and activities in the area of marketing communication:

- Provision of marketing audits
- Organization and provision of trainings and consultations for marketing workers
- Organization of conferences to exchange experience in the area of marketing communication strategies
- Organization of events for business partners
- Provision of direct marketing services
- Design and administration (including updating) of a business web page
- Provision of complex advertisement services
- Development of marketing communication plan for a set period of time

REFERENCES

1. Nováková, R.: Prednášky z predmetu Marketingové komunikačné stratégie II.
2. Halaj, D.: Prehľad marketingových nástrojov podporujúcich využitie dreva ako obnoviteľného zdroja energie. In: Lesnícky časopis – Forestry Journal, 2011, 57 (1), p. 65-71. ISSN 0323-1046.
3. Ovsenák, V.: Marketing communication and its place in quality management system. In: MMK 2014: mezinárodní Masarykova konference pro doktorandy a mladé vědecké pracovníky : sborník příspěvků z mezinárodní vědecké conference. Hradec Králové : Magnanimitas, 2014. ISBN 978-80-87952-07-8, s. 690-695.
4. Oblak, L., JOŠT, M: Methodology for studying the ecological quality of furniture. In: Drvna industrija, 2011, 62 (3), p. 171-176. ISSN: 0012-6772.

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USE OF ELECTRONIC AND PRINT MEDIA FOR THE PURPOSE OF PROMOTING FURNITURE AND WOOD PRODUCTS IN CERTAIN SEE COUNTRIES

Slavica Petrović, Denis Jelačić, Leon Oblak

ABSTRACT

The paper presents research results of the scope of promoting furniture and wood products in print and electronic media. Beside the market in Serbia, the research included the markets in Slovenia and Croatia as well, which enabled the conducting of comparative analysis of the obtained results for promoting these products in the three stated countries. Research results showed that, although production of furniture and wood products is an important branch of industry in all analyzed countries, media space given to these products is significantly lower than the space given to certain other product categories.
Key words: furniture, wood products, promotion, electronic media, print media

1. INTRODUCTION

Analysis of the use of electronic and print media for the purpose of promoting furniture and wood products was conducted for the market in Serbia, Croatia and Slovenia. During the selection of countries, attention was paid to the similarities existing among them in terms of economic characteristics, as well as attitudes, requirements and behavior of consumers on the market. For furniture and wood products, as well as for other product types, promotion in the media is of extreme importance because as *Stanton, Etzel and Walker* say, the most useful product or brand will fail if nobody knows that they exist. Also, the function of the promotion is to present the product characteristics, to maintain the popularity of the existing products, to inform where they can be bought, to persuade the consumers to use another – more expensive product instead of the existing one as well as to increase the consumers' loyalty (Evans, J. R., Berman, B., 1997).

2. MATERIAL AND METHODS

Analysis of the use of electronic and print media for the purpose of promoting furniture and wood products was conducted based on the data provided by renowned marketing agencies AGB Nielsen and IPSOS which operate in Serbia, Croatia and Slovenia. Use of electronic media for the purpose of promoting the stated products is analyzed based on insertations, the insertation being the number of broadcastings of a particular advert on TV stations. During the period 2006-2011, 19 national TV channels were monitored in Serbia, while in the period 2012-2014 this number increased to 32.[14] In Croatia, the data on insertations were obtained by monitoring six national TV channels and 5 in Slovenia.

Use of print media for the purpose of promoting furniture and wood products was analyzed based on the amount of financial resources invested for this purpose.

[14]Data refer to the territory of Serbia without Kosovo.

The research, the results of which are presented in the paper, was conducted for the period 2006-2014, which is a sufficiently long period for observing the most significant changes which occurred in the research field.

For the needs of the research, the results of which are presented in the paper, certain general scientific methods are used such as the method of comparative analysis, methods of generalization, induction and deduction. Comparative analysis was used for comparing adequate phenomena researched in the countries which are analyzed in the paper. Methods of generalization, induction and deduction were used for drawing certain conclusions about the current situation in the field of furniture and wood products promotion in electronic and print media in the analyzed countries.

3. RESEARCH RESULTS AND DISCUSSION

Compared to Slovenia and Croatia, Serbia had the biggest total number of insertations on TV in the period 2006-2014. In the analyzed period, the number of insertations on TV in Serbia increased by 412%, i.e. from 606,482 in 2006 to 3,104,969 in 2014. In the same period, this figure increased by 206.7% in Croatia, from 242,843 which was the amount in 2006 to 744,934 in 2014 and in Slovenia it increased by 76.3%, i.e. from 369,338 in 2006 to 651,068 in 2014 (graph 1).
In addition to the biggest number of insertations, the biggest number of viewers of these was also registered in Serbia (Total Individual Universe) which reached 6,855,048 in the period 2012-2014, while in Croatia this figure was 4,145,543 in the same period and in Slovenia 1,953,203.

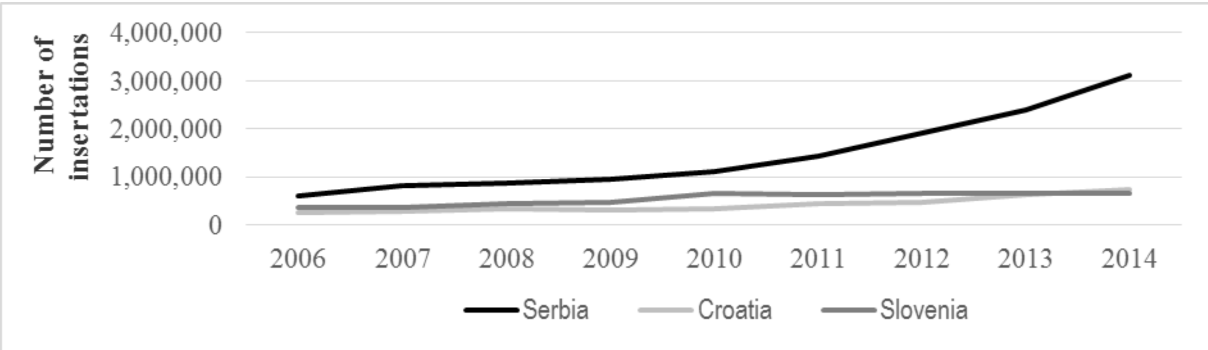


Figure 1. Total number of TV insertations in Serbia, Croatia and Slovenia in the period 2006-2014 (Source: AGB Nielsen Serbia, Croatia, Slovenia, 2015)

Categories of products and services promoted most on TV stations in Serbia, Croatia and Slovenia are quite similar. In the period 2006-2011, the following was promoted most in Serbia: food and non-alcoholic drinks, hobby and free time, cosmetics and telecommunications; in Croatia the following was promoted: personal hygiene products, food, communications and telecommunications and household cleaning products; and in Slovenia: mobile telecommunications, wholesale and retail shops, cars and laundry detergents (Jelačić, D., et all, 2012).

In the period 2012-2014, food and non-alcoholic drinks remained most promoted product category in Serbia followed by cosmetics, telecommunications and wholesale shops. In the same period, in the other two countries, the ranking of the most promoted products changed, namely food, wholesale shops, personal hygiene products, communications and telecommunications were promoted most in Croatia while in Slovenia wholesale shops, mobile telecommunications, cars and pharmaceuticals were most promoted.

Analysis of the share of insertations for equipping residential and office space (in Croatia and Slovenia the name of this category is furniture, home appliances and equipment) in the total annual number of insertations on TV stations shows that in the period 2006-2011 this share was the biggest in Serbia, followed by Croatia and Slovenia. However, in the period 2012-2014, significant changes occurred since Slovenia had the biggest share, while Croatia remained on the second position and Serbia dropped to be the third (graph 2). In general, during the period 2006-2014, the share of insertations for equipping residential and office space in the total annual number of insertations on TV stations dropped only in Serbia from 1.59% to 0.35%, while in the same period in Croatia it increased from 0.57% to 0.93% and in Slovenia it increased from 0.43% to 1.49%.

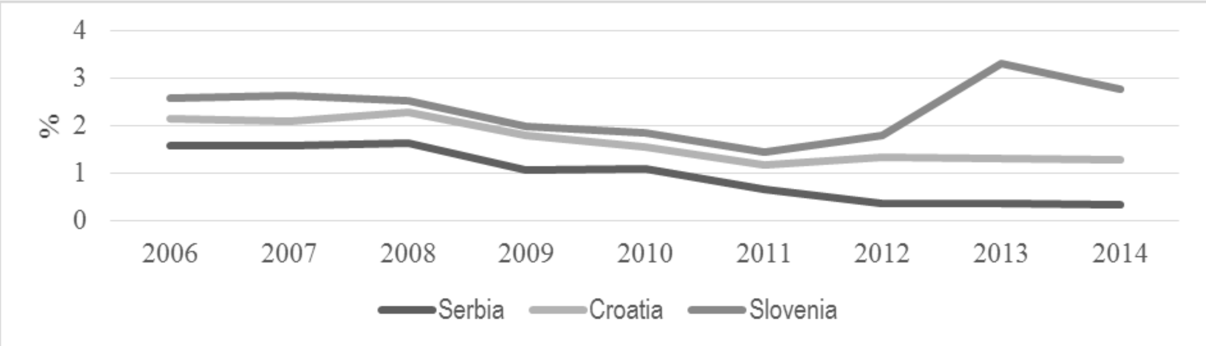


Figure 2: Share of insertations for equipping residential and office space in the total annual number of insertations on TV stations in Serbia, Slovenia and Croatia in the period 2006-2014 (Source: AGB Nielsen Serbia, Croatia, Slovenia, 2015)

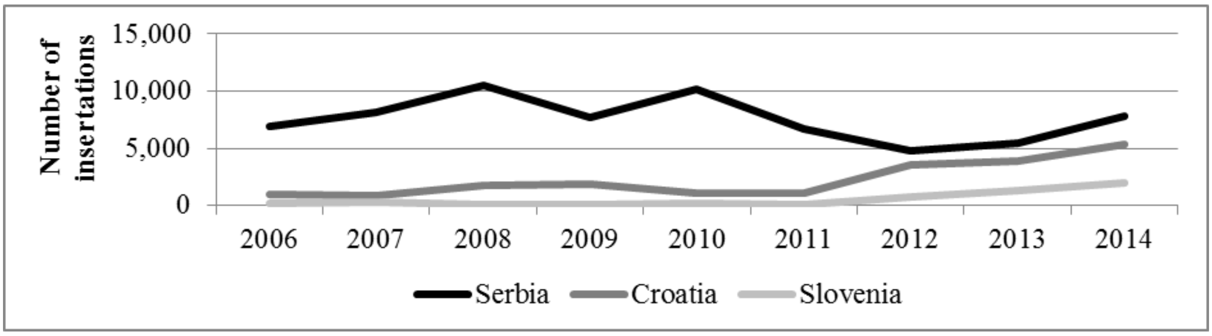
However, although the share of insertations for equipping residential and office space in the annual number of insertations on TV stations in Serbia reduced during the analyzed period, the number of insertations for this category increased in the period 2006-2014. With the unstable trend, namely, it increased and dropped alternatingly, the number of insertations for equipping residential and office space on TV stations in Serbia in the period 2006-2014 increased by 65.6% to amount 16,588 in 2014. Unlike Serbia, in Croatia in the same period the number of insertations of this category on TV stations increased 5 times to amount 6,903 in 2014 and in Slovenia it increased 6.1 times to 9,722 in 2014.

In all three analyzed countries, furniture has the highest share in the total number of insertations for equipping residential and office space.[15] Results of the analysis for the period 2006-2014 show that in the stated period the number of insertations for furniture in Croatia increased 5.7 times to 5,299, in Slovenia 8.7 times to 1,933, while Serbia had the lowest increase of 11.7% and in 2014 this figure reached the level of 7,774. Results of the analysis of the share of insertations only for furniture in the total annual number of insertations on TV stations in Serbia show that it reduced from 1.15% in 2006 to 0.25% in 2014. Opposite to the situation in Serbia, in Croatia this share increased from 0.38% in 2006 to 0.71% in 2014 and in the same period in Slovenia it increased from 0.06% to 0.3%.

During the period 2006-2014, compared to the other two analyzed countries, Serbia had the lowest total investments for promoting products and services in the print media, namely in this period they dropped by 22.5% to 49.3 million EUR in 2014 (graph 4). In the same period, Croatia had the biggest total investments for the promotion of all categories of products and services in the print media, although they were also reduced by 8.3% to 164.7 million EUR in 2014. Unlike the situation in Serbia

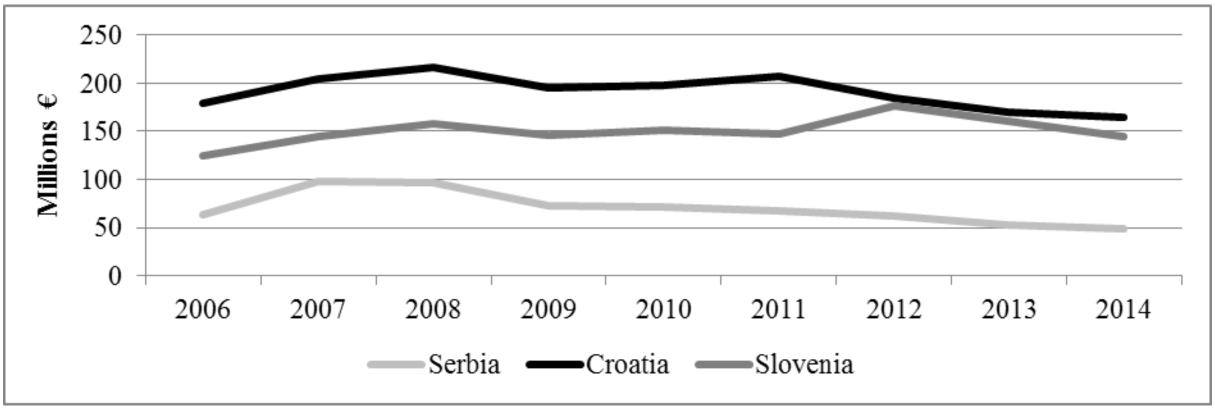
[15] The category of equipping residential and office space in Serbia includes: 1. home furniture and furniture stores, 2. office furniture, 3. furniture and bathroom equipment, 4. other furniture and home equipment, 5. carpets, flooring, curtains and other textile accessories, 6. lighting, 7. additional kitchen equipment, 8. air conditions and 9. heating. In Croatia, the category of furniture, home appliances and equipment includes: 1. furniture, 2. carpets, flooring, soft furnishing, 3. bedding, towels, blankets, linen, 4. baths, washbasins, showers, toilets, 5. household decorative accessories, 6. kitchen utensils, 7. household non - electrical tools, 8. tents, sunshades, 9. barbecues, fireplaces, ovens, 10. lighting. In Slovenia, the category of furniture, home appliances and equipment includes: 1. furniture, 2. furniture showrooms, 3. flooring and 4. office equipment.

and Croatia, in the same period Slovenia increased total investments for the promotion in print media by 16.5% to 145.1 million EUR in 2014.



Graph 3: Number of furniture insertations on TV stations in Serbia, Croatia and Slovenia in the period 2006-2014 (Source: AGB Nielsen Serbia, Croatia, Slovenia, 2015)

Results of the comparative analysis of investments in print media for promotional purposes for the three analyzed countries in 2014 show that total investments in Serbia were 3.3 times lower than in Croatia and 2.9 times lower than in Slovenia.



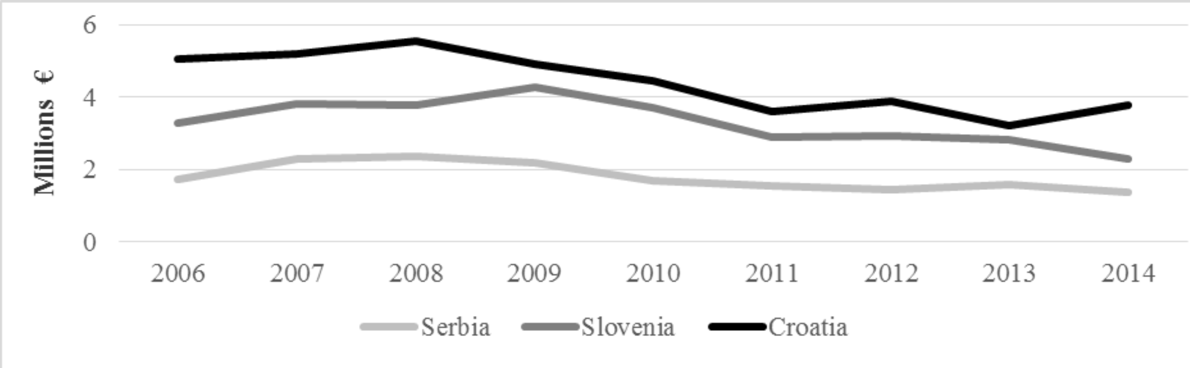
Graph 4: Total investments for the promotion of all categories of products and services in print media in Serbia, Croatia and Slovenia in the period 2006-2014
(Source: IPSOS Serbia, Croatia, Slovenia, 2015)

In Serbia in the period 2006-2012, the biggest funds for the promotion in print media were invested for promoting banks and banking services, other services, cars, media and mobile communications and the sequence of the stated categories changed every year. In Croatia in the same period, magazines and newspapers, trade centers and markets, financial institutions, cars and telecommunications were promoted most and insurance, finance, mobile telecommunications, trade centers and markets and cars were promoted most in Slovenia (Jelačić, D., et all, 2012).

During the period 2012-2014, the biggest changes in categories and sequence of their promotion in the print media occurred in Serbia. The biggest funds for the promotion in print media in the stated period were invested for mobile packages, televisions, supermarkets and food shops, other food supplements and cars. In the same period in Croatia, there was a change only on the third place because electronic media replaced financial institutions, while in Slovenia insurance remained on the first position, followed by electronic media, events, shops and pharmaceuticals.

Results of the comparative analysis of the invested funds in the promotion of furniture, furniture showrooms and wood products in the print media for the period 2006-2014 show that Serbia had the lowest investments of 16.3 million EUR, while in Slovenia they were 29.8 million EUR and the biggest amount was in Croatia of 39.7 million EUR. Generally, in the period 2006-2014, all three countries

reduced the funds for promoting furniture, furniture showrooms and wood products in the print media, namely Serbia reduced them by 20.2% to 1.4 million EUR in 2014, Croatia reduced by 25.6% to 3.8 million EUR and Slovenia reduced by 29.9% to 2.3 million EUR (graph 5).
In Serbia in 2014, the share of funds invested in the promotion of furniture, furniture showrooms and wood products in the total funds invested in the promotion in print media was 2.8%, while in Slovenia this share was slightly lower 2.6% and it was the lowest in Croatia 1.4%.



Graph 5: Investments in print media for the promotion of furniture, furniture showrooms and wood products in Serbia, Croatia and Slovenia in the period 2006-2014
(Source: IPSOS Serbia, Slovenia, Croatia, 2015)

In all three analyzed countries, in the category furniture and wood products, the biggest funds for the promotion in print media are invested for home furniture and furniture showrooms. In 2014 in Serbia, funds invested in the promotion of this category represented 96.1% of the total invested funds for the promotion of furniture and wood products, in Slovenia this percentage was 87.3% and in Croatia it was 78.7%.[16] Apart from home furniture, office furniture and joinery are also promoted in print media in Serbia, wood processing, garden furniture and wood products are also promoted in Slovenia and joinery, wood products and office furniture are also promoted in Croatia.

4. CONCLUSION

Although wood industry is an extremely important branch of industry in Serbia, Croatia and Slovenia, furniture and wood products occupy only a small segment in the media space, both in electronic and print media in these countries. The fact that in 2014 the share of insertations for furniture in the total number of insertations on TV stations was 0.25% in Serbia, 0.3% in Slovenia and 0.71% in Croatia goes in favor of the above stated. Nevertheless, although the shares were quite small, results of the analysis of the number of insertations for furniture in the period 2006-2014 show that this number increased from 6,956 to 7,774 in Serbia, from 936 to 5,299 in Croatia and from 223 to 1933 in Slovenia.

The period of 2006-2014 was also characterized by the reduction of financial resources invested in the promotion of furniture and wood products in the print media. Results of the comparative analysis showed that in this period Serbia had the lowest investments in this purpose of only 16.3 million EUR, while they amounted to 29.8 million EUR in Slovenia and 39.7 million EUR in Croatia. However, during the analyzed period, all the countries reduced financial resources for the promotion of furniture and wood products in print media as follows: Serbia by 20.2%, Croatia by 25.6% and Slovenia by 29.9%.

[16] Monitoring system conducted for the promotion of furniture and wood products in print media in Serbia, Croatia and Slovenia is such that wood furniture is not differentiated from furniture made of other materials.

Difficult economic situation which struck Serbia, Croatia and Slovenia during the previous years has largely reflected on the purchasing power of the population and their interest in furniture and wood products. Under the conditions of daily concerns about bare survival it is quite understandable why food, drinks and shops of these products are most frequent in the promotion in electronic and print media.

REFERENCES

1. AGB Nielsen 2015, REPORT ON THE TV PROMOTION FOR THE PERIOD 2006-2014. Belgrade.
2. AGB Nielsen 2015, REPORT ON THE TV PROMOTION FOR THE PERIOD 2006-2014. Zagreb.
3. AGB Nielsen 2015, REPORT ON THE TV PROMOTION FOR THE PERIOD 2006-2014. Ljubljana.
4. Evans, J. R., Berman, B. (1997): MARKETING, International-seventh edition, Prentice Hall International, United States of America
5. IPSOS 2015, REPORT ON THE PRINTED MEDIA PROMOTION FOR THE PERIOD 2006-2014. Belgrade.
6. IPSOS 2015, REPORT ON THE PRINTED MEDIA PROMOTION FOR THE PERIOD 2006-2014. Zagreb.
7. IPSOS 2015, REPORT ON THE PRINTED MEDIA PROMOTION FOR THE PERIOD 2006-2014. Ljubljana.
8. Jelačić, D., Oblak, L., Petrović, S., Moro, M., Pirc Barčić, A., Ćočić, V., Meloska, Ž. (2012): WOOD SECTOR MEDIA PROMOTION IN SOME SOUTH-EAST EUROPEAN COUNTRIES, Drvna industrija, Vol. 63, No 3.
9. Stanton, W. J., Etzel, M. J., Walker, B. J. (1994): FUNDAMENTALS OF MARKETING, Tenth Edition, McGraw-Hill Inc., United States of America

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ANALYSIS OF LABOUR PRODUCTIVITY IN WOOD PROCESSING AND FURNITURE INDUSTRY

Andrea Sujová, Petra Hlaváčková

ABSTRACT

Performance of enterprises, sectors and economies depends on effectiveness of production factors utilization. Labour is one of the main production factors which can significantly affect the performance growth of the enterprise or industry. The aim of the paper is to present indicators designed to measure the labour productivity at the sector level and assess the labour productivity in the wood processing and furniture industry of the Czech Republic, Slovakia and Austria for a period of ten years. On the basis of an analysis of available scientific literature, a system of indicators measuring labour productivity at the sector level was set up. Input data for the analysis was obtained from databases of Statistics Offices with annual data on selected economic indicators in wood processing industry for a period of years 2002 - 2011. Data was used in calculation of individual indicators.

Key words: labour productivity, sectorial indicators, wood processing industry, furniture industry

1. INTRODUCTION

The WPI is an important part of developing economies, new prospective direction based on biotechnology. Production of wood-based products in conditions of European countries has, in regard to sufficient supply of input wood material, long tradition and as one of the options for obtaining renewable resources it is closely connected with many sectors of the national economy. The interest of the European Union is to build economy based on renewable natural resources, resulting in the need to pay increased attention to the development and support of the WPI.

Effectiveness of using production factors is marked by term productivity. High productivity of production factors lowers costs and enables price decreasing, production volume, sales and profit increase. Productivity of one production input is called a partial productivity.

Productivity is commonly defined as a ratio of a volume measure of output to a measure of input use. Among other productivity measures such as multi-factor productivity or capital productivity, labour productivity is particularly important in the economic and statistical analysis of a country. Labour productivity is a revealing indicator of several economic indicators as it offers a dynamic measure of economic growth, competitiveness, and living standards within an economy. (OECD, 2001)

Labour productivity ia a relationship between production and factors of production. Although the ratio used to calculate labour productivity provides a measure of the efficiency with which inputs are used in an economy to produce goods and services, it can be measured in various ways.

The aim of this paper is to evaluate the effectiveness of using labour via indicators of labour productivity in wood processing industry of Slovakia and the Czech Republic.

2. MATERIAL AND METHODS

Required material for obtaining relevant outputs we obtained from a secondary research, on the basis of an analysis of available scientific literature dealing with issue of evaluating effectiveness of investments and on the basis of processing statistical data of the wood processing industry. Input data for our analysis we obtained from database of Statistics Office of Slovakia and the Czech Republic with annual data on selected economic indicators for a period of years 2002 - 2011.

Analysis of scientific knowledge was found out that evaluation of inputs´ effectiveness can be performed by a wide scale of indicators which are different at a micro a macro level.

The OECD Statistics Directorate (STD) publishes series on labour productivity for all OECD member countries. The two principal databases that provide such series are the OECD Productivity Database, first published in March 2003, and the OECD System of Unit Labour Cost and Related Indicators, first published in March 2007. Labour productivity is equal to the ratio between a volume measure of output and a measure of input use. Labour input is measured either by the total number of hours worked of all persons employed or total employment (head count). On the macroeconomic level the volume measure of output is measured either by gross domestic product (GDP) or gross value added (GVA). There is also a preference for value added as taxes are excluded. (Freeman, 2008)

According to Synek (2011), a labour productivity is measured through ratio of added value or production value or production volume or revenues and number of employees.

In the microeconomic theory the labour productivity is defined as an average product of labour which is interpreted as a number of products produced by one employee. Another indicator is a marginal labour productivity that means number of products produced by next or the last employee. (Šálka et al., 2009)

Based on scientific literature study a system of indicators for labour productivity at the sector level was set up. Indicators of labour productivity are as follows:

- Labour productivity (LP) has a several modifications and presents a share of revenues (R), production (Q) and profit (P) to one employee of the sector:
-

$$\mathrm{LP_R} = \frac{\text{revenues}}{\text{number of employees}}\ (€) \tag{1}$$

$$\mathrm{LP_Q} = \frac{\text{production value}}{\text{number of employees}}\ (€) \tag{2}$$

$$\mathrm{LP_P} = \frac{\text{profit}}{\text{number of employees}}\ (€) \tag{3}$$

- Labour productivity rate (LPR) expresses number of employees for one monetary unit of revenues or production:

$$\mathrm{LPR_R} = \frac{\text{number of employees}}{\text{trevenues}}\ (\text{persons}) \tag{4}$$

$$\mathrm{LPR_Q} = \frac{\text{number of employees}}{\text{production}}\ (\text{persons}) \tag{5}$$

- Marginal labour productivity (MLP) expresses accession of financial values of the industry (revenues, production, profit, added value) by increase of employment in the industry in one employee:

$$\mathrm{MLP} = \frac{\Delta\ \text{economic indicator}}{\Delta\ \text{number of employees}}\ (€) \tag{6}$$

For indicators MLP applies:

- if MLP > 0 then rise of employees induces an increase of economic indicator,
- if MLP < 0 then rise of employees induces a decrease of economic indicator.

Calculation of individual indicators for measuring the labour productivity was applied in the wood processing industry (WPI) and its individual sections in selected, abovementioned countries. A characteristic feature of the WPI is processing of raw wood and wood products production at various stage of finalisation. WPI within the classification of business activities of the EU (NACE) consists of following sections: NACE 16, NACE 17 and NACE 31.

For appropriate calculation of indicators values we created application in MS Excel and we analysed labour productivity in WPI and its individual sections from several views:

- trend line analysis of indicators in the period of years 2002 - 2011 in selected countries;
- comparative analysis: based on calculation of average a median values of indicators the achieved labour productivity in Slovakia and the Czech Republic was compared.

3. RESULTS AND DISCUSSION

Achieved values of indicators measuring labour productivity in wood processing industry (WPI) of Slovakia and the Czech Republic are shown in Table 1.

Table 1. Indicators of labour productivity of WPI in a period of years 2003 – 2012 in thousand euro

Indicator	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Slovakia										
employees	32396	31307	29994	31655	31064	32394	28069	23925	22387	22491
LP_R	71,5	82,5	89,4	89,9	97,3	101,7	102,2	92,4	95,8	113,2
LP_Q	78,1	83,5	84,9	91,5	96,9	100,9	85,1	96,0	100,0	109,6
LP_P	2,2	1,5	1,9	2,8	4,8	4,3	4,8	0,7	4,7	2,2
LP_{VA}	15,4	15,5	16,5	17,8	19,7	18,9	19,6	20,9	24,1	24,2
LPR_R (prs)	13,98	12,12	11,18	11,12	10,28	9,84	9,79	10,82	10,43	8,84
LPR_Q (prs)	14,74	12,81	11,97	11,77	10,93	10,32	9,91	11,75	10,42	10,00
LPR_{VA}(prs)	64,90	64,56	60,55	56,16	50,79	52,92	51,07	47,96	41,56	41,24
MLP_R		-0,24	-0,08	0,10	-0,30	0,20	0,10	0,16	0,04	0,85
MLP_Q		-0,23	-0,05	0,11	-0,26	0,22	0,07	0,19	0,07	0,96
MLP_{VA}		0,00	0,00	0,02	0,01	0,00	-0,03	0,00	0,00	0,00
MLP_P		0,02	-0,01	0,02	-0,10	-0,01	0,00	0,03	-0,06	-0,55
The Czech Republic										
employees	97020	94732	93603	92998	95519	95870	92278	82246	77065	74433
LP_R	86,9	88,8	106,4	68,3	73,4	82,8	78,7	79,1	92,4	96,2
LP_Q	50,7	51,4	58,8	64,2	70,1	80,0	79,8	78,9	90,7	93,9
LP_P	3,3	4,3	6,0	3,9	4,5	5,7	4,1	3,6	4,5	4,4
LP_{VA}	14,0	14,5	17,4	17,0	18,9	21,0	19,7	20,2	22,9	22,5
LPR_R (prs)	11,51	11,27	9,40	14,63	13,62	12,08	12,71	12,64	10,83	10,39
LPR_Q (prs)	19,71	19,44	17,00	15,57	14,27	12,51	12,54	12,67	11,03	10,65
LPR_{VA}(prs)	71,56	68,90	57,33	58,90	52,93	47,54	50,70	49,42	43,59	44,40
MLP_R		-0,01	-1,37	5,95	0,26	2,62	0,19	0,07	-0,12	0,02
MLP_Q		-0,02	-0,56	0,77	0,29	2,76	0,08	0,09	-0,10	0,00
MLP_{VA}		-0,01	-0,23	0,09	0,09	0,60	0,05	0,02	-0,02	0,03
MLP_P		-0,04	-0,14	0,33	0,03	0,33	0,05	0,01	-0,01	0,01

Results of labour productivity of WPI in Slovakia show increasing trend when labour productivity of revenues increased gradually from 71, 5 thousand euro per employee in 2002 to 113, 2 in 2011, labour productivity of production increased from 78, 1 thousand euro per employee to 109, 6 in 2011 and labour productivity of value added raised from 15, 4 thousand euro per employee in 2002 to 24, 2 in 2011. Fall of labour productivity was noticed in 2009. Labour productivity has raised in 30 thousand euro per employee during ten years. Rate of labour productivity in relation to revenues and production showed positive decreasing trend during period 2002 – 2008 due to reduction of number of employees in the WPI except year 2009. Rate of labour productivity to value added has a decreasing trend over all analysed years. As for indicators of marginal labour productivity the change of employees' number caused a slight increase in revenues and production with decreasing trend till 2007. From 2009 by a decrease of employees also revenues and production have fallen. The change of employees didn´t have meaningful influence on value added.

Looking at the results of WPI in the Czech Republic can be seen the same positive, rising trend of labour productivity as in Slovakia. However, its level is much lower in relation to production as in Slovakia. Labour productivity of revenues was in 2002 higher than in Slovakia, at the level of 86, 9 thousand euro per employee and it raised only in 10 thousand euro to amount 96, 2 in 2011. The highest increase is noticed by labour productivity of production which increased from 50, 7 thousand euro per employee in 2002 to 93, 9 in 2011, what is in 43 thousand euro. Labour productivity of value added reached the highest value 22, 9 thousand euro per employee. Rate of labour productivity in relation to revenues had a negative rising trend from 2002 to 2008 despite decreasing number of employees. Decreasing trend was noticed by labour productivity rate by production and value added. As for marginal labour productivity the decrease of number of employees in 2003, 2004 and 2011 and its increase in 2006 and 2007 caused a rise of economic indicators. In 2005, 2008 and 2009 lower number of employees caused a slight fall of economic indicators.

The interesting results are noticed in year 2006 and 2007 when in both countries the labour productivity increased by increase of number of employees.

Comparative analysis is used to compare the results of the labour productivity in wood processing industry analysed in both countries: Slovakia and the Czech Republic. Basis for this analysis, mean (average) and median values of indicators representing labour productivity were. Median value presents the value in the middle of a set of calculated values of indicators for the 10-year period. The obtained results of the analysis are shown in Table 2. Comparison of the results of selected indicators is showed in Figure 1.

Table 2. Average and median values of indicators in WPI

indicator (*in tsd. €*)	**Slovakia**		**Czech Republic**	
	mean	***median***	***mean***	***median***
LP_R	95,6	95,8	85,3	84,8
LP_Q	90,4	91,5	71,9	74,5
LP_{VA}	18,8	18,9	18,8	19,3
LPR_R (prs)	10,6	10,4	11,9	11,8
LPR_Q (prs)	11,3	10,9	14,5	13,5
LPR_{VA}(prs)	54,6	52,9	54,5	51,8
MLP_R	0,4	0,1	0,8	0,1
MLP_Q	0,1	0,0	0,2	0,0
MLP_{VA}	0,0	0,0	0,1	0,0

The results of the comparative analysis show that, according to the mean values, the labour productivity in relation to revenues and production value is much higher in Slovakia. Labour productivity rate is higher in the Czech Republic. The change of employment in the industry has only a little influence on change of economic indicators in the same way, but higher influence is in the Czech Republic. From the comparison can be concluded, that worse results are achieved in the Czech Republic.

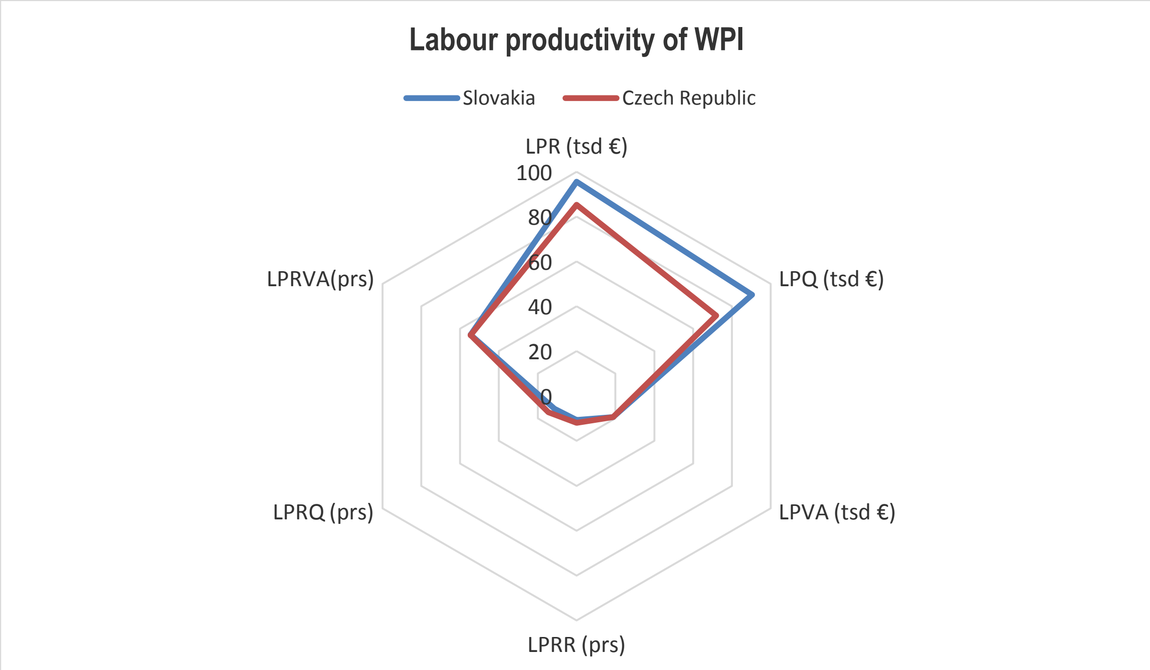

Figure 1. Labour productivity of WPI

4. CONCLUSION

Labour productivity measures the output per worker in a period of time. Labour productivity is an important factor in determining the productive potential of the economy. Countries with strong labour productivity growth tend to benefit from high rates of growth, strong export demand and low inflation. Increased labour productivity can enable a higher long run trend rate of growth.

Achieved results of labour productivity in wood processing industry showed better results in Slovakia than in the Czech Republic. Labour productivity in WPI of Slovakia reached the level 100 thousand euro of revenues and production value per worker, whereas in the Czech Republic it is 96 thousand euro. The results showed that labour productivity has increased also by the rise of employment. The positive decreasing trend is by indicators of labour productivity rate which is connected with lowering number of employees in the industry. Marginal labour productivity showed only little influence of change in employment in WPI on economic indicators.

We can conclude that a rise of labour productivity in wood processing industry in Slovakia and the Czech Republic is due to decreasing number of employees. However there exist other factors affecting labour productivity: skills and qualifications of workers, morale of workers, technological progress, substitution of capital to labour, capacity utilization, labour rules and regulations (Pettinger, 2014). In the aim to achieve higher productivity, the factors affecting it should be analysed.

REFERENCES

1. Jelačić, D., Moro, M., Drábek, J., Sujová, A. (2012): MOTIVATION FACTORS IN WOOD PROCESSING PLANTS. Wood Research, No. 2, 317 – 330.
2. Merková, M., Drábek, J., Jelačić, D. (2012): DETERMINANTS OF EFFECTS OF FOREIGN DIRECT INVESTMENT IN TERMS OF SLOVAK REPUBLIC AND WOOD-PROCESSING INDUSTRY OF SLOVAKIA. Drvna Industrija, No. 2, 129–142.
3. OECD Publications (2001): MEASURING PRODUCTIVITY, OECD Manuel: measurement of aggregate and industry-level productivity growth, chapter 2.

4. Freeman, R. (2008): LABOUR PRODUCTIVITY INDICATORS, OECD Statistics Directorate.
5. Pettinger, T. (2014): UK LABOUR PRODUCTIVITY. [online]. Available at: http://www.economicshelp.org/blog/5887/economics/uk-labour-productivity/
6. Sujová, A. (2013): BUSINESS PROCESS PERFORMANCE MANAGEMENT - A MODERN APPROACH TO CORPORATE BUSINESS MANAGEMENT. Liberec Economic Forum 2013: proceedings of scientific papers. TU in Liberec, pp. 542-550.
7. Synek, M. et al. (2011): MANAŽERSKÁ EKONOMIKA, 5th Ed. Grada Publishing, Praha
8. Šálka, J. et al. (2009): MIKROEKONÓMIA. TU in Zvolen, Zvolen.
9. Czech Statistical Office. © 2015. [online]. Available at: <http://www.czso.cz>. [Accessed: 2015, May, 14].
10. Statistical Office of the Slovak Republic. © 2015. [online]. Available at: <http:// slovak.statistics.sk> [Accessed: 2015, May, 20].

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MOTIVATION OF EMPLOYEES IN WOOD PROCESSING COMPANY BEFORE AND AFTER RESTRUCTURING

Josip Faletar, Marko Previšić, Denis Jelačić, Ante Dučić, Marek Drimal

ABSTRACT

This article analyses motivation factors in wood processing company. Research was conducted before company restructuring, in year 2010 when economic downturn was in its peak, and after company restructuring, in year 2014 when company started to improve its business results. Research method was questionnaire survey. About 180 employees were surveyed. The aim was to establish the level of motivation among employees in the company and the main differences between results of the same survey conducted before and after company restructuring. Significant difference was established and the change in the way of thinking was established. It was established that different motivating factors motivate or de-motivate emoployees in different economic environment.

Key words: motivation factors, company restructuring, employees, motivation, de-motivation

1. INTRODUCTION

Economic recession has strongly influenced the operation of companies We can notice its influence in all business fields, also in motivation of the employees. A lot of de-motivational factors occurred, and the ones that already existed became even stronger. The employees are experiencing insecurity and some other additional fears (i.e. fear of losing a job, fear of lower wages etc.). In order for the companies to avoid all of the stated and other problems, they need to focus on seeking opportunities for sales increase and cost reduction on one hand, and on the other hand they need to establish conditions for more efficient work. The latter is strongly connected with the way the employees are motivated. It is a fact that the motivational strategies that worked in the past are not so efficient in current difficult economic conditions. If the managers continue to treat the employees in the same way, their already low motivation for work will decrease even more. The management of the companies can count on satisfactory working results and satisfied workers mostly if they insert motivational factors into the working environment. We can say that practically all motivators are in the hands of the management.

According to economic situation of crisis companies started to search for solution of the problem of achieving better results. Different were the ways of trying to achieve more efficient work environment in different companies. This particular company, where this research was conducted, considered economic down-turn to be the best time to make major changes and they decided to change the economic and business environment by restructuring the company. To do so, company managers decided to change the number and organization of their profit centers, changed the price-calculation system, changed the work evaluation system from the scratch, changed the promotion and awarding system for each and every employee in the company with full transparent system of evaluation.

The main goal of the research was to study the situation of motivating the employees of this particular Croatian wood processing company in the conditions of economic recession in its full, in the year 2010, and after the company restructuring and at the end of economic crisis, in the year 2014 . We wanted to find out, to which factors of motivation the managers pay the most attention, and if the existing ways of motivation enable efficient satisfaction of the employees' needs. We also tried to establish the differences in the types of motivation within company in a times of a different economic behavior, i.e. in the time of economic crisis and in the time of normal economic environment.

2. RESEARCH METHOD

The information needed for the research was collected with the method of direct opinion poll method with questionnaires. With the questionnaire the condition of key presumptions of different motivational theories were checked. Questions were of closed type and respondents were using Likert four-level scale of importance for each statement.

The pool was conducted during the year 2010, in the peak of economic crisis and before the restructuring, and the same survey was made in the year 2014, at the end of economic crisis and after the company restructuring was made. The questionnaire was filled out by 180 employees within the company, in all profit centers. To compare the results the means of individual factors were calculated.

To compare the results between the research conducted in years 2010 and 2014 we used the statistical χ^2-test for establishing the significant differences between given statistical data from both years.

3. RESEARCH RESULTS

In the first question of the survey we wanted to establish what is the level of satisfying employees' needs in the company. Among the 10 given answers, employees graded them very differently in the year 2010 and in the year 2014, which was confirmed by χ^2-test. That test showed that there is a statistically significant difference between all answers given in those 2 observed years.

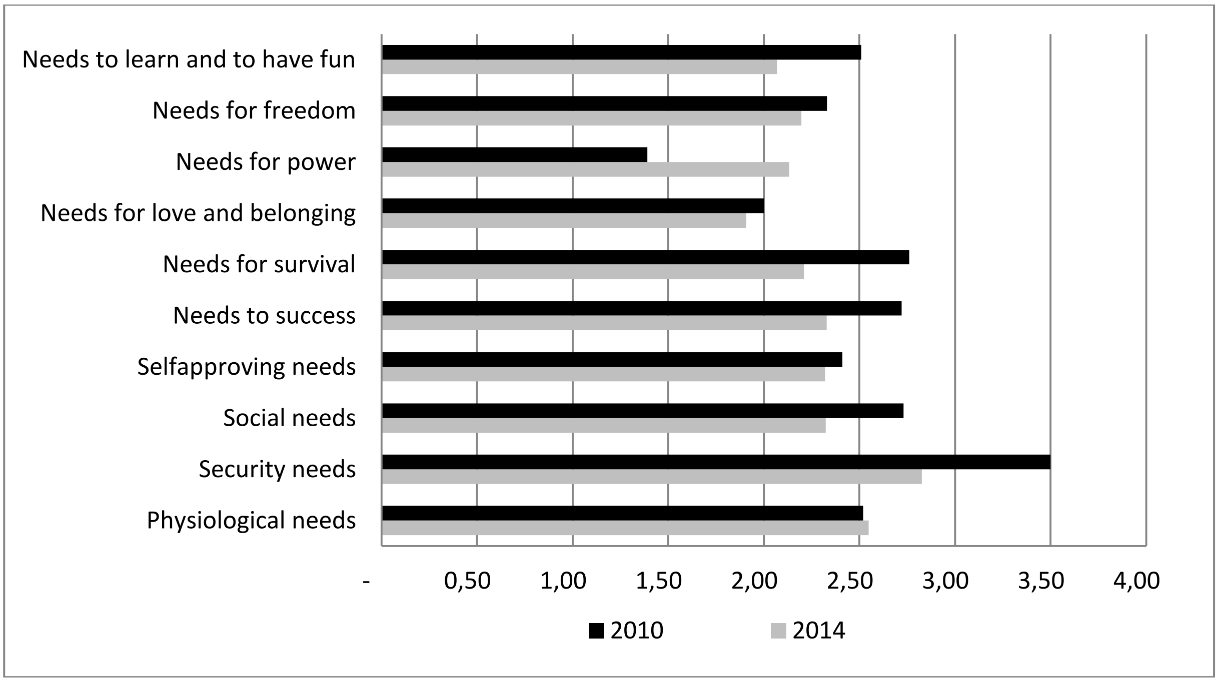

Figure 1. Grades to different empoloyees' needs

Second question was about the motivating factors which employees charish the most, i.e. which motivating factor would employees give the highest grade regarding its importance to them. Among 21 given possibilities according to χ^2-test again between grades given in the year 2010 and grades given in the year 2014 statistically significant difference was established in each answer.

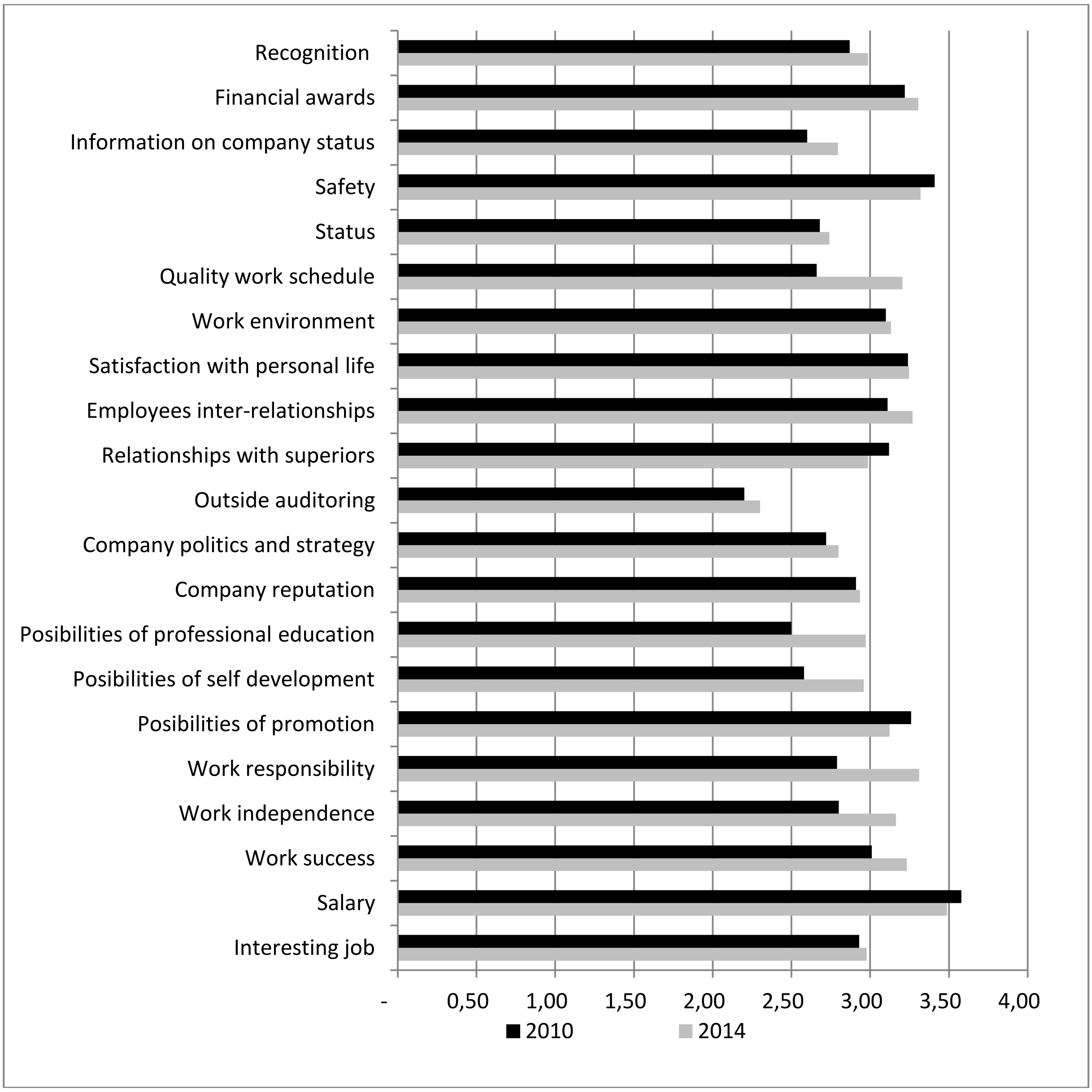

Figure 2. Grades for different motivation factors

The third question was trying to establish the way of thinking among employees regarding problem as motivator. Two answers were given (un-motivated worker does not see the problem, and problem is additional motive for the worker), and statistically significant difference between both answers in years 2010 and 2014 was established. Average grades for answer to first question were 2,5 for year 2014 and 3 for year 2010, and awerage grades for answers to second question were 2,1 for year 2010 and 2,4 for year 2014.

Grades for answer *People work to have something* were higher than grades for answer *People work to be someone* were higher in 2014 than in 2010 for both answers, but the difference between average grade in 2010 and those in 2014 for each answer were statistically significant.

We were trying to establish which of 3 key psychological conditions of work is the most important to employees. In the year 2010 the most important key psychological condition by far was sence of responsibility, with average grade of 2,9. In the year 2014 all 3 conditions (sence of responsibility, sence of importnace of work and awareness of a final work result) are very similarilly graded - all average grades were between 3,2 and 3,25.

De-motivating factors are always present, and the idea is to find out which of them makes employees worry the most. Grades to 9 answers given with that question were very different in years 2010 and 2014, which is understandable, since 2010 was the year of full crisis and uncertainity, and 2014 was the year of beginning of recovery after the restructuring.

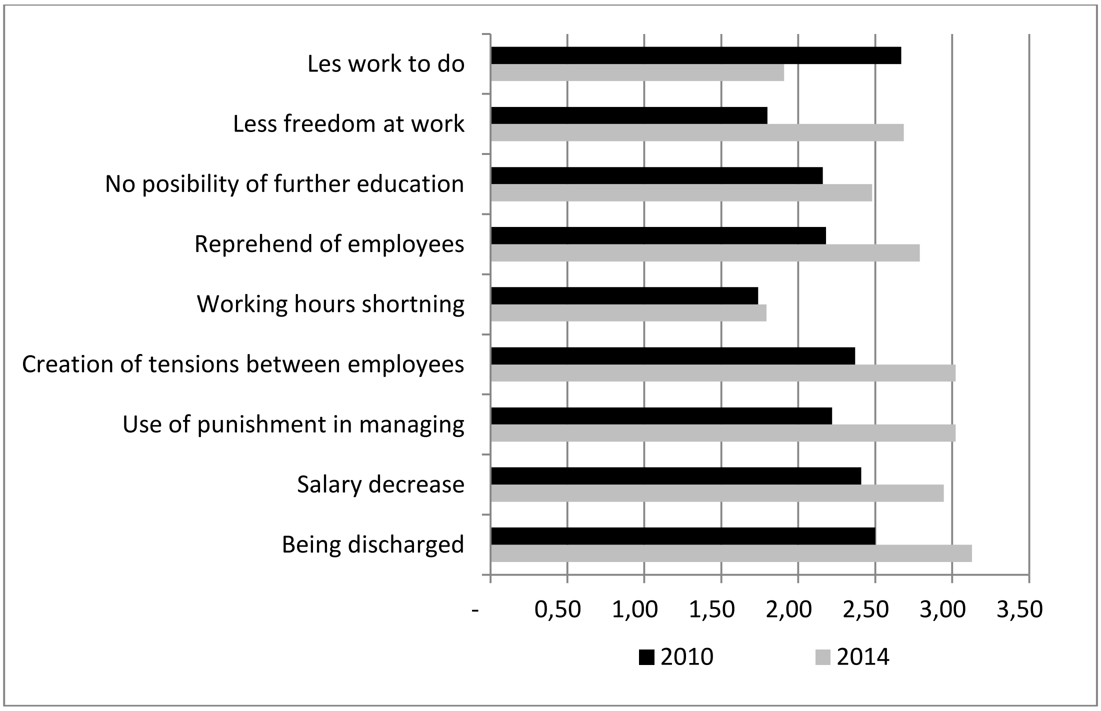

Figure 3. De-motivating factors

4. CONCLUSION

In this research we had the intention to observe the differences between particular motivation factors and the way of thinking of employees regarding work environment in the wood processing company during the economic crisis and at the end of crisis, before the restructuring and after it. Most of the results were expected, but some of them could be a bit puzzling if one does not have the full picture. During the economic crisis most of the employees were afraid for the security of their jobs. Crisis was long and very deep, level of production was significantly decreased and there was no need for so many workers to do the necessary work. So, security of having a job as motivation factor was evaluated with the highest grades. Restructuring itself brought many changes, not just for company, but for each employee as well, so the grade for security of having a job is still the highest because of the experience that each employee had during the observed period.

But, other motivation factors, such as quality scheduled work time, work responsibility, posibilities to get additionally educated and posibility for personal development are motivating factors that achieved significantly higher grades in 2014 than in 2010, meaning that employees apreciated restructuring as something positive that was done, especially in the field of work evaluation and different model for work evaluation, motivation and stimulation.

As well as motivating factors, de-motivating factors' grades are consequences from a long period of crisis and restructuring. But, there are changes that can be observed which point to the change in the way of thinking of employees. While decreasing of the production level and lay-off were de-motivating factors employees considered as those to be affraid of the most in year 2010, in year 2014 production level decreasing grade is much lower, but grades for tentions between employess and using punishment in managing reached much higher grades, which very clearly indicates that employees think of their work results and success much more than they think of crisis and loosing their jobs because of it.

According to the results of this research it can be stated that changes in management, changes in the organization structure positively influenced on the way of thinking and on the behaviour of the employees within the wood processing company.

REFERENCES

1. Bryan L., Farrell D., 2008. LEADING THROUGH UNCERTAINTY. McKinsey & Company http://www.vedzen.com/Mackenzie.pdf
2. Charan R. 2008. LEADERSHIP IN THE ERA OF ECONOMIC UNCERTAINTY: MANAGING IN A DOWNTURN (1st edition). McGraw-Hill. 160 p.
3. Daft L. R., Marcic D., 2000. UNDERSTANDING MANAGEMENT. London, Thgompson Learning, 666 p.
4. Fromm E. 1996. TO HAVE OR TO BE? Continuum International Publishing Group, 242 p.
5. George, J.M., Jones G.R., 1999. ORGANIZATIONAL BEHAVIOUR. Second edition. Addison-Wesley Publishing Company, Reading, 724 p.
6. Glasser W. 1994. THE CONTROL THEORY MANAGER. New York, HarperBusiness. 123 p.
7. Glasser W. 1999. CHOICE THEORY : A NEW PSYCHOLOGY OF PERSONAL FREEDOM. New York, HarperPerennial. 352 p.
8. Herzberg F., Mausner B. Bloch Snyderman, B. 1993. THE MOTIVATION TO WORK. Transaction Publishers, 180 p.
9. Herzberg F. 2008. ONE MORE TIME: HOW DO YOU MOTIVATE EMPLOYEES? Harvard Business Press. 80 p.
10. Jelačić D., Galajdova, V., Sujova, A. 2007. EMPLOYEES SATISFACTION IN WOOD PROCESSING PLANTS IN SLOVAKIA AND CROATIA. Human resource management & Ergonomics (HRM&E), vol. 1, No. 3/2007, pp. 15-23.
11. Jelačić D., Grladinović, T., Sujova, A., Galajdova, V. 2008. MOTIVIRAJUĆI ČIMBENICI U PRERADI DRVA I PROIZVODNJI NAMJEŠTAJA. Drvna industrija, vol. 59, No. 1/2008, pp. 11-21.
12. Keenan K., 1996. THE MANAGEMENT GUIDE TO MOTIVATING. Ravette Publishing 62 p.
13. Kropivšek J. 2003. THE IMPACT OF HUMAN RESOURCES MANAGEMENT AND ORGANIZATIONAL CULTURE ON ADAPTABILITY OF SLOVENIAN WOOD-INDUSTRY FIRMS. *Zb. gozd. lesar.*, No. 70, pp. 5-29.
14. Kropivšek J. 2007. VODENJE Z UPORABO TEORIJE POTREB. Lesarski utrip, 13. pp. 42 – 43
15. Lipičnik B., Možina S. 1993. PSIHOLOGIJA V PODJETJIH. Ljubljana, DZS. 166 p.
16. Možina S. 1998. ZADOVOLJSTVO ZAPOSLENIH IN MOTIVACIJA ZA POSLOVNO ODLIČNOST. Industrijska demokracija. pp 5 – 8

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INDUSTRIAL SYMBIOSIS AND GREEN BUSINESS PARKS IN THE WOOD-BASED SECTOR IN POLAND

Jan Chudobiecki, Leszek Wanat

ABSTRACT

An eco-industrial park (EIP) should be something more than just a part of an industrialised area. The dynamic development of industrial parks and special economic zones in Poland is considered to be the initial step to the establishment of eco-industrial parks. EIP's should not be limited to having only passive qualities (area, infrastructure, real estate, etc.). They must possess an identity and be active, like other typical creative economic structures. There is a tendency in Poland to create economic societies of pro-ecological targeting, the so-called "green business parks" or "green entrepreneurship parks". Industrial symbiosis is an opportunity for the development of small and medium-sized enterprises in forestry and wood-based sector in Poland. This article is devoted to scientific research into the development and competitiveness of industrial symbiosis actors in the Polish wood industry.
Key words: eco-industrial park, green business park, industrial symbiosis, wood-based sector.

1. INTRODUCTION

The forest- and wood-based industry belongs to special sectors of the economy. Problems of the economic, environmental and industrial nature coexist within its boundaries. It may seem obvious, because the concept of "sustainable development" comes directly from forestry. The author of this concept – Hans Carl von Carlowitz – defined as such the concept of forest economy which consists in obtaining only the amount of industrial wood that can be recreated based on natural renewal. The idea by von Carlowitz was propagated in 19th-century Europe as Sustained Yield Forestry, while the term "sustainable" became the key word in the theory of sustainable development, thus creating a new chapter in economic sciences [Mantel 1973]. Additionally, the traditional model of the economy is questioned increasingly more often. A need has been identified to seek new paths of economic growth based on the concept of the so-called green road to development. Questions begin to appear about the social responsibility of our generation for making use of the resources of the green economy on credit. Actually, nobody has released us from the responsibility for the condition of the resources and the quality of life of future generations [Francis 2015].

The concept of ecological industrial parks (also referred to as eco-industrial parks or eco-parks) has become part of the research perspective formulated in this way. This idea is rooted in partner cooperation of entities, acting on a separated and strictly defined area (functional area). It combines experience of companies, self-governments and citizens in the process of implementing the "green economy" initiative. The purpose of these actions is to obtain measurable economic benefits, among others from common management of resources, energy and waste, with simultaneous reduction of a negative impact of the industry on the natural environment. Mutual interactions and, mainly, cooperation and coopetition between partners are the foundations for the development of eco-parks. As a result of this process, it is possible to create a system, within which the activity of entities will be executed in economic circulation of a closed nature (e.g. production waste can be used once again in a different facility as a substitute for an original raw material) [Kaputa 2013, Wanat, Lis and Chudobiecki 2013].

An eco-industrial park (EIP) should not reflect only passive features (area, real property, infrastructure, etc.), but should be "something more than just a fragment of an industrialised area" [Doniec 2011]. To give eco-parks economic identity, which enables to use the potentials of established

EIP entities, an individually formulated strategy of management as well as an appropriate method and way of action are necessary. So far, it has been difficult to find an example of a perfectly functioning eco-industrial park in Poland. Concurrently dynamic development of traditional industrial parks (IP) may be considered the initial stage of building EIPs. Those parks are characterised by a diverse level of organisation. The changes taking place in this field are confirmed by a tendency towards formation of new industrial communities, in Polish conditions referred to as "green parks of entrepreneurship". The tendency, based on the concept of "eco-industrial symbiosis", seems particularly important for the forest- and wood-based industry and potential changes in the structure of the sector.

The existence of production and processing is conditioned continuously by the flow of raw materials, for which the demand is constantly increasing in a dynamically developing economy. Identification of an industrial chain: raw material – process – product, including the creation of side products in this chain, has become the basis for the formation of symbiotic links between enterprises. It turns out that the use of an "unwanted stream" constitutes an important element of competitive potential. The branch processing chain is supplemented by materials, reused in production circulation, generated as a consequence of using ready-made products (recycling). Considering an analysis of the current state of knowledge the starting point as well as making use of case studies, descriptive analyses, an attempt was made in this paper to evaluate the opportunities and threats of creating and perspectives for the development of eco-industrial parks of the wood-based industry in Poland. At the same time, identification of potential factors which affect the competitiveness of the Polish wood-based industry, being a result of industrial symbiosis processes in the examined branch, was conducted. Having found a gap in the literature on the subject, it seems necessary to conduct a scientific discourse over the possibilities of creating and developing green parks of entrepreneurship in the forest- and wood-based industry. Due to the fact the needs of economic practice dominate over theory in studies of this sector, an attempt was made to supplement the scientific achievements with mesoeconomic aspects.

2. CONDITIONS FOR THE ESTABLISHMENT OF ECO-INDUSTRIAL PARKS (EIP) IN THE WOOD-BASED INDUSTRY

The analysis of conditions for the establishment and functioning of eco-industrial parks in the wood-based industry was based on an original survey study and an analysis of the current legal status. As a result, significant groups of **natural**, **institutional**, **economic** and **social** factors were identified.

One of the consequences of industrial symbiosis in the industry is the formation of permanent structures, which are an institutional reflection of the actual cooperation between enterprises. This process usually begins through mutual exchange of surpluses of materials and energy, and running a common system of organisation and management, which reduces costs. In the theory of industrial ecology, enterprises imitate nature, nothing is waste in this scope and every element is subject to continuous recycling and use. Therefore, actions aimed at using a full stream of materials, i.e. original, semi-finished, of worse quality and, eventually, waste as a production material, are something natural. In a situation where such actions cannot be executed in the course of own production processes, the use of the remaining part of material flow within the scope of partner's structures (technologies) is planned – preferably of another nearby located enterprise. These rules are fully correlated with the assumptions of sustainable forest management. Hence, a natural space for the establishment of eco-industrial parks is created at the meeting point of forestry and the wood-based industry, which comprises both enterprises as well as other partners, who transfer natural models into the anthropogenic world by developing a system of symbiotic links between them (see: Table1).

Although eco-industrial parks have been faced with a series of requirements, they are still very universal and implementing the concept of EIP in the Polish conditions is possible. The conditions required to establish an eco-industrial park include: effectiveness of functioning of business partners creating a specific EIP, rational environmental management by proper spatial management, including protection and care for the existing ecosystems. Implementation of the condition of business effectiveness depends directly on the success of attempts to include own products of EIP partners into the symbiosis-based process. This effectiveness may be achieved both in the economic dimension (reduction of production costs, additional revenues from sales and management of production waste), environmental dimension (reduction of pressure on resources caused by an increase of their use in the production process) and social dimension (potential new jobs, positive influence of the undertaking on the functioning of local communities, improvement of living and working conditions for citizens).

Table 1. Overview of selected indicator groups – comparative summary (OECD proposed)

INDUSTRIAL SYMBIOSIS IN GREEN ECONOMY - SELECTED INDICATOR GROUPS		
I.	The environmental and resource productivity of the economy	* Carbon and energy productivity; * Resource productivity: materials, nutrients, water; * Multi-factor productivity;
II.	The natural asset base	* Renewable stocks: **forest (wood)**, water, fish resources; * Non-renewable stocks: mineral resources; * Biodiversity and ecosystems;
III.	The environmental dimension of quality of life	* Environmental health and risks; * Environmental services and amenities;
IV.	Economic opportunities and policy responses	* Technology and innovation; * Environmental goods and services; * International financial flows; * Prices and transfers; * Skills and training; * Regulations and management approaches;
SOCIO-ECONOMIC CONTEXT		* Economic growth and structure; * Productivity and trade; * Labour markets, education and income; * Socio-demographic patterns.

Source: http://www.oecd.org/greengrowth/greengrowthindicators.htm [accessed: 21.06.2015].

Based on completed research studies, Polish past experiences refer mainly to the broadening of the structure of a traditional industrial park by adding environmental aspects. This process may take place by means of:
- introducing the "eco" added value to an existing industrial park: **brownfield-type park**;
- designing EIP from scratch: **greenfield-type park**.

In both cases, certain dilemmas arise which are associated with the necessity to gather an appropriate group of partners (including in particular production enterprises), whose profile of activities will enable to create symbiotic links.

The most important **environmental conditions** for the establishment of an EIP include the factors identified in the sphere of abiotic matter and the factors in the biosphere. Among the geographical factors, the most commonly mentioned ones include the lie of the land, geological formations, minerals and soils, surface and underground water, and biosphere. Therefore, it is required to include the already existing level of natural environment degradation, as well as a future impact of an EIP on air, water, land and biosphere. The location of a park must not be a source of biosphere degradation. Meanwhile, potential possibilities of using the resources of a biosphere in the production activities of an EIP (e.g. forest areas) constitute a desirable environmental factor [Graczyk 2005].

When designing a **greenfield-type** eco-industrial park, it is important to take into account a wider spectrum of environmental factors. In case of **brownfield-type** parks, an analysis of some of them may be omitted due to the specific location of a park. The most significant geographical conditions are: altitude and lie of the land (transport conditions, localisation difficulties in mountainous regions, threats associated with the presence of depressions and seaside locations), hydrogeological conditions (water table depth, thickness of water-bearing strata, chemical composition of water), quality of soil (protection against degradation, use of soils for planting of trees), geological structure and presence of minerals, relationship of underground and surface waters (a possibility of using geothermal water, water traffic routes, presence of aquatic animals), as well as climatic conditions (strength and direction of winds, sun exposure) and the presence of individual biological resources, including forests and protected areas.

Case: Rantasalmi Eco-industrial Park in Finland is an example of a park based on biosphere conditions. It includes enterprises from the wood-based industry: producers of windows and doors, log houses, as well as a power plant operating on wood dust (generated electricity is used to supply directly the wood enterprises belonging to the EIP). Deforestation was limited, the amount of generated waste and costs of production were reduced. The Park also develops its non-production functions through the use of specific environmental conditions. The EIP's scope of activities includes also: tourism, ecological tourism and education (a legally protected area found on the premises of the Park); hunting and gathering (forests); recreation (scenically and environmentally appealing area), as well as fish processing [Saikku and Lehtonen 2006].

The application of state-of-the-art technologies in the process of industrial symbiosis (BAT) is also beneficial for the environment. Therefore the concept of ***Visione Null*** is promoted, i.e. no pollution, no injuries, no accidents. One of the effects of the EIP's activity may also be land reclamation based on the restoration of lost commercial and environmental attributes [Liwarska-Bizukojć and Bizukojć 2011].

Case: The Ruhr District, where the Internationale Bauausstellung Emscher Park eco-industrial park is located, which comprises green areas, scenically appealing areas and reclaimed commercially active areas [Klipper 1999].

The key factor determining the establishment of eco-industrial parks is identification of legal conditions (in the examined case: Polish law, European Union legislation and local regulations). Presently, there are no separate and detailed provisions of law in Poland that regulate the activity of eco-industrial parks, and the status of EIP is not defined in the legislation in force. The application of the EIP concept under the provisions governing the functioning of special economic zones, industrial parks (traditional – IP) or industrial zones created within municipalities would be a solution to this problem. An important observation is the lack of identified legal barriers for the transformation of industrial parks (IP) into ecological industrial parks (EIP). As long as the very functioning of an ecological industrial park has not been defined in the Polish law [Forest Act 1991], it is possible to find regulations which refer to symbiotic associations between enterprises. However, instead of to facilitate the functioning of industrial symbiosis structures, those regulations most often create an additional, often hard to overcome, bureaucratic barrier.

Case: Surpluses of generated energy, which can be transferred to another enterprise, are regulated by the act of 10 April 1997 – Energy Law [Energy Act 1997]. This legislation imposes an obligation to obtain a licence from the President of the Energy Regulatory Office for the generation, storage and transfer of energy. The enterprises that were given such licence are obliged to work out a tariff system for energy recipients, which is connected with drafting exhaustive legal documents. A similar situation is observed in the case of water sales, regulated by the act of 7 June 2001 on collective supply in water and collective discharge of waste water [Water Act 2001]. The act imposes obligations regarding technical preparation of network systems and laboratory tests over water quality. Sales of matter classified as waste is another extremely complex process (act of 27 April 2001 on waste). Mutual transfer of waste between enterprises, if executed with the use of internal roads, is subject to the regulations of the act of 28 October 2002 on road transport of dangerous goods. Moreover, the REACH regulation imposes limitations which hinder recycling of raw materials from post-production waste [Waste Act 2001]. It is necessary to take into account local regulations, including spatial development plans and the waste management plan associated with environmental protection. On the other hand, the legal form of an entity in charge of EIP management remains a neutral factor, with the reservation that participation of local self-government and local entrepreneurs in specific conditions may turn out to be a pro-development determinant.

Based on the studies conducted, the most important barriers for the establishment and functioning of EIPs include lack or instability of legal regulations, no incentives for the establishment of EIPs and widely-understood limitations in the scope of waste management. No regulations concerning EIPs in the act on forests is yet another problem for the forest- and wood-based industry. At the same time, however, based on the experiences of the Promotional Forest Complexes (25 in Poland, with surface area of 1,267,803 ha), it seems possible to work out analogous structures relying on symbiotic links between production enterprises of the wood-based industry [Pokusa 2011].

3. COMPETITIVENESS FACTORS OF ECO-INDUSTRIAL PARKS (EIP) IN THE WOOD-BASED INDUSTRY

Forest resources, which constitute a natural source of wood, are an inextricable element of the natural environment. Their greatest assets include constant sustainability of resources and the ecological character of the economic chain at every stage of wood usage (from logging to recycling). This is conducive in a natural way to the tendencies towards industrial symbiosis by creating proper conditions for the development of eco-industrial parks. The most commonly mentioned determinant of competitiveness in literature is price. After transferring this observation into this study, the criterion of economic effectiveness of eco-industrial parks was accepted as an endogenous variable. A research question was formulated: to what extent potential economic effectiveness, possible to be achieved by EIP, is shaped by price factors, and to what extent by non-price factors of competitiveness. In order to verify that a hypothesis was made that the establishment, development and effectiveness of EIP in the wood-based industry in Poland is mainly affected by the price-related competitiveness factors.

To identify the factors that constitute potential competitive advantages of eco-industrial parks in the wood-based sector, a reference was made to a comprehensive research study of the competitiveness of the wood market in Poland, taking into account both economic and behavioural criteria [Wanat, Lis and Chudobiecki 2013]. Using the methodology proposed by Popek and Wanat [2014], significant competitiveness criteria were identified based on the author's questionnaire addressed to selected respondents. The researched population was determined with the use of the Lis' method [Lis 2012] applied to delimit and aggregate entities of the forest- and wood-based industry, while the size of the sample was estimated according to Steczkowski's formula [Steczkowski 1995].

Based on a theoretical analysis, selection of variables (measurable and non-measurable) for qualitative research was made. Regardless of primary features, all selected factors were given the character of qualitative variables (table 2). The research was carried out with the use of descriptive statistics methods, applying successively a correlation analysis and method of step wise regression, as well as a descriptive analysis by conducting a discussion of results and conclusions.

As part of the statistical analysis, the linkage of the Q1 variable (EVG&D, commonly: price) with other predictors (exogenous variables) was evaluated by performing their aggregation on the basis of the value of the Pearson linear correlation coefficient calculated for each variable. The non-price factors turned out to be significant competitiveness criteria, while the impact of the price factors was much weaker as opposed to what had been assumed. By aggregating the observations made in the study, the competitive situation which is conducive to the establishment and development of eco-industrial parks is determined by institutional conditions, non-price factors and, most of all, **market stability**.

Afterwards, an attempt was made to build a model for prognostication of the effectiveness of functioning of an eco-industrial park in the wood-based industry based on the selection of competitiveness factors that met the specified criteria to the largest extent. The variables that did not meet to conditions of significance as well as the variables that were hard to measure were excluded from the model built on the basis of the method of step wise regression. When analysing the value of the coefficient of determination R^2 it was noticed that the inclusion in the model of the remaining endogenous variables made it possible to explain only 15% of the dependant variable value (effectiveness). Prognosticating potential effectiveness of an eco-industrial park, based on the estimated model of regression, is linked with the occurrence of an average error of prognosis totalling 0.27.

Table 2. Factors selected for the qualitative research (Parameter Q_n).

Q_n	The EIP's Competitiveness Qualitative Factor (Q_n) Characteristics
Q_1	Direct Economic Value Generated and Distributed in the EIP's [EVG&D; commonly: price];
Q_2	Government Financial Assistance (received from the state- and local government);
Q_3	Market opening measure for EIP's (offer for new subject, elimination of barriers to market entry);
Q_4	Power of the EIP's structure impact for the local market;
Q_5	Employment preferences measure in the EIP's on the local market;
Q_6	Power of the EIP's impact on the local community (society);
Q_7	Power of the EIP's impact on the environment (reduction of emissions, quality of life);
Q_8	Measure of the degree of EIP's byproducts (waste products, recycling) on the local market;
Q_9	The EIP's industrial added value measure;
Q_{10}	State's and local's sectoral policy stabilization;
Q_{11}	Power of direct competition (interactions, relationships between EIP's participants);
Q_{12}	Power of sector environment's impact (related and supporting sectors);
Q_{13}	Innovativeness in the EIP's;
Q_{14}	Power of the EIP's strategy (knowledge, skills and competences application measure);
Q_{15}	Power of demand for EIP's products (fashion for wood, products position).

Source: own elaboration.

A regression model was created, which can be presented in the following manner:

$$\hat{Y} = 3.015 - 0.068\,Q_{12} + 0.056\,Q_{15} - 0.05\,Q_3 - 0.027\,Q_{11} + 0.023\,Q_7 - 0.02\,Q_8$$

Individual symbols mean:

$\hat{Y}$ – Prognosticating (based on the model) of the economic effectiveness of eco-industrial parks (EIP);
Q_{12} – Power of sector environment's impact (related and supporting sectors);
Q_{15} – Power of demand for EIP's products (for example: fashion for wood);
Q_3 – Market opening measure for EIP's (offer for new subject, elimination of barriers to market entry);
Q_{11} – Power of direct competition (interactions, relationships between EIP's participants);
Q_7 – Power of the EIP's impact on the environment (reduction of emissions and material consumption);
Q_8 – Measure of the degree of EIP's byproducts (waste products, recycling) on the local market.

The interpretation of the model is presented in table 3. It turns out that when applying a model based on price criteria, as much as 85% of $\hat{Y}$ variability (potential effectiveness of EIP) remains unexplained.

Table 3. The impact of parameter $\mathbf{Q_n}$ on the value of endogenous variable $\hat{\mathbf{Y}}$ in the regression model

PARAMETER Q_n, R^2	Impact of parameter Q_n on the value of endogenous variable $\hat{Y}$ in the regression model
Q_{12}	When Q_{12} increases by one unit, the value of $\hat{Y}$ will decrease by 0.068 on average;
Q_{15}	When Q_{15} increases by one unit, the value of $\hat{Y}$ will increase by 0.056 on average;
Q_3	When Q_3 increases by one unit, the value of $\hat{Y}$ will decrease by 0.05 on average;
Q_{11}	When Q_{11} increases by one unit, the value of $\hat{Y}$ will decrease by 0.027 on average;
Q_7	When Q_7 increases by one unit, the value of $\hat{Y}$ will increase by 0.023 on average;
Q_8	When Q_8 increases by one unit, the value of $\hat{Y}$ will decrease by 0.02 on average;
R^2	The designed model explains 15% of the variability of predictor $\hat{Y}$ (endogenous variable). Assuming only the inclusion of the impact of the variable used in the construction of the model to explain the set variable $\hat{Y}$, the remaining 85% of $\hat{Y}$ variability is still not explained.

Source: own elaboration (confidence level 90%, fraction size 0.5, and maximum error of estimate 10%)

4. CONCLUSIONS

It seems that identification of non-price factors of competitiveness turns out to be particularly important in the Polish wood-based industry, shaped by the monopolistic wood produce market. The research did not confirm the initially assumed hypothesis that competitiveness of eco-industrial parks in the industries based on wood was determined mainly by price factors of competitiveness. The identified institutional conditions constitute a strong barrier that hinders the development of industrial symbiosis in the wood-based industry. Simultaneously, an increase of the role of associated and supporting sectors, as well as clusters of cooperation and coopetition, has a positive influence on the tendency to establish and develop eco-industrial parks in the wood-based sector. Complementarity of their market offer is considered an opportunity in both the economic and environmental perspective.

Competitiveness of the forest- and wood-based industry is determined by a strong conflict between the production, recreational and protective functions. It seems that the conflict can be limited by greater specialisation of entities that form the wood-based sector. Symbiotic links in the form of eco-industrial parks provide a chance to build a new structure in the wood-based industry by shaping its competitiveness ex ante. However, industrial symbiosis in the wood-based industry depends both on the sectoral policy of the state and on local institutional conditions. Stabilisation of these factors may in a short- and mid-term perspective affect a change in the situation identified in the study, leading to the establishment of new eco-industrial parks in forestry and the wood-based industry, which may in the future decide about the formation of competitive advantages of the Polish forest and wood industry.

REFERENCES

1. Doniec A. (2011): SYMBIOZA I PARKI EKOPRZEMYSŁOWE, Wolters Kluwer Polska, Warszawa, pp. 100-108, 184-214.
2. Energy Act (1997): USTAWA Z DNIA 10 KWIETNIA 1997 ROKU, PRAWO ENERGETYCZNE, Dz.U. 1997, No 54, Pos. 348.
3. Forest Act (1991): USTAWA Z DNIA 21 WRZEŚNIA 1991 ROKU O LASACH, Dz.U., No 63, Pos. 494.
4. Francis (2015): "LAUDATO SI" ENCYCLICAL LETTER OF THE HOLY FATHER FRANCIS, : http://w2.vatican.va/content/dam/francesco/pdf/encyclicals/documents/papa-francesco_20150524_enciclica-laudato-si_en.pdf [accessed: 18.06.2015].
5. Graczyk A. (2005): LASY ORAZ GOSPODARKA LEŚNA W STRATEGII WZROSTU GOSPODARCZEGO I ROZWOJU ZRÓWNOWAŻONYM [in:] Święcicki Z.Ś. (eds.) Polskie lasy i leśnictwo w Europie, Centrum Informacyjne Lasów Państwowych, pp. 85-86.
6. Kaputa V. (2013): TRH A ENVIRONMENTÁLNE ATRIBÚTY VÝROBKOV Z DREVA, Technická univerzita vo Zvolene, Zvolen, ISBN 978-80-228-2620-4.
7. Klipper H. (1999), DIE INTERNATIONALE BAUAUSSTELLUNG EMSCHER PARK.EINE STUDIE ZUR STEUERUNGSPROBLEMATIK KOMPLEXER ERNEUERUNGSPROZESSE IN EINER ALTEN INDUSTRIEREGION, Springer Fachmedien Wiesbaden GmbH, ISBN: 978-3-8100-2516-6.
8. Lis W. (2012): GRUPOWANIE ODBIORCÓW DREWNA OKRĄGŁEGO Z LASÓW PAŃSTWOWYCH, [in:] Rynek Drzewny, No. 3/2012, pp.9-11.
9. Liwarska-Bizukojć E., Bizukojć M. (2011), UWARUNKOWANIA PRZYRODNICZE TWORZENIA PARKÓW EKOPRZEMYSŁOWYCH [in:] A. Doniec (eds.), Symbioza i parki ekoprzemysłowe, Wolters Kluwer Polska, Warszawa.
10. Mantel K. (1973): HOLZMARKTLEHRE. EIN LEHR- UND HANDBUCH DER HOLZMARKTÖKONOMIE UND HOLZWIRTSCHAFTSPOLITIK, Melsungen, Berlin, Basel und Wien.

11. OECD (2011): http://www.oecd.org/greengrowth/greengrowthindicators.htm [accessed: 24.06.2015].
12. Pokusa T. (2011): KLASTER DRZEWNY, KLASTER ENERGII ODNAWIALNYCH, KLASTER CHEMICZNY. MOŻLIWOŚCI FUNKCJONOWANIA I ROZWOJU KLASTRA REKREACYJNO-RUCHOWEGO W WOJEWÓDZTWIE OPOLSKIM, Wyższa Szkoła Zarządzania i Administracji, Opole.
13. Popek M., Wanat L. (2014): PRICE VERSUS NON-PRICE FACTORS OF SECTOR COMPETITIVENESS: CASE STUDY OF THE ROUND WOOD MARKET IN POLAND, [in:] Intercathedra, No. 30-2, pp. 71-77, Poznań, ISSN 1640-3622..
14. Saikku L., Lehtonen T.J. (2006): RANTASALMI ECO-INDUSTRIAL PARK. PLANNING AN "ECOLOGICAL" ECO-INDUSTRIAL PARK IN FINLAND, Regional Council of Etelä-Savo, http://www.mv.helsinki.fi/home/lsaikku/publications/Posteri,%20konferenssi.pdf [accessed: 24.06.2015].
15. Steczkowski J. (1995): METODA REPREZENTACYJNA W BADANIU ZJAWISK EKONOMICZNO SPOŁECZNYCH, PWN, Warszawa – Kraków.
16. Wanat L., Lis W., Chudobiecki J. (2013): SECTOR SPECIFIC SOURCES OF COMPETITIVENESS ON THE POLISH WOOD MARKET - PERSPECTIVE OF THE ELIMINATION OF SEVERAL BARRIERS, [in:] Fórum Manažéra, No 2/2013, pp.56-60, ISSN 1336-7773.
17. Waste Act (2001): USTAWA Z 27 KWIETNIA 2001 R. O ODPADACH, Dz.U. 2001, No 62, Pos. 628.
18. Water Act (2001): USTAWA Z DNIA 7 CZERWCA 2001 R. O ZBIOROWYM ZAOPATRYWANIU W WODĘ I ZBIOROWYM ODPROWADZANIU ŚCIEKÓW, Dz.U. 2001 No 72, Pos. 747.
19. This paper was prepared within the project "Scholarship support for PH.D. students specializing in majors strategic for Wielkopolska's development", Sub-measure 8.2.2 Human Capital Operational Programme, co-financed by European Union under the European Social Fund.

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THE POSSIBILITIES OF USING C-O-C CERTIFICATIONS IN THE CZECH REPUBLIC

Roman Dudík, Marcel Riedl

ABSTRACT

The paper outlines possible application of FSC and PEFC forest certification systems in placing timber and timber products on the EU market (EU Timber Regulation – EUTR). Particularly, our attention is focused on the analysis of the EUTR legislation requirements, related to operators. Requirements of forestry certification systems are analysed, in relation to the certified organizations and to the EUTR generally. The comparison of the surveyed requirements clarifies the role of forest certification systems in the EUTR. Our study also brings recommendations for operators who have already implemented one of existing forest certification systems. Moreover, our recommendations represent ways to the most efficient use of the forest certification system in the context of the EUTR legislation requirements. In the final part, the potential role of forest certification in creating more effective communications with general public is discussed and how a marketing differentiation strategy with the application of Porter's value chain can be developed bringing certified organizations competitive advantage.
Keywords: PEFC, FSC, EU Timber Regulation, operator, due diligence system, marketing strategy, Porter's value chain

1 INTRODUCTION

The paper outlines possible application of FSC and PEFC forest certification systems in placing timber and timber products on the EU market (EUTR). Particularly, our attention is focused on the analysis of the EUTR legislation requirements, related to operators.

This topic is from the beginning pursued by authors in the Czech Republic – for example by Dudík and Šišák (2014) or Ventrubová and Dudík (2014). This issue has a Europe-wide impact that is why an attention is paid to this topic also abroad. In this field we can mention renowned authors such as Paluš et al. (2014).

2 THE FRAMEWORK OF THE EUTR

First and foremost, we have to define whether the natural person or organization is an operator, trader or a subject unbound by the requirements of the Timber Regulation (Regulation (EU) No 995/2010). In case the natural person or organization identifies themselves as operators, they are liable for the following:

1. It is prohibited to place illegally harvested timber and products derived from such timber on the EU market for the first time;
2. It requires EU traders who place timber products on the EU market for the first time to exercise due diligence system (a set of processes and measurements stated in Article 6).
3. Keep and regularly evaluate their own due diligence system, unless the operator applies the due diligence system introduced by a monitoring organization (see Article 8 of the Timber Regulation).

The core of the due diligence notion is that operators undertake a risk management exercise so as to minimise the risk of placing illegally harvested timber, or timber products containing illegally harvested timber, on the EU market. The three key elements of the due diligence system are:

1. Information: The operator must have access to information describing the timber and timber products.
2. Risk assessment.
3. Risk mitigation.

3 FORESTRY CERTIFICATION SYSTEMS

Requirements of forestry certification systems are analysed, in relation to the certified organizations and to the EUTR generally. The comparison of the surveyed requirements clarifies the role of forest certification systems in the EUTR.

Discussions on EUTR issues in the Czech Republic have been marked by two myths lately. First, people often erroneously suppose an operator can keep to current records (records of forestry output, among others) and that would sufficiently meet the requirements of the Timber Regulation and due diligence system. The first misconception was dispelled (explained) in the paragraphs above. The other misconception is based on a presumption that an operator might as well get by with a certified FSC or PEFC system to meet the and that would comply with the Timber Regulation.

First, it is worth highlighting that the Commission Implementing Regulation (EU) No 607/2012 sets basic terms of use of certification in risk assessment and mitigation. When a forest certification system meets the requirements, it can be used in the framework of EUTR. Besides, forest certification systems in the context of the Czech Republic constitute an independent and separate certification:

- Sustainable Forest Management (SFM) and
- Chain-of-Custody of Forest Based Product (C-o-C).

Forest certification systems applied in the Czech Republic:

- FCS – Forest Stewardship Council
- PEFC – Programme for the Endorsement of Forest Certification

In the framework of both systems, SFM and C-o-C are separately certified. On the face of it, it is misleading to presume: “When you have PEFC, you meet the demands of the Regulation”, at the very least. The misleading conception was forged in the following context: In 2013, the PEFC International revised its international standard for C-o-C, and consequently, the Czech Republic revised its technical document setting the requirements for C-o-C. A revised C-o-C document TD CFCS 2002:2013 resulted. This technical document contains – apart of standard demands for C-o-C – also minimum requirements for the due diligence system. Actually, if operators apply C-o-C system together with the TD CFCS 2002:2013, they will also, in principle, meet the due diligence system requirements. Nevertheless, operators should take on the responsibility to create a due diligence system customized for their particular circumstances. TD CFCS 2002:2013 standard formulates concrete requirements in defined frameworks, i.e. not the particular circumstances of a particular operator; therefore, it is important to apply a due diligence system in accordance with EUTR European regulations. The above mentioned standard, however, presents a good concept of how the due diligence system might look like.

EUTR Implementation Rules complements the situation: “Certification of the supply chain can be used as a proof that no non-certified or non-controlled timber enters the supply chain. Generally, it is desirable that only licensed timber enters the supply chain ‘at critical check points’ and that the timber is traceable to its previous owner (who must also be certified), not only to the forest it was harvested in. A supply-chain-certified product might contain a mix of certified and other licensed materials from various sources. If the certification of the supply chain is used as a proof of legitimate origin, the operator should ensure that all the material is licensed, certified, and its monitoring processes sufficient to eliminate other than the licensed material."

The citation applies to C-o-C certification of any forest certification system. It is obvious – in relation to the explanation above – that it might be cost ineffective for some operators to create an appropriate due diligence system by TD CFCS 2002:2013 – especially in case of our smaller subjects who apply an easy and unambiguous identification of their timber sources. Major subjects with varied sources of timber entering the market might find the creation of a due diligence system (by TD CFCS 2002:2013 standards) a possible way to comply with the Timber Regulation. This conclusion basically corresponds with conclusion of Paluš et al. (2014).

For the sake of completeness, we have to mention the circumstances of SFM certification. The Commission Implementing Regulation (EU) No 607/2012 obliges "a third party to carry out an appropriate monitoring regularly, at least once a year, including on-site checks"; therefore, the SFM certification does not meet the criterion, as every subject in the group certification usually fails to be checked upon annually. This also applies in the Czech Republic – to use SFM certification in the framework of EUTR, the operator must be audited annually by a third party (certifying body).

4 MARKETING POTENTIAL OF FOREST CERTIFICATION

Major importing countries, Germany and the United Kingdom have had active groups of companies, led by retailers, demanding supply of certified forest products. This strong demand for certified products has probably driven Finnish companies to become chain-of-custody certified (Karna et al., 2003). Forest certification schemes have tended to presume implicitly that the ''invisible hand'' of the market will without intervention translate consumers' values into supply of social and environmental services. Rather than encourage investment in difficult-to-control end consumer demand, forest certification has relied heavily on large retailer demand.

According to a large multicountry survey by McKinsey (Bonini and Oppenheim, 2008), 87% of consumers surveyed are concerned about the environmental and social impact of the products they buy, 33% say they are willing to pay a premium for sustainable products, and another 54% care about the environment, and want to help tackle climate change. Consumers want to act green, but they expect businesses to lead the way... businesses can do a lot more to help would-be green consumers turn their talk into walk. Following other industries, the wood processing industry should be increasingly focused on the end customer. So the tool that continues to grow in importance for the wood processing sector is branding (Tokarczyk, 2006). Branding is the marketing practice of creating a name, symbol or design that identifies and differentiates a product from other products.

As Yasushi (2014) noticed …it is difficult to direct consumer spending toward certified forest products. Only a small proportion of consumers understand the forest certification system (only 8.0% according to our results); thus, forest certification has a limited impact on the merchandise choice at present. According to Peck (2001) of all the commodities of importance in international trade, wood products are one of the most complex and diversified, ranging from basic raw materials straight from the forest to sophisticated manufactured products. Most of these wood products arrive to end consumers as complex combinations of natural and synthetic materials sourced from multiple locations worldwide.

Companies should proactively evaluate the potential for environmental marketing strategies and how forest certification might be used to develop competitive advantage (Hansen, 1997). A more sophisticated marketing differentiation strategy together with the application of Porters value chain for benefits of the whole industry column, can be developed by using the potential of forest certification and certification of chain of custody. As observes (Owari et al., 2006) charging a price premium was not possible for most certified companies. Although certified companies tended to gain improved customer retention and satisfaction, in addition to a positive public reputation, certification did not generally help them to improve their financial performance.

In the CR there are about 300 companies certified in so called chain of custody certification. But the weaknesses of certification systems in the CR are similar as reported Cubbage (2010): lack of recognition (see tab. 1), no market structure to take advantage of certification, no country/government incentives for certification, poor funding for certification, no price benefits for certification.

Table 1: Assisted Brand Awareness - Logo PEFC

	Yes, I have	No, I have not	I do not know
Have you ever seen this logo?	10%	82%	8%

	Yes, I do	I do not know
Do you know what this logo means?	7%	93%

Notice: Number of respondents 951. *Source: PEFC Czech Republic*

Although a Czech customer is not probably willing to pay more for certified products, branding products from certified wood and paper opens up new possibilities for differentiation strategy at the point of sale. Additionally branding can increase the impressive psychological value of the certified products and thus can increase their competitiveness in situations where pricing is comparable with uncertified products and can consequently increase demand for certified products. Examples of such marketing strategies aiming to increase the perceived value of the certified wooden products can be so called co-branding strategy (Helmig et al., 2008) or advertising alliance used by certification system PEFC and hobby market Bauhaus in the Czech Republic (see fig. 1).

Figure 1: Illustration of P.O.S. (point of sales) materials (source: www.bauhaus.cz)

5 CONCLUSION

Generally, it can be said, that SFM certification cannot substitute the due diligence system in case of operators who place timber and timber products on the EU market. The certification can, though, simplify the implementation and maintenance of the due diligence system. The SFM certification is based on an evidential monitoring and evaluation of keeping the forest management requirements. Timber harvested in certified forests can therefore be branded as legitimate. It ensures the origin is not a problematic issue.

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REFERENCES

1. Bonini, S., Oppenheim, J., 2008. Cultivating the green consumer. Stanford Social Innovation Review. 56 pp.
2. Cubbage, F., Diaz, D., Yapura, P., Dube F., 2010. Impacts of forest management certification in Argentina and Chile. Forest Policy and Economics 12 (7), 497-504.

3. Dudík, R., Šišák, L., 2014. Placing Timber and Timber Products on the Market in the Czech Republic and Related Economic Impacts. In Schiberna, E., Stark, M. (Eds.), Adaptation in Forest Management under Changing Framework Conditions. Proceedings IUFRO Symposium. Foundation for Sustainable Forest Management, 35-42.
4. Hansen, E., 1997. Forest certification and its role in marketing strategy. Forest Products Journal 47 (3), 16-22.
5. Helmig, B., Huber, J.A., Leeflang, P.S.H., 2008. Co-Branding: The State of the Art. University of Fribourg Marketing Working Paper No. 1. Available at SSRN: http://ssrn.com/abstract=993470.
6. Karna, J., Hansen, E., Juslin, H., 2003. Environmental activity and forest certification in marketing of forest products - A case study in Europe. Silva Fennica, 37 (2), 253-267.
7. Paluš, H., Parobek, J., Kaputa, V. 2014. The role of forest certification in the European timber regulation. In Šupín, M., Paluš, H. (Eds.), Position and role of the forest based sector in the green economy: proceedings of scientific papers. Zagreb: WoodEMA, 111-117.
8. Peck, T., 2001. The International Timber Trade. 1st ed. Woodhead Publishing, 344 pp.
9. Tokarczyk, J., Hansen, E., 2006. Creating Intangible Competitive Advantages in the Forest Products Industry. Forest Products Journal 56 (7/8).
10. Owari, T., Juslin, H., Rummukainen, A., Yoshimura, T., 2006. Strategies, functions and benefits of forest certification in wood products marketing: Perspectives of Finnish suppliers. Forest Policy and Economics 9 (4), 380-391.
11. Ventrubová, K., Dudík, R., 2014. Legislativní opatření spojená s uváděním dřeva a dřevařských výrobků na trh EU. ÚZEI: Praha. 110 pp.
12. Yasushi, S., Nobuhiko, N., Yukari, U., Hiroaki, K., Takuro, H., 2014. Preferences for certified forest products in Japan: A case study on interior materials. Forest Policy and Economics 43, 1-9.

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THE EFFECT OF PERIODIC STRESSING AND MATERIAL THICKNESS ON THE BENDING STRENGHT OF DENSIFIED BEECH WOOD

Elena Miftieva, Miroslav Gašparík, Miroslav Suchopár

ABSTRACT

In this article, we engage in examining the selected characteristics of densified beech wood (strength at bending) and the effects of selected factors (number of stressing cycles and material thickness). Densification of the test pieces to the value of 30% was achieved by rolling. This method of wood densification is characteristic by lower energetic expensiveness when densifying, compared to other methods of wood modification by pressing. Further, the test pieces were exposed to periodic stressing of 1000, 3000 and 7000 cycles. For the identification of the examined characteristic, the three-point stress bending test for the center of the test piece was used. Ascertained results represent a foundation for further practical utilization of wood in the production process.
Keywords: wood densification, periodical stressing, bending strength, beech wood

1 INTRODUCTION

Wood is a natural, renewable material of versatile utilization, which is characteristic by its positive, as well as by certain undesirable natural properties. However, most of its physical-mechanical properties can be altered by intentional changes. In wood-processing industry, new technologies of diminishing the undesirable wood properties and broadening the possibilities of application of the wood in unconventional ways are searched for constantly (Kurjatko et al. 2010).

By intentional modification of the material, it is possible to influence individual undesirable properties of wood to some extent and therefore broaden the options of its application in various industries of economy (Kurjatko et al. 2010; Gáborík et al. 2010). By modification of the wood properties by mechanical, thermal, chemical treatment or by their combination, we can obtain materials of intended properties for their successive technological and industrial utilization (Kurjatko et al. 2010; Gaff et al. 2010).

Densification of wood belongs among the methods of modification of the basic wood properties. The wood densification is one of the modification technologies, in which the wood is pressed by e.g. rolling, by which it reduces its volume and simultaneously increases its density. This technology is used in the building industry, but mostly in the furniture industry (Gaff and Gašparík, 2015; Kurjatko et al. 2010). By wood densification, the qualitative change of its properties can be achieved and therefore obtain a material of enhanced properties. The final product is characteristic by its enhanced physical-mechanical properties compared to the solid timber, which increases its area of utilization in production of finished products for various purposes (Kurjatko et al. 2010; Zemiar et al. 2011; Fang et al. 2012). The knowledge mentioned above represent the reason why it is essential to focus on the examination of the strength characteristics of the densified beech wood.

2 METHODS

For the purpose of examination of the effect of the selected factors on the observed characteristic, the wood of Fagus Sylvatica was modified by densification perpendicular to the fibers in the radial direction at pressing level of 30%. The value of pressing – degree of pressing was evaluated in relation to the original dimensions of the test piece. As a way of densification, the method of rolling with continual load throughout the cross section was selected. The pressing rollers are not affecting the whole area of the densified material at once, but only locally, in the place of the rollers. The test pieces were in no way plasticized during the densification and the pressure during the rolling reached 30 MPa.

The merit of the work was an experimental assessment of the effect of periodical stressing of densified beech wood of various thickness on the bending strength „σ_p“ during bending perpendicular to the fibers in radial direction. Assessment of the observed characteristics took place before and after the periodical stressing of the test pieces. A four-stage periodical stressing of 0, 1000, 3000 and 7000 cycles was assessed for the individual sets of test pieces. The periodical stressing was executed on a special cyclic machine, principle of which lies in periodical bending of the test pieces by uniaxial load. During the periodical stressing of the test pieces, the loading was executed up to 90% of the proportional limit, which was assessed during a preliminary experimental measurement of stressing the test pieces by static bending. For the purpose of assessing the effect of material thickness, tests were executed on the densified test pieces of 2,8 mm, 4,2 mm, 7 mm and 12,6 mm thickness (accordingly, before the actual densification by 30%, the test pieces had a thickness of 4 mm, 6 mm, 10 mm a 18 mm). Subsequently, the test pieces were conditioned at a temperature of 20±2 °C and an air moisture of 60% to a final moisture of 8%. Accurate classification of the individual sets of test pieces is listed in the Fig. 1.

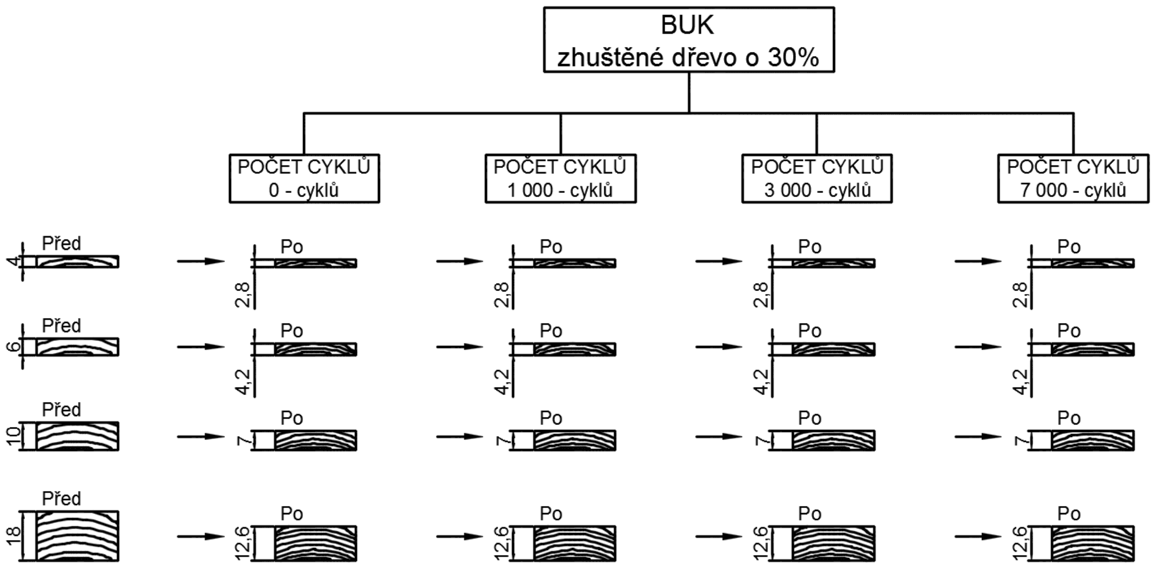

Fig. 1 Scheme of beech wood test pieces

The tests of strength at bending perpendicular to the fibers in the radial direction were executed before and after the periodical stressing on test pieces treated this way.

2.1 Methods of determining the bending strength

The determination of the bending strength was executed according to norm ČSN EN 310 (1995) on a special machine instrument during a bend-stressing the test piece in its center. This norm is concerned with determining the module of bending flexibility and strength. The test pieces after densification had the dimensions of w=30 mm × t=2,8 mm, 4,2 mm, 7 mm a 12,6 mm × l=600 mm. By reason of precluding the effect of material thickness, the distance of the supports was set as l1=20*t during the bending (Fig. 2). Scheme of the three-point bending is depicted in the picture 2.

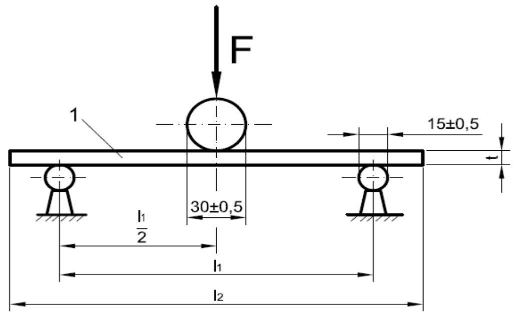

Fig. 2 The setup of the bending test
ČSN EN 310 (1995)
1 – test piece, F—load, t – test piece thickness, l_1=20×t, l_2=l_1±50 mm

The rate of stressing was set in a manner in which the maximal stress was achieved in (1,5±0,5) minutes. The bend was measured in the center of the test pieces under the stressing head with accuracy of 0,1 mm. The measured values along with the corresponding stress were recorded with ±1% accuracy of a measured value.

The bending strength at the three-point bend was calculated in accordance with the norm ČSN EN 310 (1995) following a formula (1):

$$\sigma_p = \frac{3 * F_{\max} * l_1}{2 * b * t^2}, \text{ [MPa]} \qquad (1)$$

Where:

σ_p – bending strenght limit [MPa]
F_{max} – is a force recorded at the breaking point of a test piece [N]
l_1 – distance of the supports during the test [mm]
b – width of the test piece [mm]
t – thickness of the test piece [mm]

Measured results of the bending strength were recalculated for the 12% humidity according to the equation number (2) (ČSN EN 310, 1995):

$$\sigma_{12} = \sigma_w [1 + \alpha (w - 12)], \text{ [MPa]} \qquad (2)$$

Where:

σ_w – bending strength of wood at a humidity at the time of testing [MPa]
σ_{12} – bending strength of wood at 12 % humidity [MPa]
w – the humidity of a test piece at the time of testing [%]
α – correctional humidity coefficient, which is 0,04 for all of the wood pulps [-]

3 RESULTS AND DISCUSION

The results of the work are findings about individual factors on the values of bending strength and the interaction of combination of examined factors at the same time.

Table 1 contains the values of 2-factor analysis of variance, which reflects the statistic significance "P" of the individual factors (number of stressing cycles and material thickness) and their mutual interaction. Based on these values, it can be stated that the effect of periodical stressing can be considered as a factor, which has no effect on the values of bending strength of densified beech wood. The second examined factor - thickness of the material can be considered as a statistically significantly agential on the values of bending strength. It is possible to consider the interaction of both examined factors as an interaction, which has a moderately significant effect on the examined characteristics.

Table 1. Basic table of the two-factorial analysis of variance, evaluating the effects of the individual factors on the change in bending strength of the densified beech wood

Observed factor	Summary of squares	Independence levels	Variance	Fischer's F-test	Significance level P
Abs. element	1394760	1	1394760	2380.026	0.000001
Number of cycles	1289	3	430	0.733	0.535423
Thickness	55219	3	18406	31.409	0.000001
Number of cycles*Thickness	17118	9	1902	3.246	0.002254
Error	43366	74	586		

From the Fig. 3, it is apparent that the effect of material thickness has a statistically significant effect. With increasing material thickness, the values of bending strength decrease (Fig. 3). Statistically the most significant difference was evident during the material thickness of the 6, 10 mm and 18 mm interval. The decrease in bending strength with increasing material thickness is a consequence of increase of the cross section module being greater than the increase of the agential force. Therefore, the increase in thickness results in an increase of the test piece surface and the force consequently distributes over the increased area of the cross section and it comes to a decrease in strength.

It is possible to consider the effect of the observed number of stress cycles on the values of bending strength as an insignificant factor (Fig. 4). During the 0 to 1000 and 3000 to 7000 intervals, the values of bending strength gradually decreased. Slight increase in bending strength at number of 3000 cycles can be considered as negligible.

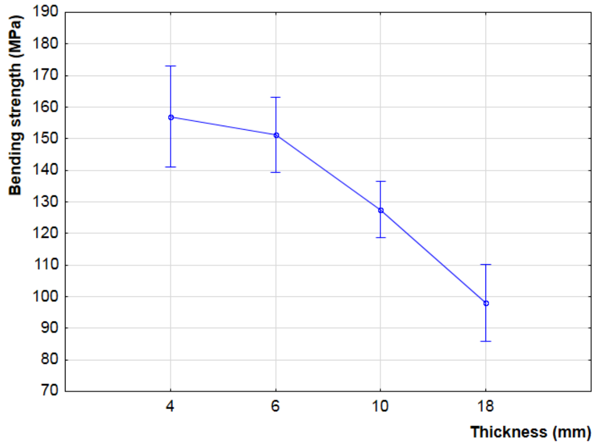

Fig. 3 Graph of the 95% intervals of reliability illustrating the effect of the material thickness on the values of average arithmetic bending strength of the densified beech wood

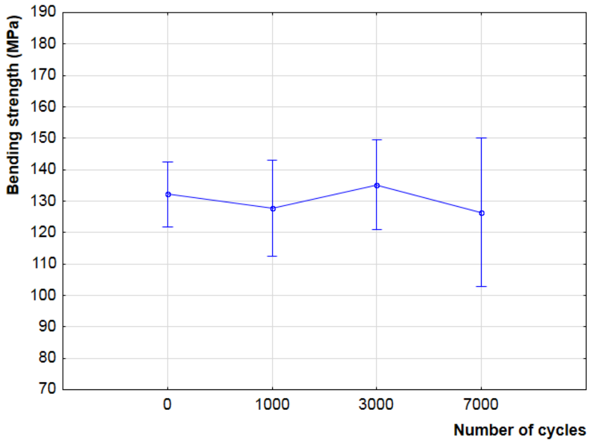

Fig. 4 Graph of the 95% intervals of reliability illustrating the effect of the number of cycles on the values of average arithmetic bending strength of the densified beech wood

Conformably to the graphs of 95% intervals of reliability illustrating the effects of material thickness and number of cycles on the bending strength of the densified beech wood (Fig. 5 and Fig. 6), it can be stated that the interaction of both observed factors has a statistically moderate influence and we can observe, that the mentioned effect shown as a consequence of significant effect of different material thickness.

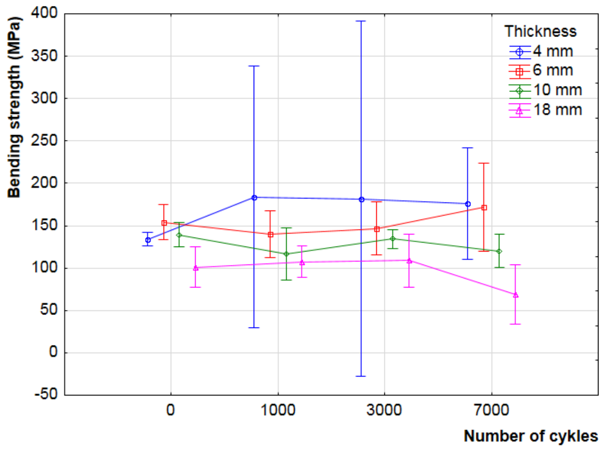

Fig. 5 Graph of the 95% intervals of reliability illustrating the effect of the interaction of material thickness and number of cycles on the values of average arithmetic bending strength of the densified beech wood

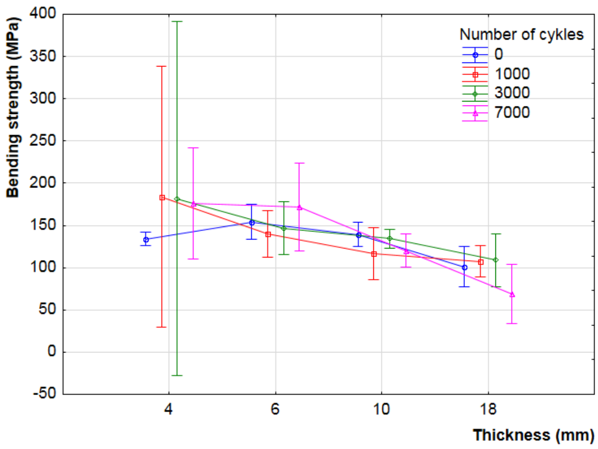

Fig. 6 Graph of the 95% intervals of reliability illustrating the effect of the interaction of material thickness and number of cycles on the values of average arithmetic bending strength of the densified beech wood

4 CONCLUSION

From the results listed in the paper ensues:

- Number of stress cycles proved to be a factor, which has no significant effect on the values of bending strength.
- In following works, it is necessary to focus on examination of the effect of greater number of stress cycles - 7000 and more.
- Significant effect of the material thickness demonstrated. As a consequence of increase in material thickness, values of bending strength of the densified beech wood decrease significantly.
- The interaction of material thickness and number of cycles factors can be considered as a interaction affecting the values of bending strength. From the pictures 5 and 6 it ensues that mentioned was caused by the effect of material thickness.
- Recorded effect of decreasing bending strength with increasing material thickness concurs with the results in work of Milan Gaff et al. (Gaff et al. 2014), where he states, that even with preserved conditions of the slenderness ratio (20x material thickness) the values of bending strength decrease as a consequence of greater increase of cross section module of the material compared to the increase in agential force, therefore the decrease in strength takes place.

Results found in this measurement contribute to the knowledge of densified wood properties, which can be taken advantage of in the following research papers in the area of wood densification and represent a foundation for the search of further options of wood-based material modification in the form of layered composite, from native non-densified wood, as well as in combination of densified and non-densified wood, for the purpose of increasing its utility properties and further research of properties of such treated materials.

BIBLIOGRAPHY

1. Fang, C. -H., Mariotti, N., Cloutier, A., Koubaa, A., and Blanchet, P. (2012). „Densification of wood veneers by compression combined with heat and steam“, European Journal of Wood and Wood Products 70(1-3), 155-163. DOI: 10.1007/s00107-011-0524-4

2. Gáborík, J., Dudas, J., and Kulík, J. (2010). „Selected properties of laminated wood of poplar". In: Annals of Warsaw University of Life Sciences– SGGW. Forestry and Wood Technology No 71. Warsaw University of Life Sciences Press, Warsaw Poland, 182-186. ISSN 1898-5912.
3. Gaff, M., and Gašparík, M. (2015). „Influence of densification on bending strenght of laminated beech wood", BioResources 10(1), 1506-1518. DOI: 10.15376/biores.10.1.1506-1518
4. Gaff, M., Gašparík, M., and Barcík, Š. (2014). „The influence of cyckic loading on ultimate bending strength of beech solid and laminated wood", Drvna Industrija 65(3), 197-203. DOI: 10.5552/drind.2014.1336
5. Gaff, M., Macek, Š., and Zemiar, J. (2010). „Model analysis of laminar materials stressed by bending". In: Annals of Warsaw University of Life Sciences– SGGW. Forestry and Wood Technology No 71. Warsaw University of Life Sciences Press, Warsaw Poland, 187-193. ISSN 1898-5912.
6. Kurjatko, S., et al.: Parametre kvality dreva určujúce jeho finálne použitie / Stanislav Kurjatko et al.; rec. Ivan Makovíny, Štefan Šteller. - Zvolen : Technická univerzita vo Zvolene, 2010. - 352 s. : obr., tab. - APVV-0282-06. - ISBN 978-80-228-2095-0
7. SUCHOPÁR, M.: Vliv cyklického namáhání na ohybovou pevnost zhuštěného dřeva. Diplomová práce. 2015
8. Zemiar, J., Zbončák, R., and Gaff, M. (2011). „Thickness changes of cyclical pressed veneer". In: Annals of Warsaw University of Life Sciences– SGGW. Forestry and Wood Technology No 76. Warsaw University of Life Sciences Press, Warsaw Poland, 218-222. ISSN 1898-5912.
9. ČSN EN 310. 1995: Desky ze dřeva. Stanovení modulu pružnosti v ohybu a pevnosti v ohybu

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DETERMINING THE EFFECT OF POPULUS TREMULA DENSIFICATION ON THE DEFORMATION TENSION CHARACTERISTICS UNDER PRESSURE PERPENDICULAR TO THE RADIAL DIRECTION FIBERS

Tomáš Svoboda, Milan Gaff, Tomáš Brutovský

ABSTRACT

The paper is oriented to determining the effect of densification (10% and 30%) of Populus tremula wood-pulp on the evaluated characteristics, which are the deformation tension characteristics under pressure perpendicular to the radial direction fibers. Aim of the paper was to determine the behavior of densified (10%, 30%) and non-densified Populus tremula up to the proportional limit for the purpose of creating materials of specific characteristics for given application intent. The resulting values of the tests were graphically processed and evaluated by the form of tables.
Keywords: densification, Populus tremula, proportional limit

1. INTRODUCTION

As a consequence of improved properties and excellent mechanical properties of composite wood-based materials, the wood finds ever wider utilization as an ecological and renewable material. Thanks to composite materials, such as glued laminated beams (Sviták et al., 2014), it ascends among leading positions of utilization, ahead of other construction materials, which until now have shown better technical properties compared to untreated wood. We can assume, that its properties will improve up to some point of surface pressing, and after the violation of this limit, great differences in created deformations may occur, by which the structure and integrity of the wood begins to disrupt (Gaff, M., Zemiar, J., Koristová, E., 2010). By this reason we are trying to determine the limit up to which is possible to consider the densification as an enhancement to the examined wood characteristics.

The state, in which the wood achieves the highest level of plasticity, however, with the lignine – saccharide matrice compounds of the wood undamaged as much as possible, is convenient for the technology of molding (Gaff, M. , Zemiar J., 2008).

The process of surface densification by pressing generally takes place in three phases.

Those are plasticization, actual pressing and conditioning (Gaff, M., Gáborík, J., 2009). The results of the authors' work (GAFF, M. , ZEMIAR J., 2006) showed that for the process of densification, the moisture higher than 12% is better than a lower one, and on that account we examined the effect of the mentioned factors at 12% moisture.

With wood-based materials, contrary to the actual wood, we can regulate the level of anisotropy, for example the size and orientation of the wood particles. This is a significant advantage of these materials, considering we can control their properties in individual areas according to demands on the final utilization. Non-negligible fact is also the option to utilize a raw material of lower quality for the production of high quality product.

In construction industry and lumber industry we encounter with increasing frequency material designs, properties of which have to be examined before they are actually created. An example of this could be floorings, on which specific demands are made. Flooring should be resistant to mechanical damage, which should be ensured by upper treading layer, and also flexible and resistant to dynamic stressing.

The level of densification was a basic factor during the observations. The observed parameter during the evaluation of strength under pressure perpendicular to the fibers was the proportional limit, as an indicator, which is measured with this characteristics.

2. WORK METHOD

2.1. Preparation of the test pieces

During the lumber production from logs, the circular cutting (Fig. 1a) was chosen for the purpose of tangential lumber. The lumber was laid by the mean of lintel bars and dried spontaneously in the lumber magazine down to the moisture of 16% (± 2%).

Dried lumber was shortened to desired rough dimensions (Fig. 1b), cleared – (Fig. 1c) and cut into concurrent cut pieces (Fig. 1d). For the purpose of achieving of two perpendicular planes, the surfaces of the material were leveled by a surface planer. Consequently, the cut pieces were treated by thicknesser (Fig. 1e). That is how the thickness before molding with allowance or already final thickness of the non-molded cut pieces was specified.

Individual cut pieces (densified and also non-densified) were shortened by the dimensioning saw to the desired dimensions of test pieces (Fig. 1f). The dimensions of pieces for the pressure test are 20 x 60 x 60 mm (Fig. 1g).

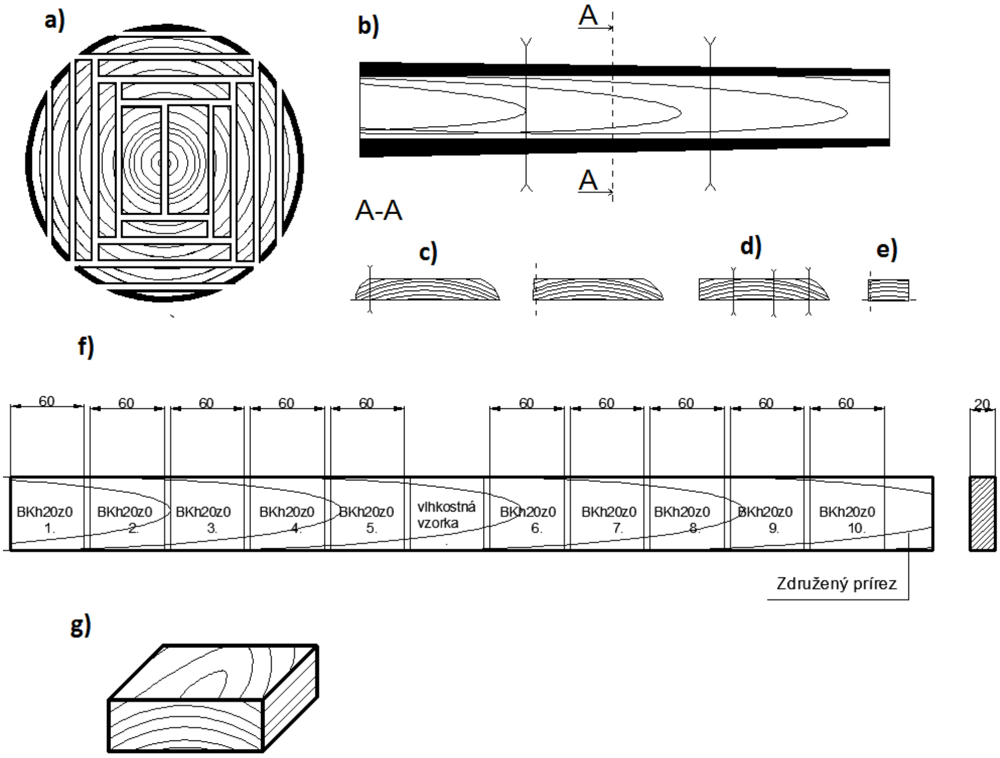

Fig. 1 Process of test pieces preparation

2.2. Densification of cut pieces

The samples were densified to the desired thickness by uniform molding of wood crosswise the fibers at 16% moisture using a hydraulic press. To achieve the final thickness of 20 mm, it was necessary to account for the allowance before molding. The molded samples were compressed by 10% and 30% of their thickness, whereby we have to account for the elastic deformation of the material. During the densification, cut pieces of 22 mm thickness, which were molded to 20 mm, i.e. by 10%,

were used. The cut pieces of 26 mm thickness were molded to final 20 mm, i.e. by 30%. At higher levels of densification we reach higher wood density, but at the expense of damaged structure.
Density is assessed according to formula (1):

$$\rho = \frac{m}{V} \left[kg/m^3 \right], \qquad (1)$$

Where: m – weight [kg],
V – volume in [m³].

2.3. Conditioning

The test material was conditioned in an environment of relative air humidity of φ = (65 ± 5)% and of temperature of t = (20 ± 2) °C to a state of equilibrium. These conditions were assessed based on the Čullický diagram and match the 12% equilibrium moisture of wood, at which the test was executed.
The moisture assessment was executed by weighting method according to the norm ČSN 49 0103.

2.4. Tests on the tensile testing machine

The properties of the Populus tremula material of 20 mm thickness were assessed (Fig. 2) (Table 3 ordinal number 1, 2, 3).

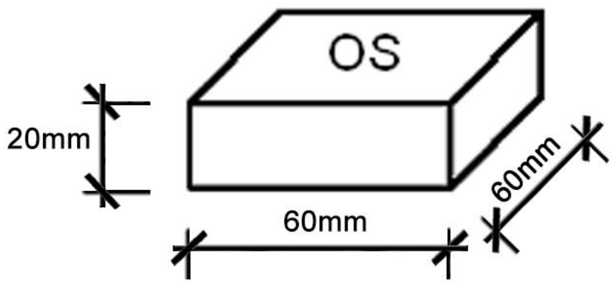

Fig. 2 Populus tremula of 20 mm thickness

During the tests, 3 possible levels of densification were anlysed. For each set of test pieces, 10 samples were used, which constitute 30 samples overall.

Table 1 Compositions and combinations of materials

O.No.	Wood species	Thickness (h) in mm	Densification	Index
1	PT	20	0%	OSh20z0
2	PT	20	10%	OSh20z10
3	PT	20	30%	OSh20z30

2.5. Method of assessing the strength under pressure perpendicular to the fibers

Strength under pressure perpendicular to the fibers was assessed on the conditioned samples with 12% moisture using the FPZ 100/1 tensile testing machine and the ALMEMO measuring device (Fig. 3).

Given deformation relationship in the "strength - deformation" diagram was achieved by testing (Fig. 4). The strength necessary for breaking and the corresponding values of proportional lengthening are input parameters at all times, based on which it is possible to evaluate the conclusions of these tests (Sviták, et al., 2013). The point of contact of the tangent on the curve was specified so that the tangent of the angle formed by the tangent and the load axis was 1,5 times higher than the tangent of the angle formed by the linear part of the curve and the load axis. The value of strength on the proportional limit (Fu) was deducted from the final diagram. Then we calculate the tension on the proportional limit according to the formula determined by the relationship (2).

Fig. 3 The ALMEMO measuring device and the FPZ 100/1 tensile testing machine

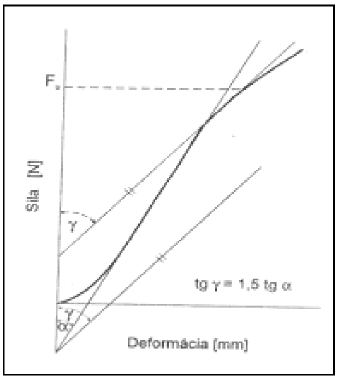

Fig. 4 "Strength - deformation" diagram for the pressure perpendicular to the fibers (DUBOVSKÝ, J. et al., 2001)

3. THE TEST PROCESS

1. Width and length of the conditioned test piece in the axes of symmetry with accuracy of 0,1 mm using was assessed using a digital caliper.
2. The test piece was inserted into the tensile testing machine between the plates in a way in which force was applied in the radial direction (Fig. 5).

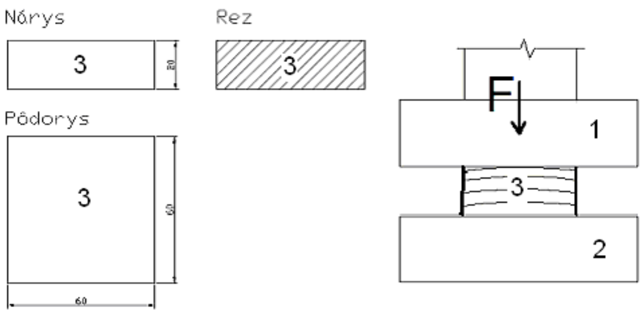

Fig. 5 Test piece for assessing the strength under pressure perpendicular to the fibers: 1 – pressure plate, 2 – fixed plate, 3 – test piece.

3. When using the testing machine without a recording device, the deformation was assessed using a numerical indicator with accuracy of 0,01 mm at the same intervals of load accession. The interval has to be at least 10 times smaller than the load corresúponding to the conventional fracture limit. It is allowed to use an interval of 200 N load accession for soft woods and 400 N for hard woods during the tests with pressure across fibers on the whole test piece. Similarly, 150 N and 300 N during tests with concentrated local pressure.In our case, a testing machine with ALMEMO recording device was used, which scanned the material using measuring probes attached on the machine. ALMEMO device was connected to tensile testing machine and also to a computer, to which the measured data was transfered. The test piece was loaded at steady speed.
4. The test carried on until visible violation of the proportional limit, which was assessed by diagram or by numerical indicator.

Measured data was processed using Microsoft Excel application, the tension-deformation graph was created and from it the proportional limit was assessed. The proportional limit of pressure perpendicular to the fibers is assessed according to formula (2) (Požgaj. 1987):

$$\sigma_u = \frac{F_u}{S} \text{ [MPa]}, \quad (2)$$

Where: σu – proportional limit,
Fu – force at proportional limit in N,
S – loaded area of test piece in mm2.

4. RESULTS AND DISCUSSION

4.1. Evaluation of proportional limit for solid samples

It is possible to compare the illustration of tension on the proportional limit of all average values of solid samples on the bar chart (Fig. 7). The value of proportional limit for Populus tremula at 0% densification (non-densified) is 4,72 MPa. In the results listed in the chart we can see that by increasing the densification the proportional limit decreases.

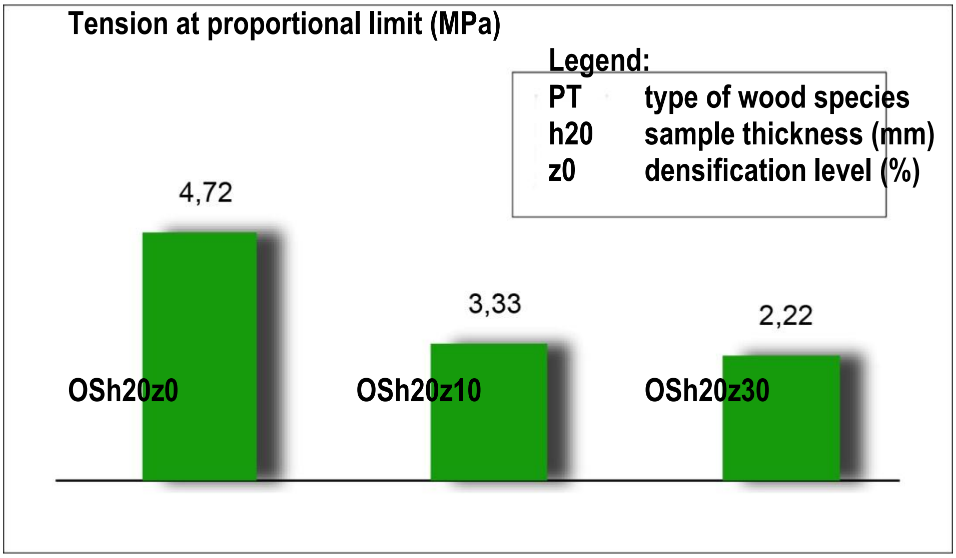

Fig. 6 Tension at proportional limit of solid samples of Populus tremula

Assessed average values of force at the proportional limit (Fu) of the solid samples of Populus tremula are depicted in chart (Fig. 8). Force achieved with non-densified sample of Populus tremula is 17 MPa. With an increase in densification, we can observe a decrease in value of force achieved at the proportional limit.

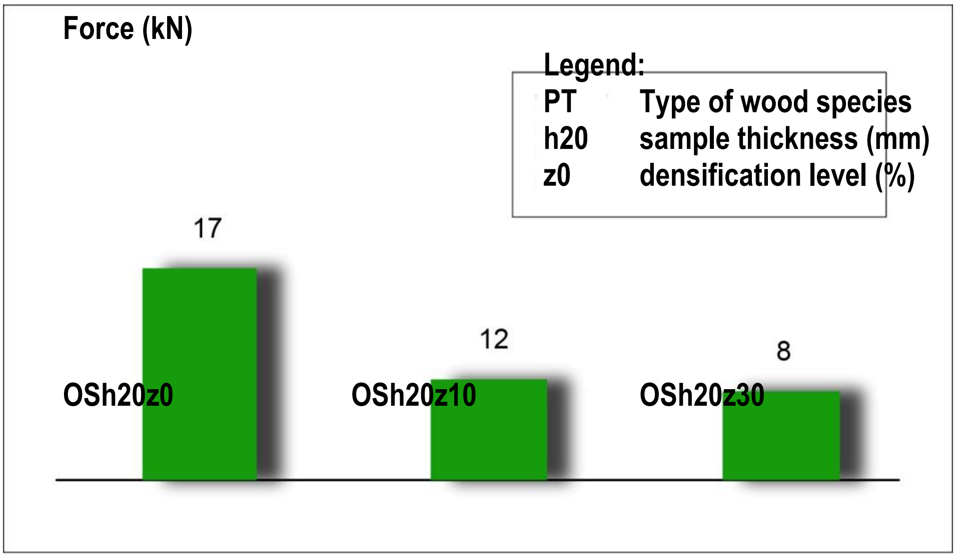

Fig. 7 Effect of force on solid samples of Populus tremula

It accrues from the measured average values of deformation at the proportional limit (mm) of the samples, that the elastic deformation achieved at non-densified sample of Populus tremula is 1,4 mm. With the increase in densification, we can observe slight increase in deformation, which can also be seen in the chart (Fig. 9).

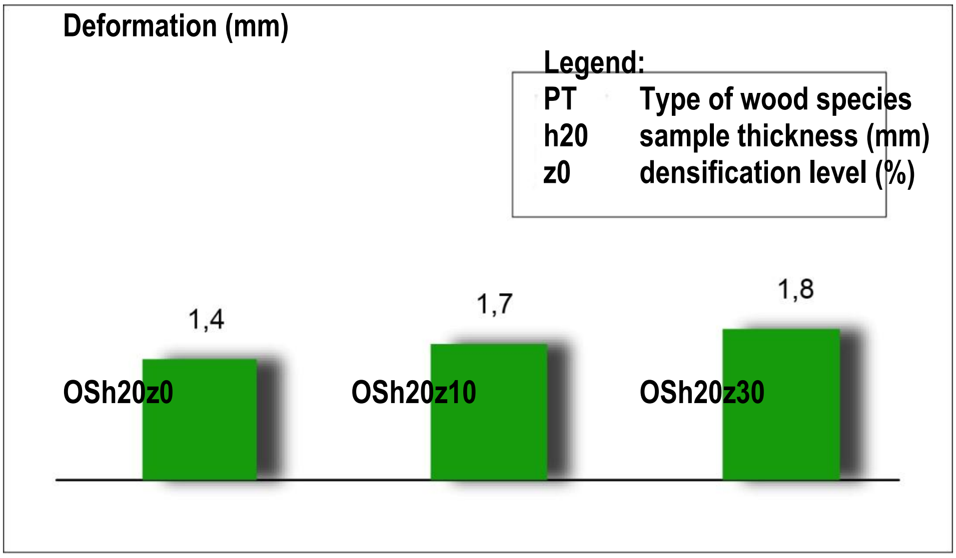

Fig. 8 Deformation of solid samples of Populus tremula

5. CONCLUSION

The capacity of wood to resist certain load – tension is one of the characteristics, which plays an important role in practice. Resistant and hard material, either solid or engineered, assumes the achievement of the highest possible proportional limit.

The options of optimal utilization of modified material properties were examined.

By executed measurements, we reached the conclusion that if the highest possible strength under pressure of material is to be achieved, the proportional limit has to as high as possible.

Based on the analyses, a lower strength under pressure was found for densified samples, expressed by the proportional limit. Therefore it accrues from the results of the paper, that we do not achieve higher strength under pressure perpendicular to the fibers in radial direction by densification.

Analyses did not prove better capacity for mechanical damage resistance of Populus tremula after the densification, densified Populus tremula therefore is not ideal for use as a treading layer of flooring. The use of non-densified sample is the most advantageous for the use of Populus tremula wood in flooring.

BIBLIOGRAPHY

1. BRUTOVSKÝ, T. 2013. Pružnostné vlastnosti lamelových materiálov na báze dreva a nedrevených komponentov. M.S. thesis, Technical University in Zvolen, Zvolen, Slovakia.
2. DUBOVSKÝ, J. – BABIAK, M. – ČUNDERLÍK, I. 2001. Textúra, štruktúra a úžitkové vlastnosti dreva. 3. vyd. Zvolen: Technická univerzita, 2001. 106 pp. ISBN 80-228-1014-2.
3. GAFF, M. , ZEMIAR J., 2006: Analýza vplyvu vybraných faktorov na tvarové a rozmerové zmeny reliéfu a kvalitu jeho povrchu. In Trieskové a beztrieskové obrábanie dreva 2006 : V. medzinárodná vedecká konferencia : zborník prednášok. - Zvolen : Technická univerzita vo Zvolene, 2006. - ISBN 80-228-1674-4. - pp. 119-128.
4. GAFF, M. , ZEMIAR J., 2008: Vplyv vlhkosti dreva a ohrevu lisovacieho nástroja na tvarovú stabilitu a kvalitu nerovnomerne zlisovanej plochy osikového dreva. In Trieskové a beztrieskové obrábanie dreva 2008 : VI. Medzinárodná vedecká konferencia, 11.-13. September 2008 Hotel Thermal, Štúrovo : zborník prednášok. - Zvolen : Technická univerzita vo Zvolene, 2008. - ISBN 978-80-228-1913-8. - S. 315-320.
5. GAFF, M., GÁBORÍK, J., 2009: Vlastnosti povrchu dreva modifikovaného reliéfovaním, Zvolen : Technická univerzita vo Zvolene, 2009. - 80 pp. ISBN 978-80-228-2035-6
6. GAFF, M., ZEMIAR, J., KORISTOVÁ, E., 2010: Tvarová a rozmerová stabilita povrchu dreva modifikovaného lisovaním – reliéfovaním. Zvolen : Technická univerzita vo Zvolene, 2010. - 75 pp. : 65 obr., 6 tab. - ISBN 978-80-228-2107-0
7. POŽGAJ, A. 1987. Metódy zisťovania mechanických vlastností dreva a drevných veľkoplošných kompozitných materiálov. Zvolen: Vysoká škola lesnícka a drevárska, 1987. 170 pp.
8. SVITÁK, M., BARCÍK, Š., RYSPLER, J. Application of Carbon Fibers on Wood Beams. Acta Facultatis Xylologiae Zvolen. 2013. pp. 5 - 13. 55 (2). ISSN: 1336-3824
9. SVITÁK, M., GAŠPARÍK, M., PENC, J. Heat resistance of glued finger joints in spruce wood constructions. Bioresources. 2014. pp. 7529 – 7541. 9 (4). ISSN: 1930-2126.

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CONSUMERS OF WOOD BIOMASS IN THE SLOVAK REPUBLIC

Vladislav Kaputa, Roman Sucháň

ABSTRACT

The paper deals with the assessment of wood biomass consumption on the market in Slovak Republic. Wooden biomass in Slovakia is appointed for the consumption in the pulp and paper industry, production of wood-based panels and energy utilization. Consumption of biomass for the three competing sectors is analysed in country range including the comparison of prices of the pulp wood and wood chip. The results showed that despite the more favourable price of wood chip in a certain period, the pulpwood remained still attractive and highly demanding input for a variety of market subjects.
Key words: wood biomass, pulpwood, wood chips, pulp and paper industry, energy sector.

1. INTRODUCTION

There are many specifics influencing production and consumption patterns in the domestic market. On one hand, timber production is subject to available resources, which are the result of long-term forest management and long-term planning. Timber production has been recently influenced by the high proportion of accidental felling. On the other hand, timber production tries to adapt to rapidly changing market conditions and the requirements of wood processing sectors that vary over a relatively short period of time (Parobek, Paluš, Šupín, Kaputa, 2014).

Wood biomass is a product consists of ligneous mass or part of ligneous vegetal mass come from forestry, agriculture, wood processing industry or other sources, e.g. municipal sphere (Lieskovský et al., 2009). Public usually perceive the term wood biomass as something appointed for energy uses (heating and power) also due to loudly environmental policy. But there are other two significant industry consumers demanding wood biomass as an input for specific wood products production. Besides of energy utilization is wood biomass in Slovakia also chemically as well as mechanically processed in pulp and paper industry, respectively in agglomerate materials production. Hence, the market meets demand of three major industry consumers (excluding exporters and consumption in the private sector). Majority of demand aimed at the same input assortments. This fact causes pressure on the price, insufficient availableness of supply and changes in the input assortments into above mentioned sectors (Kaputa, Sucháň, 2012).

After the year 2000 wood processing capacity in Slovakia increased significantly and improved domestic wood consumption. The highest economic growth was recorded during the years before the economic and financial crisis (driven by the global economic growth, Slovakia's accession to the EU etc.). Different sectors within the industry started to develop variously, reflected to domestic and foreign conditions (Paluš, Parobek, 2011). In line with the EU target of a 20% share of energy from renewable sources by 2020, Slovakia committed to increase its share of renewable energy sources to 14% by 2020. However, there has not yet been established a comprehensive legislative and conceptual framework supporting the systematic production of fuel wood biomass in the forest and non-forest land and its energy use (Paluš, 2013). The principal operator in the Slovak Republic – state forest enterprise has partially responded to the strategy of the production of biomass as a renewable energy by setting up a regional biomass centre that focuses on the production of energy biomass, particularly the production of fuel wood, energy wood and wood chips (Šupín, 2013). Although wood biomass is a product which comes from different sources (forestry, agriculture, watercourses management, municipal activities) the most demanding are recently wood chips coming from pulpwood as well as wood residues which come from wood processing industry. Wood residues are generated by primary and secondary manufacturers, users of wooden pallets and containers, wholesalers and retailers of wood products, and construction and demolition of residential and commercial properties. Generally, the wood processing industry considered wood residues for waste in a past. Nowadays, the residues are considered to be co-products alongside with the main products. Wood residues are those co-products which come from industrial processing of wood – represented mainly by woodchips and residues such as bark, trimmings, split wood, planer shavings, sanderdust (produced during the abrasive sanding of lumber, plywood and particleboard and due to its size and very low moisture content it is well suited for direct firing) and sawdust.

Except the pulp and paper industry shows an extensive interest in pulpwood also the energy sector. Uncontrolled increase of consumption of plants burning wood biomass have formed increasing demand mainly for pulpwood (but also the assortments of higher quality), which largely substitute biomass for energy purposes. Relatively high-quality characteristics of pulpwood, sorted as the fifth quality class, should not be used in the energy sector. This statement is confirmed by the fact that the national economy enriches the production of products with higher added value. According to Parobek et al. (2014) at the present time, besides pulp and paper industry, forest industry producing higher added value (e.g. final wood commodities such as furniture, wood construction, etc.) is still unable to compete on the European markets. Apart from the economic benefits, socio-economic dimension is also important. Processing of 1 m³ of wood in the pulp and paper industry brings jobs for 6-7 employees, while in the energy sector it is 1-2 employees. In this way it is possible to create five jobs in addition. Therefore consumption of higher quality assortment of wood for energy purposes should not be (currently so widespread) alternative.

2. METHODOLOGY

The analytic and synthetic methods were used to assess the market situation. All the data (variables) used in graphs, tables and formulas comes from market environment and reflect the market reality based on permanent observing. In the analytical part the consumption of biomass is reviewed for each of the three competing sectors, as well as for the individual regions in the Slovak Republic, based on the analysis of the market. Comparison of the pulpwood and wood chip recalculated prices is based on introduced formulas and is expressed by conversion at the unit atro ton (tA). On the basis of the prices comparison and market information, synthesis has been done.

3. ANALYSIS

As mentioned, there are three dominant sectors creating major demand for wood biomass in the Slovak Republic: 1) Pulp and paper industry, 2) Producers of wood based panels and 3) Energy sector. Individual representatives of each sector are alongside competitors in purchase of inputs. Table 1 introduces key inputs and outputs as well as the biggest producers (in term of volume) of each sector in the Slovak Republic.

Besides of traditional inputs into specific sectors introduced in Table 1 also other wood assortments are utilized. Enormous demand for pulpwood from all the major industrial consumers in Slovakia led to the lack of supply in last five years. It is compensated by import, but also situation that assortments of higher quality classes are processed into chips, especially sawlogs.

Table 1. The key sectors consuming wood biomass in Slovakia

SECTOR	INPUTS	OUTPUTS	MAJOR PRODUCERS / Approx. annual consumption of pulpwood (2014)
PULP AND PAPER INDUSTRY	➢ Pulpwood (dominantly non-coniferous) ➢ Wood residues	➢ Paper ➢ Cellulose ➢ Energy from incineration of dissolved organic parts of wood	➢ Mondi SCP, a. s. in Ružomberok / 2 070 thousand m³ ➢ Bukóza Holding, a. s. in Hencovce / 300 thousand m³
PRODUCERS OF WOOD BASED PANELS	➢ Wood chips ➢ Wood residues (e.g. scrapwood / slabwood, sawdust) ➢ Pulpwood (dominantly coniferous)	➢ Wood-based panels	➢ Bučina DDD, s.r.o. in Zvolen / over 232 thousand m³ ➢ Ikea Industry Slovakia s.r.o. in Malacky (Sweedspan Slovakia) / 375 thousand m³
ENERGY SECTOR	➢ Fuelwood ➢ Wood chips ➢ Pulpwood	➢ Production of electricity ➢ Production of heat	➢ Dalkia, a.s. in Žiar nad Hronom / 130 thousand m³ ➢ Energy Edge ZC, s.r.o. in Žarnovica / 80 thousand m³ ➢ Zvolenská teplárenská, a.s. in Zvolen / 60 thousand m³ ➢ DAH Biomasa, s.r.o. in Bardejov and in Topoľčany / 60 and 45 thousand m³

Note: An abbreviation “s.r.o.” means Ltd. An abbreviation “a. s.” means S. A. Both designate to a type (a legal form) of corporation.

Table 2. Consumption of wood biomass (in tons) according to the regions of Slovakia (Note: Year 2013 – missing data)

	2010	2011	2012	2014
Košice region	20 000	50 000	50 000	70 000
Prešov region	184 000	334 000	384 000	303 000
Žilina region	512 700	548 700	638 700	567 500
Banská Bystrica region	203 000	348 000	658 000	344 500
Trnava region	15 000	15 000	15 000	10 000
Trenčín region	71 000	116 000	116 000	116 000
Nitra region	37 000	137 000	137 000	122 000
Bratislava region	12 000	30 000	30 000	26 000
Small consumers	15 000	20 000	40 000	40 000
TOTAL (tons)	**1 069 700**	**1 598 700**	**2 068 700**	**1 599 000**

Table 2 shows natural disparities in consumption within individual regions given by distribution of the biggest wood biomass processors throughout the country (Table 1 introduces some of them). Overall consumption of wood biomass doubled in 2012 comparing the year 2010 (Figure 1). Significant decrease of consumption is noted in 2014 comparing the year 2010 caused mostly by project and technological problems of companies in energy sector. Planned capacities of new established plants had not been achieved. Moreover, some consumers finished operation (Smrečina Hofatex, a. s.) and decrease had magnified relatively warm weather during winter season at the beginning of the year 2014.

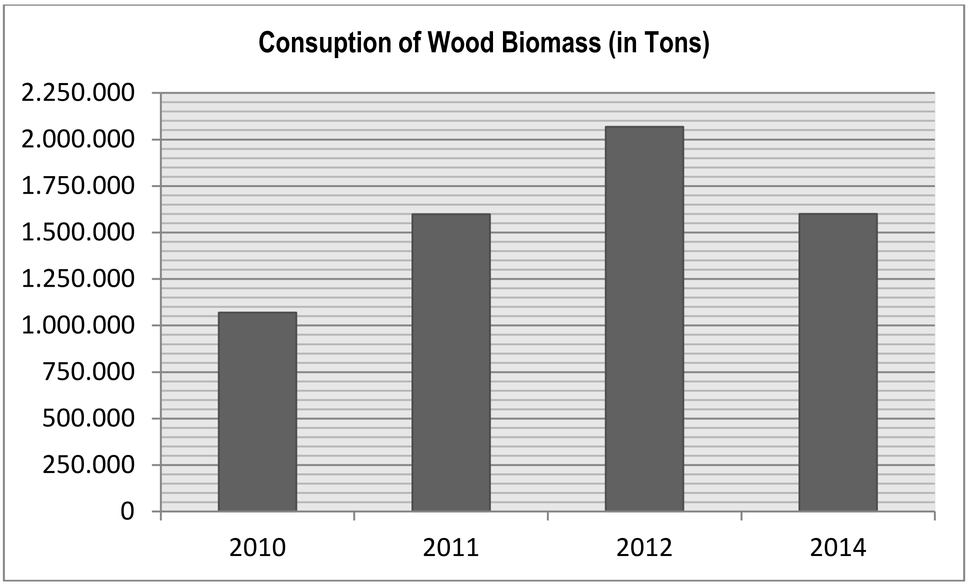

Figure 1. Consumption of wood biomass in Slovakia (Note: Year 2013 – missing data)

There was lack of supply magnified by export, resp. foreign purchase two years ago. It contributes to a growth of the wood biomass prices on the Slovak market. Significant influence had demand and purchase power of Austrian importers. This situation changed since 2014 due to a development on domestic and foreign markets. Regional market have been influenced by:

- Calamities across the Central Europe
- Development on Austrian wood biomass market (technology breakout of pulp producer in Austria and oversupply of wood biomass caused by calamity in Slovenia)

In Austria, considerable disruption in the technology happened to significant pulp producer in 2014. Due to this breakdown, consumption of wood fell by about 500-700 thousand m³ per year. Reductions of inputs into the production process (especially pulpwood) led to the reduction in pulpwood prices on the market. Saturation of wood market in Austria is enhanced also by abiotic calamity in Slovenia from the beginning of 2014 – over 3 million cubic meters of wood (40% of forestland in Slovenia). The consequence is decreasing demand and pressure of companies involved in importing wood biomass into Austria from traditional countries such as the Czech Republic, Hungary, Ukraine and Slovakia at least in the short term. It also confirms the behaviour of traditional exporters for the period of the second quarter of 2014. Moreover, calamity in Slovakia (Zofia) from the middle of 2014 caused increasing supply not only on the domestic market. These facts influenced wood market situation in the whole Central-European region.

Comparison of pulpwood and wood chips prices

Since 2012, the price of pulpwood has changed significantly over the price of energetic wood chips. In 2012, recalculated price (to atro tons) of pulpwood was lower than the price of energetic wood chips. It could be saved about 7.90 Euro by purchase of one atro ton of pulpwood (Kaputa, Sucháň, 2012). A change occurred in the first quarter of 2014 when market recorded decline in price of wood chips accompanied with rise of pulpwood price. The main reasons included in particular:

- Mild winter which caused lower consumption.
- Technologies of new consumers on the market (not in the expected condition and state) had not achieved their capacities.

- Rising demand influenced by launching of "additional resources" on the market (white areas, transmission lines, etc.).

Regardless the price of pulpwood in 2014 have increased, the demand remained strong reflecting its market attractiveness for different sectors. In 2015, the pulpwood market price fell from the previous year to 36 Euro per m^3 due to an increase of supply.

Table 3. Price development of pulpwood and energetic wood chips

	2012	2014	2015
Price of pulpwood (Euro/ m³)	36	41	36
Price of (energetic) wood chips (Euro/ton)	48	46,5	46,5

Comparison of the prices of pulpwood and (energetic) wood chips allows to understand more deeply the issue of demand for these kinds of wood biomass. A comparison is expressed by conversion at the unit atro ton (tA).

Recalculation of pulpwood price in 2015:
Market price is **36 €/m³** (price of pulpwood) **+ 8 €/m³** (transport) **+ 6 €/m³** (chipping) **= 50 €/m³ DAP**[17]

Recalculation to atro ton (tA): $\frac{50\ €/\mathrm{m}^3}{0{,}630\ \mathrm{kg/m}^3} = 79{,}37\ €/\mathrm{tA}$ *Formula 1*

Volume weight of beech: 0,630 kg/m³

Note: Variables are rounded, but the final price corresponds to the market reality. E.g. the real price for transport is about 3 % lower (approx. 7,76 €/ m³) comparing to 2014 (changes in excise tax and exchange rate of Euro/US dollar).

Recalculation of (energetic) wood chips price in 2015:
Market price is **46,5 €/t DAP** with the moisture 45 % (it means that price is divided by 0,55)

Recalculation to atro ton (tA): $\frac{46{,}5\ €/\mathrm{t}}{0{,}55} = 84{,}55\ €/\mathrm{tA}$ *Formula 2*

Recalculated prices (by given conditions) demonstrate that 5,18 € is saved by purchase of one atro ton of pulpwood instead of the same amount of wood chips.

4. CONCLUSIONS

There is an extensive wood biomass market distortion due to the (financial) support tools for consumers of biomass for energy purposes, the sharp increase in consumption of wood biomass, insufficient knowledge of the market, lack of experience in logistics and in the process of wood acceptance etc. It resulted, inter alia, into the rising share of wood intended for incineration. This volume of wood is lacking in capacities of pulp and paper industry as well as manufactures of wood-based panels. The wood processing industry tries to look for partial refund at sawmill assortments of wood on which is developing similar pressure as the energy industry for pulpwood. This way leads to a distortion at the sawlog assortments market and further pressure on the ever decaying processing capacities, particularly hardwood processors. This phenomenon has mainly the following negative effects:

[17] DAP - Delivered at Place (Incoterms 2010)

- Failure to respect the principle of "cascading wood consumption." Consumption of wood for producing lower added value is given priority over consumption with higher added value (impact of market distortion)
- Increasing negative carbon balance. By fast burning it is released an amount of carbon bound in wood for 50 years (and more). Carbon storage in forests and its following storage in products of the wood industry make a significant contribution to reducing negative carbon balance.
- The pressure on the prices of pulpwood and sawlogs assortments based on distorted prices of the energy sector and the needs of some stakeholders. It subsequently causes deterioration of the economic situation of wood industry companies.
- The systematic liquidation of the traditional industry bearing potential of employment and the creation of added value.

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REFERENCES

1. Kaputa, V., Sucháň, R. (2012): SLOVAK WOOD BIOMASS MARKET. In Intercatherda 28/1 : Annual Bulletin of Plant – Economic department of the European Wood Technology University Studies, Poznań, 2012. ISSN 1640-3622, p. 24-30.
2. Lieskovský, M., et al. (2009): ENERGETICKÝ POTENCIÁL VYBRANÝCH DRUHOV DISPONIBILNEJ BIOMASY LESA. TU Zvolen. ISBN 978-80-228-1988-6. 73 p.
3. Paluš, H. (2013): Trh a obchod s drevom a výrobkami z dreva. Zvolen : TU. 225 s. ISBN 978-80-228-2587-0.
4. Paluš, H., Parobek, J. (2011): CHANGES IN COMPETITIVENESS OF SELECTED CLUSTERS IN THE SLOVAK FOREST SECTOR. In Development trends in economic and management in wood processing and furniture manufacturing : international scientific conference. University of Ljubljana, 2011. ISBN 978-961-6144-31-5. p. 155-159
5. Parobek, J., Paluš, H., Kalamárová, M., Loučanová, E., Dovčíková, A. (2014): SLOVAK FOREIGN TRADE WITH INDUSTRIAL ROUNDWOOD. In Position and role of the forest based sector in the green economy. Zagreb : WoodEMA, 2014. ISBN 978-953-57822-1-6. p. 118-122.
6. Parobek, J., Paluš, H., Šupín, M., Kaputa, V., 2014: ANALYSIS OF WOOD FLOWS IN SLOVAKIA. BioResources 9 (4) 6453-6462.
7. Peck, T. (2001): TIMBER TRADE. Woodhead Publishing Ltd. ISBN 1-85573-190-8.
8. Šupín, M. (2013): Slovak and EU market with wood pellets. In Intercathedra No. 29/2. ISSN 1640-3622. p. 74-81.

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WOOD PELLET GLOBAL MARKET DEVELOPMENT

Mikuláš Šupín

ABSTRACT

This paper deals with the analysis of the global wood pellet market. Wood pellets are generally made of compressed sawdust or other residuals from sawmilling and manufacturing other wood products, though an increasing proportion of raw material for pellets now comes from round wood thinnings and harvest residues. Wood pellets are cleaner burning, have a higher energy density, and are easier to handle than firewood wood chips, or other forms of wood fuel. Wood pellets are one of several processed biomass feedstocks that are traded internationally and used for energy. There is also significant informal trade in solid biomass, which takes place regionally and across national borders.

Key words: wood pellet, biomass, international trade, market.

1 INTRODUCTION

Rapid deployment of renewable energies plays an important role in efforts against global warming and strengthens the security of energy supply. The global use of renewable energy has almost doubled in absolute terms between 1973 and 2008, but it is still only about 13% of the global energy consumption. Among the renewable energy sources biomass plays a specific role. It covers about two thirds of all renewables and is the fastest growing sector in absolute terms. [2], [8].

A variety of different biomass raw materials can be used for energy purposes. Many different conversion technologies are available to transform primary energy from biomass to heat, electricity or transportation fuels. The use of biomass and the potential for further development is closely related to forestry and agriculture and to the energy sector. Currently, biomass, mainly wood and wood energy products is the main from renewable sources for heat production. [7].The increasing demand in this field leads to a shortage of high-quality wood as a raw material. Concurrently, raw material prices and fuel costs are increasing and the attractiveness of renewable energy solutions compared to fossil fuel heating are increasing too. [6]. Forestry and wood-based industries produce wood, which is the largest resource of solid biomass. Biomass procurement logistics from forest to bioenergy plants are the subject to major improvements. The sector covers a wide range of different resources with different characteristics - wood logs, bark, wood chips, sawdust and more recently pellets. [4]. Pellets, due to their high energy density and standardised characteristics, offer great opportunities for developing the bioenergy market worldwide. As demand for wood increases from both wood processing industries and the energy sector, the question of whether there is enough wood is of great concern nowadays. [1]. In order to understand how much wood is available, it is essential to know how much wood is as a growing stock in the forests and how much is removed. Wood for use as an energy source comes not only from tree felling, but also from selective thinning of managed forests and other forestry practices (direct sources). Wood for energy use may also be derived as a by-product from downstream processing in wood-based manufacturing, for example, as off-cuts, trimmings, sawdust, shavings, wood chips or black liquor (indirect sources). End-of-life wood and paper products may also be used as a source of energy (recovered wood). [5].

2 WOOD PELLETS PRODUCTION AND CONSUMPTION

Global perceptions of renewables have shifted considerably over the past decade. Continuing technology advances and rapid deployment of many renewable energy technologies have demonstrated their immense potential. Most primary biomass used for energy is in a solid form and includes charcoal, fuel wood, crop residues (predominantly for traditional heating and cooking), organic municipal solid waste (MSW), wood pellets and wood chips (predominantly in modern and/or larger-scale facilities). [6]. Wood pellets are made mostly of dried and densified sawdust, shavings or wood powder. Pelletization is currently the most economic and energy saving ways to convert biomass into a fuel with high energy density and consistent quality. For this reason it is one of the fastest growing forms of upgraded biomass mainly in Europe but also worldwide. [11].

Wood pellets are a clean, CO2 neutral and convenient fuel, mostly produced from sawdust and wood shavings compressed under high pressure using no glue or other additives. They are cylindrical in shape and usually 6-10 mm in diameter. The average length is about 10-30 mm. Furthermore, due to their high energy content the convenient delivery and storage features, pellets are the ideal fuel for fully automatic small scale heating systems. With a rapidly growing share in the market, they are a key technology for increasing biomass utilisation in Europe. In the last few years pellets are increasingly used in power plants for co-firing. Pellets are also an excellent way of using local resources, thus making a concrete contribution to environmental protection and climate change prevention. [12].

The increasing popularity of biomass combustion leads to a higher demand of wood fuels, and consequently to a stronger competition for this raw material with other sectors of industry. The demand for wood biomass has undergone significant changes. Behind of rapidly growing consumption are not only traditional industrial sectors as pulp and paper and agglomerated wood based panels' producers, but also subjects of energy sector utilising wood biomass as an input. Wood pellets and wood chips, as well as biodiesel and ethanol, all are now commonly traded internationally in large volumes. In addition, some bio-methane is traded in Europe through gas pipelines. There is also significant informal trade in solid biomass that takes place regionally and across national borders. [3].

Pellets can be used both for residential and commercial heating and for power production. Pellets can be used in large pulverized fuel or circulating fluidized bed power plants. These plants can be operated in co-firing mode with coal, be retrofitted from coal up to 100 % wood pellets or be newly built. The two first options allow to replace large amounts of fossil fuel by renewable fuel within a short period of time. [12].

Tab. 1 World Wood Pellet Production Development 2000 – 2013 (in millions of tons)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Production in MT	1,75	2,21	2,67	3,12	4,23	5,23	7,61	9,72	11,73	14,52	15,71	18,3	21,2	24,6

The total energy content of all solid biomass fuels traded (mainly pellets and wood chips) remains about twice that contained in the net trade of liquid biofuels. Global pellet production reached 24.62 million tons in 2013, an increase of nearly 14 % over 2012 volumes. The EU accounted 50 % of global production, followed by North America (31 %). Companies in Canada and the United States were busy building new pellet production facilities to keep up with European demand. The 2013 shipments were up 50 % over 2012 and almost double those of 2011, reaching a value of more than USD 650 million. [9], [10].

Tab. 2 World Pellet Production/Consumption in 2013 (in millions of tons)

Region	EU 28	North America	Asia	Russia	Rest of World
Production MT	12,21	7,52	2,14	1,62	1,13
Consumption MT	18,32	2,73	0,91	1,04	0,31

During 2013, a large number of companies were actively engaged in supplying equipment and bioenergy plants that convert solid biomass - mainly wood chips and pellets - to heat and electricity. Businesses in the United States, Europe, Asia and elsewhere were busy constructing new biomass heat and power plants.

3 WOOD PELLETS TRADE

In 2000, trade in wood pellets was almost non-existent. The wood pellet market has experienced a large growth in the last years. However, in volume terms, world trade of wood pellets has now grown to surpass that of ethanol and other bio-based fuels. Europe is currently the leading market for trade in wood pellets. The EU is the main consumer of wood pellets as well as a major producer. There is a high volume of wood pellet trade among EU member countries. The EU has a much larger wood pellet production than the United States or Canada but still requires imports of wood pellets in order to satisfy the demand. Europe is a net importer.

The international market increased more than 200 percent between 2002 and 2006, shooting global production from 8 million tons in 2007 to more than 13 million tons in 2009 and 24.6 million tons in 2013. The production and trade of wood pellets as a renewable energy source have increased significantly since 2008. The USA has become a significant producer and biggest exporter of wood pellets, primarily to the European Union. Wood pellet demand is also increasing in Korea and Japan. Those countries also seek to increase use of renewable energy.

Most wood pellets that are traded globally are used for electricity generation. In the EU, residential heating accounts for the largest share of pellet demand, but there is a large and growing demand for imported wood pellets to produce electricity. World wood pellet demand were in power (power plant, CHP) 7.6 million tons and in heating (residential, commercial, district heating) 17 million tons in 2013. To meet this growing demand, the EU imported around 6.2 million tons in 2013. About 77 % of total imports were from North America (an increase of 50 % over 2012), and much of the remainder came from Russia and Eastern Europe.

Currently, bioenergy markets (including wood pellets market) are largely influenced by national policies, mainly in the EU. Apart from the impacts of energy policy and existing import duties and taxes, the trade dynamics for the bioenergy industry are influenced by three general factors: feedstock prices, sustainability governance (and legislation), and local economic reality. These issues are intertwined with each other and hence it is important to look into each aspect not only separately, but also collectively to see the opportunities and challenges that may determine the trade dynamics.

The trade dynamics of liquid and solid biofuels are significantly different. The liquid biofuels markets are reasonably developed markets and are closely related to agriculture commodities, therefore the markets are highly complex. The market is less complex and trade dynamics are more straightforward for solid biofuels. The main market is the EU. Main driver of development, mainly in the EU, are national support policies mostly for the promotion of renewable electricity production and residential heating. It is still too early to discuss the impacts of new sustainability requirements within as using are still reacting to the policies.

Tab. 3 World Wood Pellets Trade Follows in 2012 and 2013 (in millions of tons)

Region	Canada	USA	Russia	Belarus Ukraine	Other
	To EU				
2012 MT	1,35	1,77	0,65	0,33	0,19
2013 MT	1,92	2,77	0,70	0,28	0,45
Change in %	+ 43	+ 57	+ 8	- 15	+ 237

Region	Canada	USA	Russia	China	Malaysia Indonesia	Thailand Vietnam
	To Asia					
2012 MT	0,07	0,00	0,04	0,00	0,04	0,04
2013 MT	0,15	0,03	0,08	0,02	0,11	0,17
Change in %	+ 114		+ 99		+ 175	+ 325

It is also important to consider that most wood pellets procurement strategies involve long term contracts. Therefore trade flows are unlikely to change on short notice. There is also a tendency for utilities to carry out vertical integration for solid biomass operations. Due to the nature of the market, solid biofuels consumers, in particular wood pellets buyers have been working on harmonizing the existing certification schemes and systems. Beyond sustainability considerations, harmonization of technical aspects and quality specifications is also one important consideration, which requires coordination and harmonization. By putting effort in integrating diverse existing systems and regulations requirements, the industry players aim to create a commodity market for solid biofuels. Due to the vertical integration and harmonization effort, sustainability certification is less likely to become a trade barrier in the future.

4 CONCLUSIONS

The international trade with wood and wood products may expand and can have a significant impact in some markets or market segments including pellet market. In recent years the bioenergy market has increased in importance, and international trading of biomass feedstocks and biofuels has expanded. The deciding factor will be consumer reaction to the products which is far from clear at this stage. The use of renewable energy sources for heat production has increased significantly during the past years, and according to the rising energy demand and the prospective climate targets a further increase in this field can be expected. Wood pellets and wood chips, as well as biodiesel and ethanol, all are now commonly traded internationally in large volumes.

During the past decade, the global trade of wood pellets has been growing - great world expansion. Pellet market is becoming a world market. Rapid increases in the production and consumption of wood pellets and predictions on its increased demand in the near future have formed a competitive global market.

The European Union is still the main market for wood pellets and will remain as such for the next several years. The production of wood pellets in EU increased, reaching 12.21 million tons in 2013, near 50 % of the global production. In the same period EU wood pellet consumption increased to reach over 18.32 million tons in 2013, 79 % of the global wood pellet demand.

Wood pellets dominate in international trade in wood energy. About one-thirds of all those produced pellets worldwide are fired in power plants in the EU. The main exporters are and will be the USA, Canada, the Russian Federation and the some Eastern Europeans countries by 2020. In coming years Australia, Mozambique, South Africa, and several countries of Latin America are expected to become exporters of pellets. Belgium, Denmark, the Netherlands, Sweden and the UK are and will be the main importers of industrial pellets. The Netherlands serves as an import hub for northern Europe. The EU has mandated 20 percent of energy consumption must come from renewable resources by 2020. The EU demand could range between 25-50 million tons by 2020, depending to a large extent on a) the energy policies on cofiring in the UK, Netherlands, Germany and Poland, and b) on the price of heating oil and the related attractiveness to switch to wood pellets for small-scale users (households and medium-sized residential buildings).

The EU is very likely to remain the largest wood pellets consumer in the world, but East Asia is going to show a very strong growth and may be a close second position in 2020. East Asian demand strongly depends on policy developments in Japan and South Korea. Demand in the USA will probably remain limited to small scale use in households, and will not use pellets on a large scale for industrial purposes. One crucial factor will be the price of heating oil and gas.

Dry residues from sawnwood production have historically been the main feedstock for wood pellet production due to low prices, no need for thermal drying of the feedstock and a relatively homogenous composition. Such feedstock also gives low ash contents. Declining activity in the sawnwood industry has reduced the availability of feedstock for many wood pellet plants. The transition from smaller pellet plants using dry feedstock to larger plants using wet feedstock in future, pellet production can be expected to follow comparative advantages, especially regarding feedstock and energy costs, but also with respect to economies of scale. Increased production in the medium term will probably take place in larger mills based on pulpwood which offers more secure biomass supply compared to dry residues. Long term development of production, consumption and demand wood pellets also depends on the development biofuels, bio-refineries and other technologies for renewable power production as well as the development in the forestry and wood processing industry.

REFERENCES

1. AEBIOM (2015): Statistical Report 2014. Brussels, Belgium: AEBIOM - European Biomass Association.
2. Cocchi, M. et al. (2011): Global Wood Pellet Industry Market and Trade Study. IEA Bioenergy Task 40: Sustainable International Bioenergy Trade. Etaflorence Renewable Energies, 190 p.
3. Goetzl, A. (2015): Developments in the Global Trade of Wood Pellets. Office of Industries US International Trade Commission.No.ID-039.
4. Paluš, H., Parobek, J., Kaputa, V. (2014): The role of forest certification in the European timber regulation.-WOS. In Position and role of the forest based sector in the green economy: proceedings of scientific papers / Zagreb: International Association for Economics and Management in Wood Processing and Furniture Manufacturing - WoodEMA, 2014. - ISBN 978-953-57822-1-6. p. 111-117.
5. Paluš, H., Maťová, H., Kaputa, V. (2012): Consumer preferences for joinery products and furniture in Slovakia and Poland. ITMS 26220120049. In Acta facultatis xylologiae Zvolen: vedecký časopis Drevárskej fakulty. - ISSN 1336-3824. - Roč. 54, č. 2, s. 123-132.
6. Parobek, J., Paluš, H., Kaputa, V., Šupín, M. (2014): Analysis of wood flows in Slovakia /. - Spôsob prístupu:http://www.ncsu.edu/bioresources/BioRes_09/BioRes_09_4_6453_Parobek_PKS_Analysis_Wood_Flows_Slovakia_5713.pdf. - Popis urobený: 20140917. - Zverejnené na internete: 20140909.
   In BioResources [online]. - ISSN 1930-2126. - Vol. 9, no. 4 (2014), p. 6453-6462.
7. Parobek, J., Paluš, H., Kalamárová, M., Loučanová, E., Dovčíková, A. (2014): Slovak foreign trade with industrial roundwood - WOS. In Position and role of the forest based sector in the green economy : proceedings of scientific papers / Zagreb : International Association for Economics and Management in Wood Processing and Furniture Manufacturing - WoodEMA, 2014. - ISBN 978-953-57822-1-6. p.118-122.

8. Sikkema, R. et al. (2011): The European wood pellet markets: current status and prospects for 2020.Biofuels, Bioproducts and Biorefining 5(3), p. 250-278.
9. Eurostat. (2015): Available at: http://epp.eurostat.ec.europa.eu; [cit. 15.05.2015].
10. http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Renewable_energy_statistics
11. http://pelletsatlas.info/pelletsatlas_docs/showdoc.asp?id=090826102915&type [cit. 2015.03.12]
12. http://www.aebiom.org/ [cit. 2015.06.02]

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CHANGES IN ENERGY WOOD SUPPLIES IN THE SLOVAK REPUBLIC

Hubert Paluš

ABSTRACT

This paper deals with the analysis of structure of supplies of energy wood produced and supplied by forest owners in Slovakia. Development of deliveries of wood fuel and energy chips is analysed during the time period 2000-2013. Based on the economic theory of supply a simple econometric model is presented showing the basic relationships between the supply of energy chips, its price and supply of other complementary products.

Key words: energy wood, deliveries, supply, econometric model

1. INTRODUCTION

Forests cover approximately 2 million ha in Slovakia, i.e. 41 % of its territory with the tree species composition consisting roughly of 40 % coniferous and 60 % broadleaved tree species. According to the MPaRVSR (2014) the total growing stock is approximately 475 million m^3. The category of commercial forests, counting for 81 % of the planned timber felling, is crucial for timber production.

The forest industry has experienced many important changes during last twenty years. After the year 2000 wood processing capacity in Slovakia increased significantly and improved domestic wood consumption (Kaputa and Sucháň 2012). In 2013, total felling was 7,837,067 mil. m^3 and it dropped by 4.8% compared to 2012. The current volume and assortment structure of felling is the result of large-scale accidental felling due to the action of harmful agents. The proportion of incidental felling in coniferous forest stands is in the long term around 80 % of the total coniferous wood felling.

In the roundwood supply chain, assortment process is one of the most important operations. This process decides how and where timber will be use. From the technical point of view, only certain qualities of wood can be used for specific purposes. According to the valid Slovak Technical Standards (STN 48 0055 Qualitative classification softwood round timber, STN 48 0056 Qualitative classification hardwood round timber) roundwood is categorised into timber assortments. The criteria for classification are based on the tree species, timber dimensions (length and diameter) and the presence of wood defects (quality). Each quality class includes timber for particular use within industrial processing or for the final use. For coniferous and non-coniferous wood, these standards distinguish the following quality classes of assortments:

I. quality class - veneer logs (used for production of sliced veneer)
II. quality class - veneer logs (used for production of rotary cut veneer)
III. quality class – sawlogs
IV. quality class - posts, pit props, poles
V. quality class - pulpwood for chemical and mechanical processing
VI. quality class - fuel wood

Assortments in the first three classes (I.-III.) represent logs, quality class IV. stands for other industrial roundwood and quality class V. for pulpwood. Whole those classes are classified as industrial roundwood. The last quality class is fuel wood – a specific assortment of roundwood that is utilised for energy purpose. However, if the international classification is considered, fuel wood is part of energy wood category together with charcoal, wood residues chips and particles etc. Apart from wood assortments defined by the standards, there are also whole lengths, wood chips and standing timber offered to the market (Parobek et al. 2014).

The classification of timber according to the mentioned standards is principally used in timber trade; however, timber processors or merchants often demand specific timber dimensions and have specific quality requirements. From the viewpoint of timber trade the valid technical standards are not compulsory but many domestic timber growers and processors use them as a benchmark for mutual trade in terms of timber quality and dimensions. In foreign trade relations, timber classification standards of foreign timber markets are also used (Šupín, 2014). Apart from the main timber assortments, chips and, during the latest years, also standing timber has been sold. For the purposes of this paper fuel wood and forest (energy) chips will be considered the energy wood.

Demand for renewable wood resources is increasing worldwide (Parobek, 2006). In line with the EU target of a 20% share of energy from renewable sources by 2020, Slovakia committed to increase its share of renewable energy sources to 14% by 2020. However, there has not yet been established a comprehensive legislative and conceptual framework supporting the systematic production of fuel wood biomass in the forest and non-forest land and its energy use. Nor there was created and effectively implemented the system of financial support for producers of fuel wood biomass, consumers, technology companies, and R&D in this area. In 2010, Slovakia adopted a National Action Plan for Energy from Renewable Forest Resources. The plan consists of measures aimed to increase the extraction of biomass through improving the conditions for the development of technology of complex processing of wood, such as the use of technology for the processing of the crown portion trees or improving accessibility of stands for the extraction of forest chips. In order to ensure increasing production of wood raw material it is also necessary to intensify the production of wood through the use of fast-growing trees and at the same time to support measures enhancing the competitiveness of companies producing energy chips. It is also necessary to develop a strategy for optimizing energy production and use of fuel wood biomass in order to maximize the efficiency in terms of production costs, burdens to the environment, employment, etc. (Paluš, 2013). The principal operator in the Slovak Republic – state forest enterprise has partially responded to the strategy of the production of biomass as a renewable energy by setting up a regional biomass centre that focuses on the production of energy biomass, particularly the production of fuel wood, energy chips and other energy biomass (Šupín, 2013). In some forestry operations, there are several private forests also producing additional wood intended for energy purposes. The assortments of pulpwood and fuelwood can be considered as a potential source of biomass and energy chips production. However, it should be taken into account that it is not possible to use the whole volume of these wood categories for energy purposes as hardwood pulpwood fibers are mainly used for pulp production in pulp and paper industry (Suchomel and Gejdoš, 2009).

On the other hand, there are certain concerns about the negative impact of the use of wood for energy. Government programs to promote the use of renewable energy in some countries can have controversial effects. Increasing demand for timber may lead to increased prices for roundwood and harvesting residues. The energy sector creates a competitive environment for wood industry. In the areas with a shortage of timber the increased demand for energy wood has an impact on prices of material inputs, especially those which can also be used of pulp or wood based panels production. The future development of production and use of energy wood biomass from forest and non-forest land in Slovakia is influenced mainly by the following factors (Oravec et al. 2012):

- Forest cover, standing volume and assortment structure of harvested timber
- Development of prices of various wood assortments, as well as the development of domestic wood processing facilities
- Development of fossil fuel prices, energy and consumption
- Energy policy related to the use of renewable energy sources and foreign markets development

2. METHODOLOGY

The analysis of energy wood supplies (fuel wood and energy chips) is based on national data available from national statistics (Green Reports) for the period 2000-2013. Production of wood biomass for the purposes of energy production is limited to certain wood assortments and other harvesting residues. As Suchomel and Gejdoš (2009) argue that energy chips can be produced from certain assortments (pulpwood and fuelwood) it can be assumed that there is a substitution in the production of these products. For example, pulpwood originally intended for pulp production can be transformed to energy chips owing to price or other market shifters. Energy wood supply is thus increasing at the expense of decreasing pulpwood supply. This led us to the idea of creation of simple econometric model of supply of energy wood that would reveal the substitution and complementarity relations in the supply of different wood products. The supply function is the mathematical expression of the relationship between supply (Q_S) and those factors that affect the willingness and ability of a supplier to offer goods for sale. An example would be the curve implied by $Q_S = f(P, P_{RG})$, where P is the price of the good and P_{RG} is the price of a related good. It can be assumed that coefficient of P is positive following the general rule that price and quantity supplied are directly related. P_{RG} is the price of a related good. Related goods refer to goods from which inputs are derived to be used in the production of the primary good. For example, energy chips are made of harvesting residuals and pulpwood, eventually fuelwood. Therefore pulpwood would be considered a related good to chips. In this case the relationship would be negative or inverse. If the price of pulpwood goes up the supply of energy chips would decrease because the cost of production would have increased. A shift in the supply curve, referred to as a change in supply, can also occur if other non-price determinants of supply change (e.g. production of related goods). To estimate supply of energy wood (coniferous and non-coniferous separately) we assumed that the prices and volumes of related goods to be supply shifters. This hypothesis was tested and statistically verified at a level of significance $\alpha = 0.05$. The linear and log-linear forms of model functions were used. To estimate parameters of the given models, ordinary least squares estimation method was used. All monetary values were in 2000 prices.

3. RESULTS

The development of the supply of coniferous fuel wood and energy chips (wood for energy purposes) is shown in figure 1. An average share of deliveries of fuel wood on the total supply of coniferous wood during the monitored period was 3.8% with an average annual growth of 4.4%. The highest annual increase of supply of fuel wood (63.5%) was recorded in 2008 with a volume of 213 thousand m^3. The deliveries of coniferous energy chips rose significantly after the severe windstorm in the end of 2004 and in 2005 increased annually by 348%. A significant increase in the supply was also recorded in 2013 when the volume doubled (160 thousand m^3) compared to 80 thousand m^3 in 2012. On the average, a share of coniferous energy chips on overall coniferous wood supply during the reporting period counted only for 1%, however the average annual growth was almost 35%.

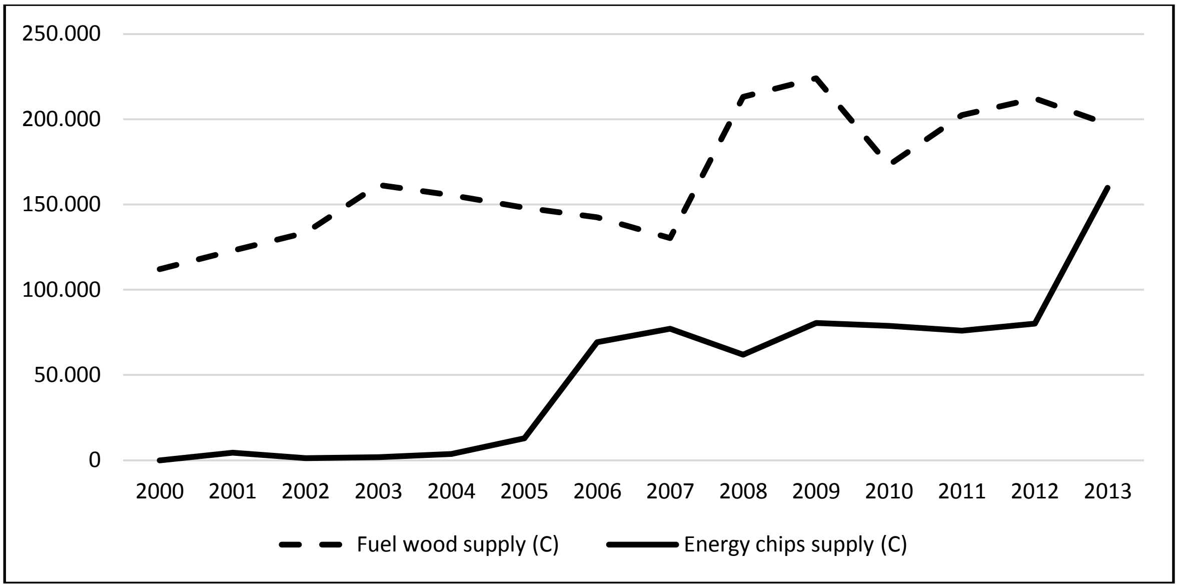

Figure 1. Development of coniferous fuel wood and energy chips supply (m^3)

The development of the supply of non-coniferous fuel wood and energy chips is shown in figure 2. An average share of deliveries of fuel wood on the total supply of non-coniferous wood during the monitored period was 5.4% with an average annual growth of 4.7%. The highest annual increase of supply of fuel wood by almost 50% was recorded in 2008 with a volume of 194 thousand m^3. The deliveries of non-coniferous energy chips rose significantly after in 2006 when they increased by 15 times from 6 thousand m^3 to 84 thousand m^3 in 2007. On the average, a share of non-coniferous energy chips on overall non-coniferous wood supply during the reporting period accounted only for 1%, however the average annual growth was almost 28%.

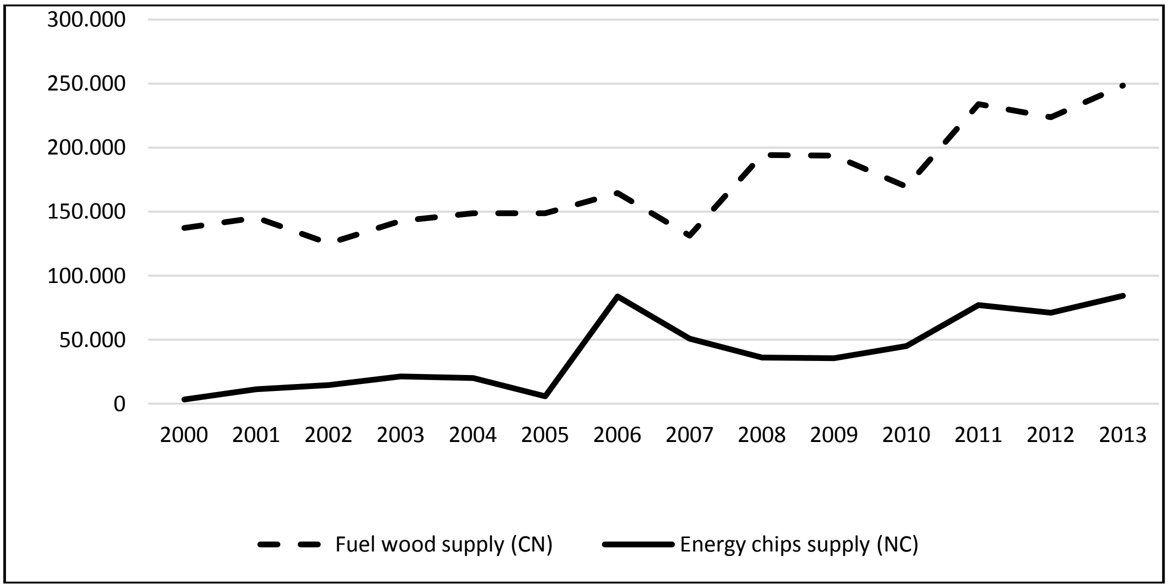

Figure 2. Development of non-coniferous fuel wood and energy chips supply (m^3)

The results of estimated supply model are shown in table 1. The parameters for linear and log-linear forms of equations were estimated in order to find the best fitted model. The models were separately constructed and tested for coniferous and non-coniferous energy wood as there are different relations between the pulpwood and energy wood markets in both cases. In order to find relations between the energy chips supply and relevant independent variables, prices and volumes of related goods were used (fuel wood, pulpwood) as supply shifters. The final model was constructed and verified for the supply of non-coniferous energy chips.

Table 1. Estimated parameters of linear model of supply of non-coniferous energy chips

Independent variable	Supply
Intercept	-149564.896
Non-coniferous chip price	***0.674 (4.57)
Non-coniferous fuelwood volume	***1.14 (7.74)
R^2	0.845 (29.3)
D	2.167
VN	2.334
S_u	26105.39

*Significance of estimated parameters: *** =0.001*

The estimated parameters suggest that supply of non-coniferous energy chips depends on its own price and is also related to the production of non-coniferous fuel wood. The supply of energy chips increases with the increase in chips price, however this supply is price inelastic (average elasticity = 0.04). The estimated model also indicates that non-coniferous chips and fuel wood are complementary goods, i.e. that production processes are interrelated and increased production (supply) of fuel wood positively influences supply of energy chips. There were no significant relations found between the supply of energy chips and pulpwood prices that would indicate that pulpwood prices are important from the viewpoint of decisions regarding the final utilisation of the respective assortments.

4. CONSLUSION

The following conclusions can be drawn from the above analyses:

- Slovakia has significant forest resources available to produce sustain production of industrial and fuel wood on a long-term basis,
- there is no effective system of support for the production of energy from renewable sources in place in the country
- share of coniferous and non-coniferous fuel wood, respectively, on total wood supplies was 3.8% and 5.4%; showing an increasing trend in absolute volumes
- share of coniferous and non-coniferous energy chips on total wood supplies was approximately 1%; showing an increasing trend in absolute volumes
- non-coniferous energy chips supplies increase with the price of chips (price inelastic supply)
- non-coniferous energy chips and fuel wood are complementary goods in terms of produced and supply volumes

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REFERENCES

1. Kaputa, V., Sucháň, R. (2012): Slovak Wood Biomass Market. In: Intercathedra No. 28/1, ISSN 1640-3622, p. 24 – 31.
2. MPaRVSR. (2014): REPORT ON THE STATUS OF FORESTRY IN THE SR 2013. GREEN REPORT. Available: http://mpsr.sk/download.php?fID=8852
3. Oravec, M., Bartko, M., Slamka, M. (2012): Postupy intenzifikácie produkcie drevnej biomasy na energetické využitie. Zvolen : NLC. 2012. 64 s.
4. Paluš, H. (2013): Trh a obchod s drevom a výrobkami z dreva. Zvolen : TU. 225 s. ISBN 978-80-228-2587-0.
5. Parobek, J. (2006) Vývoj produkcie dreva vo svete a vybraných regiónoch vplyvom rastu populácie. In Acta Facultatis Xylologiae Zvolen, Vol. 48 No. 1. ISSN 1336-3824. s. 63-71.
6. Parobek, J., Paluš, H., Šupín, M., Kaputa, V., 2014: Analysis of wood flows in Slovakia. BioResources 9 (4) 6453-6462.
7. Suchomel, J., Gejdoš, M. (2009): Ťažbovo-dopravné technológie, Časť Sortimentácia dreva a tovaroznalectvo v lesníctve. Zvolen : TU. 293 s. ISBN 978-80-228-2057-8.
8. Šupín, M. (2013): Slovak and EU market with wood pellets. In Intercathedra No. 29/2. ISSN 1640-3622. p. 74-81.
9. Šupín, M. (2014): The impact of the global recession on wood processing industry and wood products trade and the road to recovery. In Position and role of the forest based sector in the green economy: proceedings of scientific papers. - Zagreb: International Association for Economics and Management in Wood Processing and Furniture Manufacturing - WoodEMA, 2014. ISBN 978-953-57822-1-6. p. 159-164.

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AN OVERVIEW OF WOOD ENERGY IN NORTH-AMERICA

Richard Vlosky, Abhishek Bharad

ABSTRACT

Wood has been an important source of energy throughout human history. Currently over a fifth of humanity relies on the woody biomass as a key source of energy. Wood energy makes up over nine percent of the world's total primary energy supply. With its large landmass and forests North America has led rest of the world in access to biomass for energy production. Wood based biomass is collected from sources like primary and secondary mill residues, forest residues, logging and short rotation woody crops. Afterwards, collected biomass is converted into energy or fuel through processes like gasification, pyrolysis, cogeneration and pellet creation. In the U.S. woody biomass is primarily used for industrial and commercial applications. Major part of woody biomass is devoted towards electricity generation followed by pellet production. In recent years the EU biomass policy has been a major driver for North American pellet industry's growth. Climate change issues and urgency for development of clean energy has brought renewable resources like wood energy in spotlight. However, wood biomass based energy faces major infrastructure and policy challenges in coming years to sustain the current growth rate. Again North America has been at forefront to promote renewable energy by introducing guidelines like Energy Policy Act of 2005 and Energy Independence and Security Act of 2007.

Key words: Wood biomass, Wood energy, Renewable energy

1. BACKGROUND

Over the last century world energy demand has grown rapidly. North America has led the world in total energy consumption and production. Currently the U.S. ranks second in the world for amount of total energy consumed. The growth in energy production has been supported by exploiting fossil fuel reserves under the earth's surface. Figure 1 presents total primary, total renewable and biomass energy production in the U. S. between years 1949-2014. Total energy production in the U.S. almost tripled from 1949 to 2014 (Figure1).

Although over the same period total renewable energy has maintained its share in the U.S. energy production, the gap between energy produced using fossil fuel and renewable resources has widened. In 2014 energy produced from renewable resources was 12% of the total energy produced in the U.S., half of which was produced using biomass.

Forests are major source of biomass, approximately one-third of the U.S. land area (749 million acres) is covered with forests(Perlack, Wright et al. 2005). According to the U.S. Forest Service two-thirds of the forestland (504 million acres) is classified as timberland which is land capable of growing more than 20 ft3 per acre of wood annually. Over 70% of the timberland in the U.S. is privately owned(Jackson, Rials et al.). Currently, about 142 million dry tons of biomass consumption in the United States (more than 75 percent) comes from forestlands, remaining 25 percent comes from crop land.

In last three decades total primary energy production in Canada has doubled. Public policy in Canada has been systematically shifting to expand the share of renewable energy. Canada was one of the first countries to sign on Kyoto protocol which focused on issue of environmental awareness. Renewable energy sources currently provide 18 per cent of Canada's total primary energy supply, where energy obtained from biomass making 4.8 percent(COPA20 2015). Canada has 348 million hectares of forest, 9% of the world's forests and 24% of the world's boreal forests(COPA20 2015). Canada is one of the world's largest exporters of wood products. Over 44% of Canada's landmass is covered with forest, of which 93% is publicly owned forest land and remaining is privately owned(Bradley and Solutions 2006).

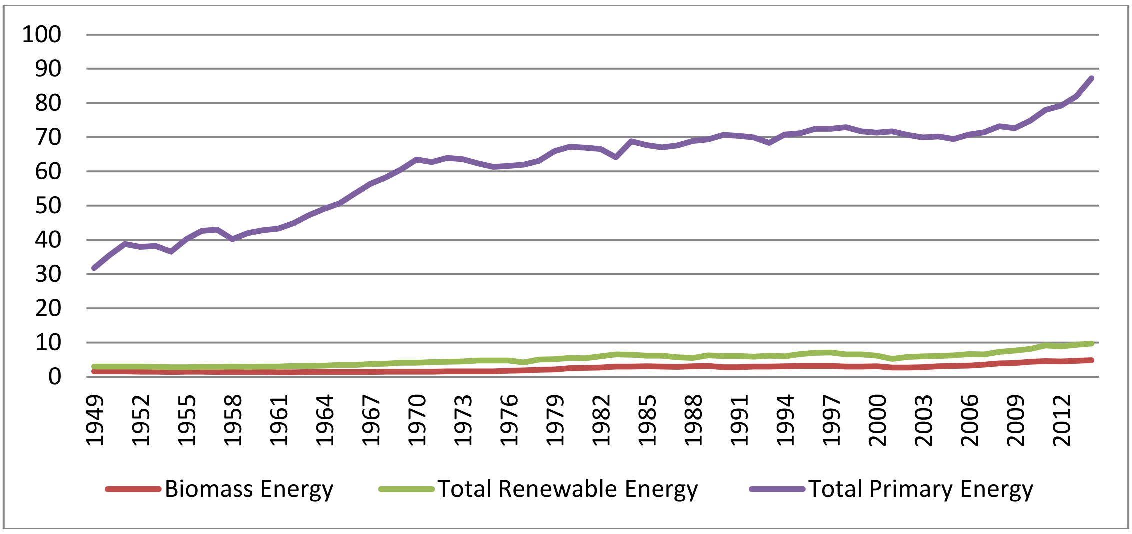


Figure1. U.S. Primary Energy Production by Source (1949-2014), Quadrillion Btu

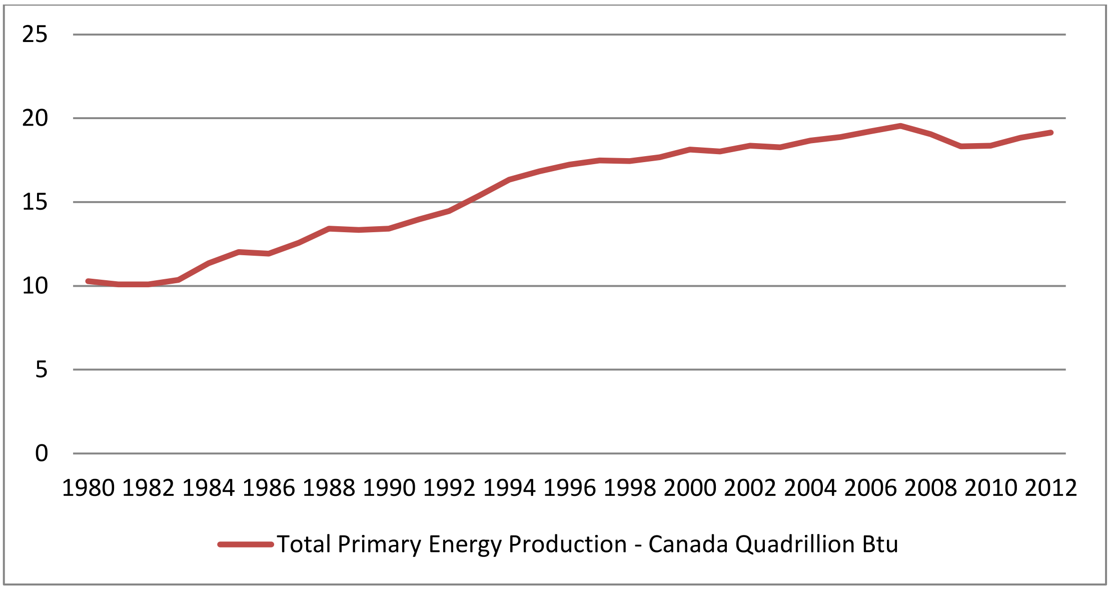
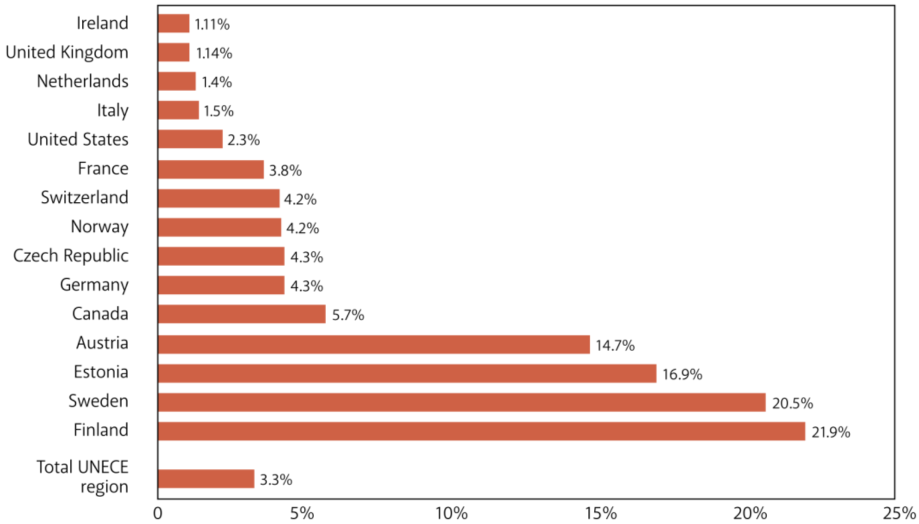


Figure 2. Total Primary Energy Production – Canada 1980-2012 (Quadrillion Btu)

2. WOOD ENERGY USAGE

Wood has been an important source of energy throughout human history. Currently over a fifth of humanity uses wood as a major source of energy for heating or cooking. Wood energy provides over nine percent of worlds total primary energy supply. Wood energy is the most important source of renewable energy today, it equals to all the renewable energy sources combined (FAO).



Source: Joint Wood Energy Enquiry 2011, a survey of wood energy consumption answered by 27 UNECE countries. http://www.unece.org/forests/jwee.html.

Figure3: Share of Wood Energy in Total Energy Supply in Select United Nations Economic Commission for Europe Member Countries in 2011

Joint Wood Energy Enquiry (JWEE) conducted by United Nations Economic Commission for Europe (UNECE) member countries in 2011 revealed that wood energy accounts for 3.3 percent of regions total energy supply. Share of wood energy in total energy supply varies by countries with forest cover, population and location. Scandinavian countries exhibit high share of wood energy in the total energy supply (Figure3). In the last two decades European Union has experienced 104 percent increase in the wood energy consumption(Aguilar 2014).

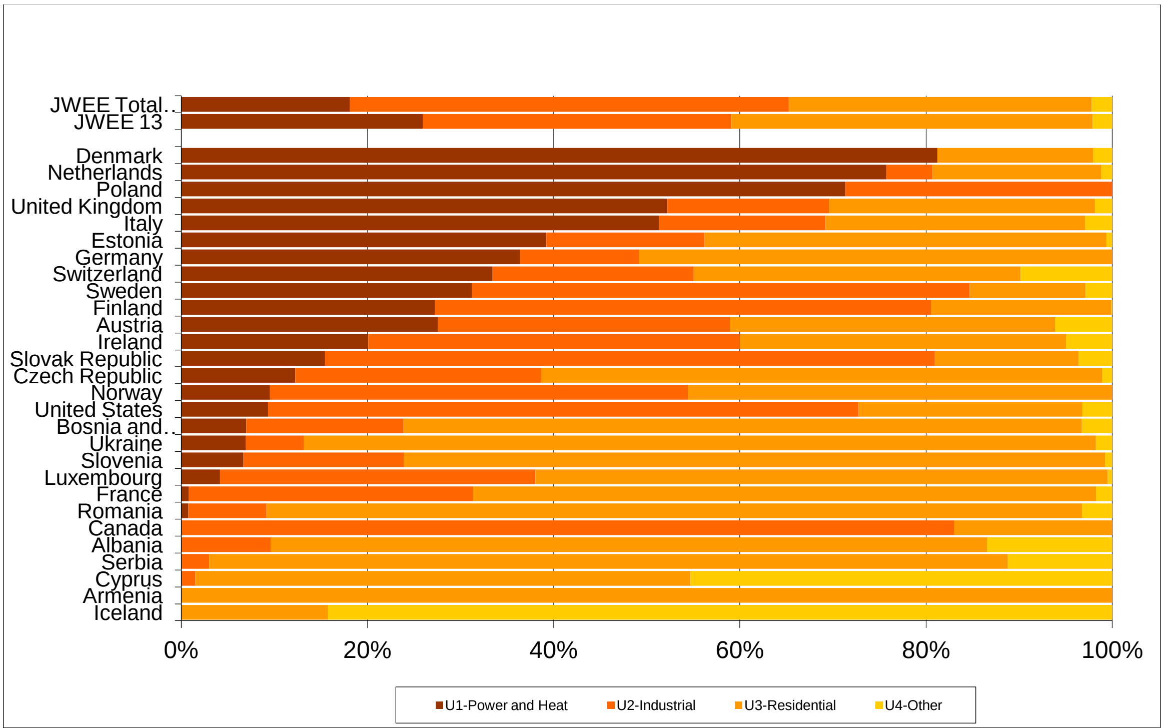


Figure4: Relative Share of Wood Energy in Total Energy Usage in United Nations Economic Commission for Europe Member Countries in 2011

Wood energy consumption varies by usage type for countries. In European countries wood energy is mostly spent for power and heat generation (Figure4). In North America most of the wood energy is used for industrial purposes. Canada spends over 80% of wood energy for industrial purposes, while the U.S. spends around 70%.

European Union's 2020 renewable energy goals and mandates have compelled member countries to increase share of renewable energy in the countries total energy supply. The high demand for woody biomass in Europe and abundance of biomass in North America has been a driving force for North American wood pellet export to Europe.

2.1 WOOD BASED BIOMASS

2.1.1 Primary mill residues

Primary mills convert round wood products (trunks, logs etc.) into other wood products. Wood materials and bark generated at primary wood-using mills is called as primary mill residue. Primary mill residue generated at manufacturing facilities includes slabs, edgings, trimmings, sawdust, veneer clippings and cores, and pulp screenings. Primary mill residues are relatively clean and concentrated at the site production. In the U.S. primary mill residue could potentially be available at a delivered price of $30/dt (Walsh 2008). Majority of the primary mill residue in the U.S. is produced in the Northwest and Southeast of the U.S. (Figure4)

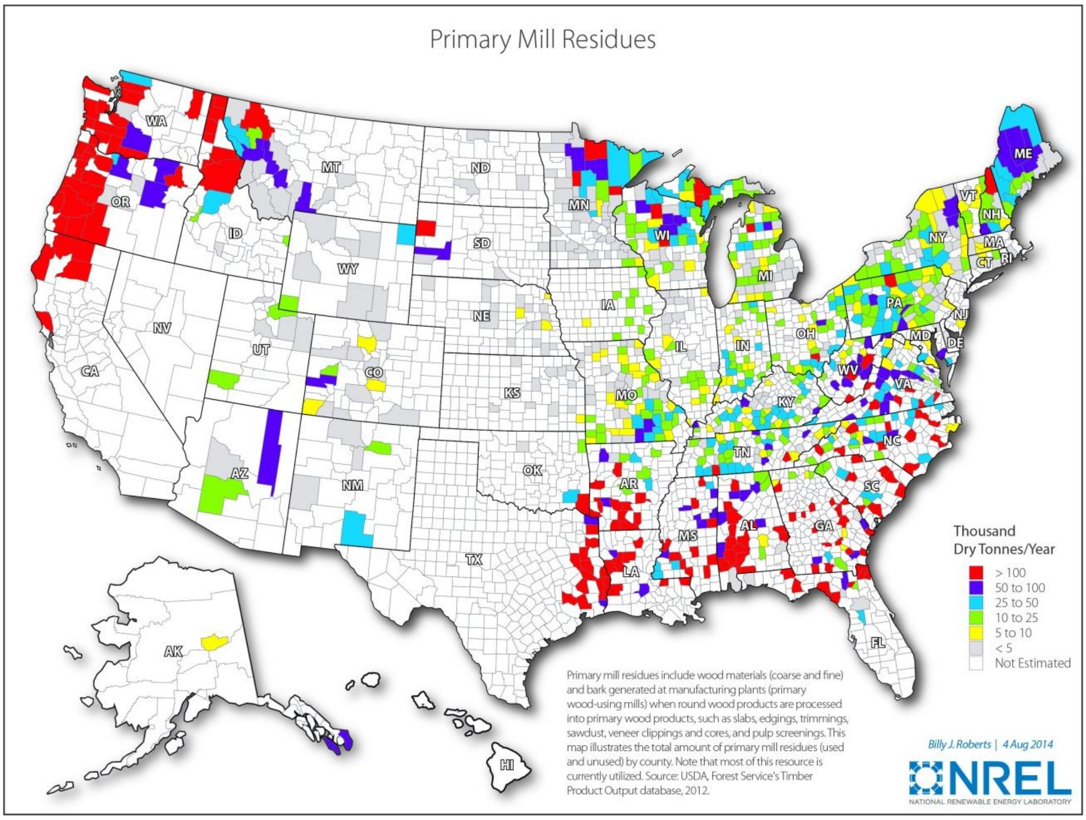


Figure4: Primary Mill Residues Production in the U.S.-2012

2.1.2 Secondary mill residues

Secondary mills use products produced at primary mills as input. Typically Primary mill and secondary mill operation are separate facilities, but primary and secondary finished product can be produced at the same facility. Woodworking shops, furniture factories, wood container and pallet mills, etc. are generally categorized as secondary mills. Secondary mill residue generally consists of wood scraps and sawdust from these facilities. A study estimated 12.5 million dry tons of secondary mill wood residue was generated in the U.S.(Rooney 1998). However, after cleaning for contaminants only 1.2 million dry tons was available for bioenergy production.

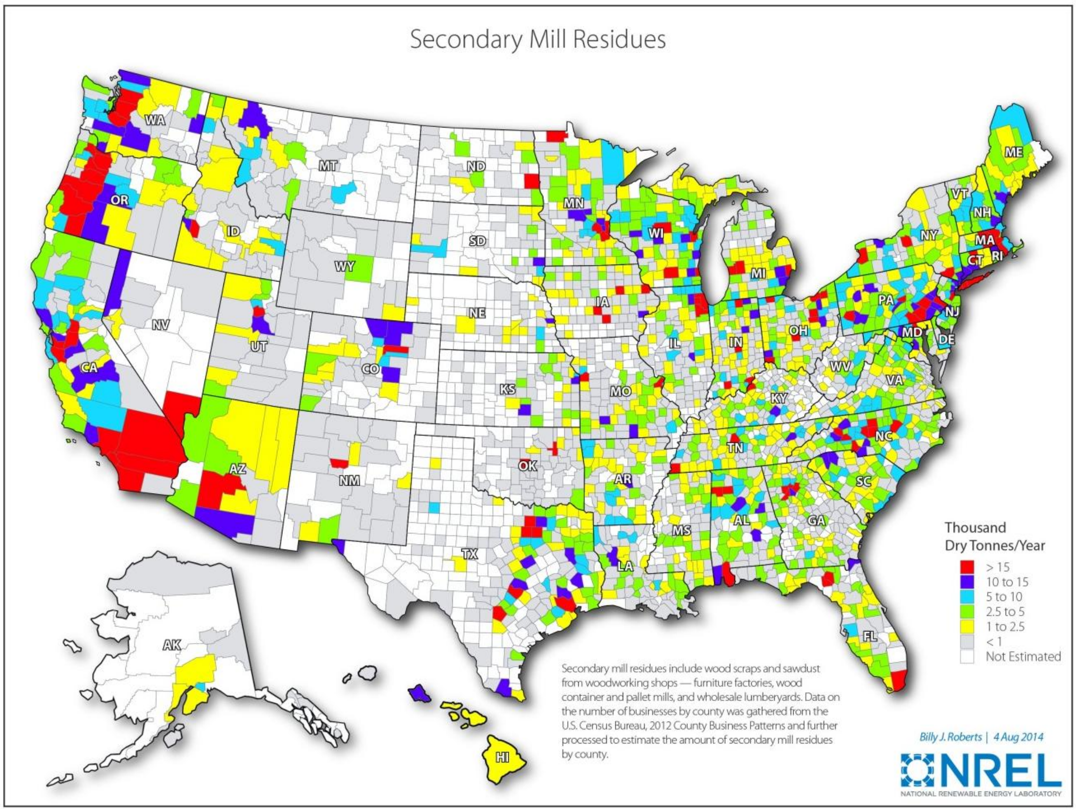


Figure5: Secondary Mill Residues Production in the U.S.-2012

2.1.3 Urban wood waste

Urban wood waste refers to discarded wood products like pallets, crates, tree trimmings, material from construction and demolition sites, discarded furniture etc. Prior to use urban wood waste incurs sorting and processing cost to take out contaminants. Corrugated boxes along with newspapers have the highest recovery. In 2007, the United States generated approximately 83 million tons of paper and paperboard—54.5 percent (45 million tons) of this was recovered for recycling or other uses. Discarded wood in furniture, durable goods, and wood packaging amounted to 14.2 million tons in the same year(White 2010).

2.1.4 Forest residues/ logging slash

Forest biomass has been a well-known source of energy. With its vast forest cover and abundance of forest biomass North America holds a promising source of energy. Forest residues provide a promising source of energy. However, inefficiencies in collection of forest residues have been a significant barrier in reaching to its optimal potential. The drop in the prices of competing fuels and collection of logging residues spread over a vast area has rendered use of forest residues uneconomical(Hacker 2004).

2.1.5 Short rotation woody crops

Woody crops exhibit a reliable source of renewable energy for the future. In the southeast United States plantation forestry has grown to be a steadfast and vital source of revenue and renewable energy. New rapidly growing and prolifically re-sprouting tree species have made biomass to biofuel conversion economically viable. Tree species like hybrid poplar, eucalyptus, and paulownia are commonly used for biomass harvesting. The advancement in biotechnology and plant breeding has generated new high yielding varieties of woody crops. The biomass obtained from utilizing the whole tree is converted to biofuel after chemical refinement.

3 WOOD TO FUEL TECHNOLOGY

3.1 Physical processes

3.1.1 Dry wood

Dry wood is one of the most widely used sources of energy. It contains more energy by weight compared to moist wood and is efficient during combustion. On industrial scale production processes wood is dried through air circulation, direct heating or indirect heating methods. Drying process helps for long term storage and reduces losses due to mold formation, rotting or deterioration. Wood drying process is a common initial step in biochemical and pelletization processes.

3.1.2 Pellets/Briquettes

Wood pellets are primarily manufactured using wood waste, including sawdust, shavings, and wood chips. In recent years increase in wood pellet demand has made woody biomass feedstock a popular option. The process involves drying, grinding, pelletizing, cooling, screening and packaging. Wood pellets offer two major advantages over traditional biomass feedstock. Firstly wood pellets are high in calorific value (61% higher than non-pelleted, non-dried wood) and are low in ash content. Secondly, size, shape and weight of wood pellets make them economical to transport(Little, Appold et al. 2013).

3.2 Thermal and Biochemical processes

3.2.1 Gasification

Gasification uses high temperatures with controlled supply of air or steam to convert organic material into carbon monoxide, hydrogen and carbon dioxide. The product obtained through the process is called as Syngas or synthetic gas which is used as fuel.

3.2.2 Pyrolysis

In pyrolysis organic materials like biomass feedstocks are chemically decomposed by heat in the absence of oxygen. Pyrolysis has been used for long time in human history; charcoal is obtained by using pyrolysis on wood leaving behind carbon and ash.

3.2.3 Cogeneration

Cogeneration refers to simultaneous production of heat and power using a single feedstock. Cogeneration system is built on the principle of thermodynamically efficient use of fuel source to utilize energy otherwise would be wasted during the process. For example, usually during electricity production thermal energy is discarded as waste heat, but in the process of cogeneration the thermal heat is captured and reutilized.

4 OUTLOOK AND CHALLANGES

Wood energy has been and will be an important source of energy in the North America. There are several factors which will play an important role in determining future of wood to energy industries. A few major drivers for the industry include public policy, technology improvements, price of competing energy sources, and economic conditions.
The World Energy Outlook report published by International Energy Agency (IEA) projected world primary energy demand to increase by 36% in the next 20 years (Figure7). Over the same period the report projects the use of modern biomass for energy production to double. The EU has set legally binding renewable energy goals and mandates for each state to create national renewable energy action plans outlining their goals.

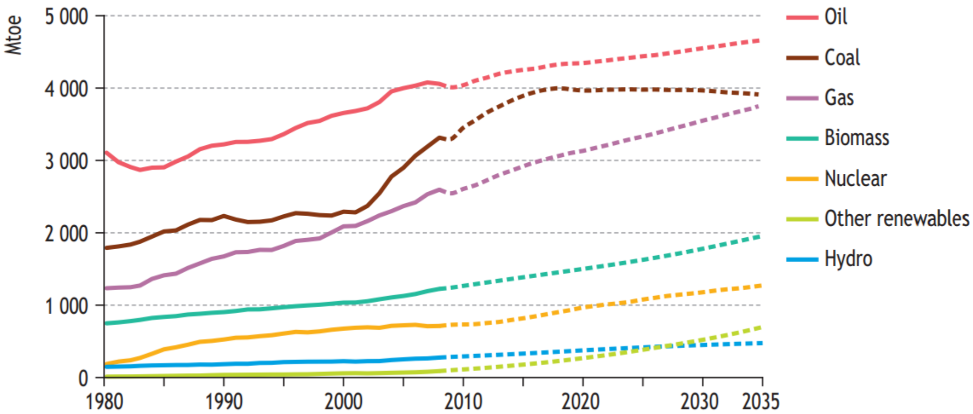
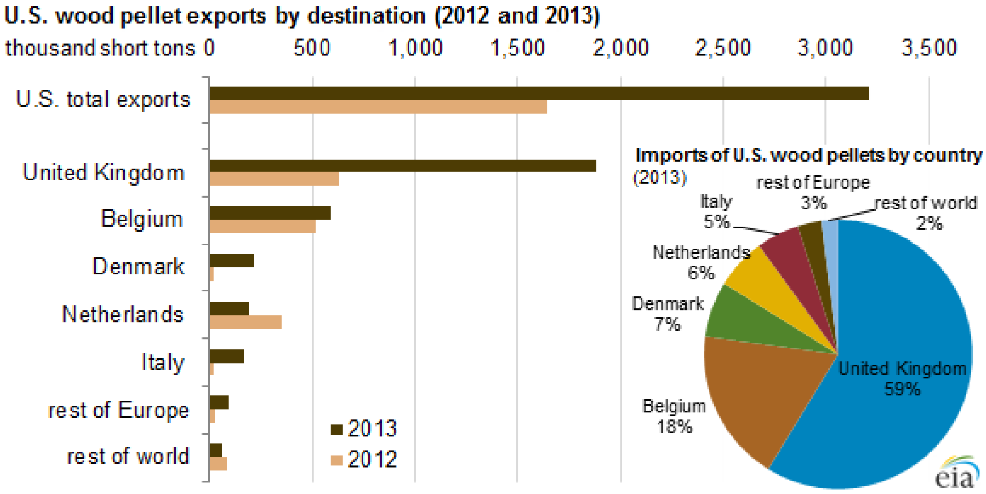


Figure7: World Primary Energy Demand Projections by Fuel in the New Policies Scenario

The Trans-Atlantic partnership between the North America and the European Union members has strengthened with increase in renewable resources trade. European Commission's 2020 climate and energy package binding legislation has amplified demand for pellets from North America. European pellet consumption per capita from 18.71 kg in 2009 increased to 24.8kg in 2011(UNECE/FAO 2013). The European Union has the largest market for wood pellet production and consumption in the world. Sweden alone consumes more than 20% of the world's wood pellets. However, the EU wood pellet production is 61% of world wood pellet supply and consumption is 85% of the world wood pellet demand (Little, Appold et al. 2013). In the United States wood pellets are primarily used as a residential heating fuel. According to the U.S. Forest Service estimate in 2008 around 80% of wood pellets produced in the U.S. were consumed domestically. The U.S. and Canadian biofuel producer have stepped up to the challenge and have increased production of biofuels to satisfy Europe's demand for cleaner energy.

In today's global wood energy market wood pellets represent an important source of bioenergy. In past few years higher prices of crude oil have helped wood pellets competitive, however it has also added to production and transportation cost. The wood to energy cost is driven by four major factors; cost drivers include transportation cost, feedstock cost, energy cost, and currency exchange rate. Along with EU policies favoring renewable energy usage, abundance of biomass and lower transportation cost has increased pellet export from the southeastern United States to the Europe. Technological innovations in conventional energy industries like oil and gas fracking has slashed the prices for the fossil energy. However, improvements in the biomass to fuel conversion technology with help from renewable fuel policies have managed to keep biomass use competitive.



Source: U.S. Energy Information Administration

Figure8: U.S. Wood Pellet exports by Destination Countries (2012 and 2013)

The North American forests and woody biomass represent a promising source of energy for the global energy needs. North American industries and renewable energy researchers have recognized its potential and are establishing sustainable and efficient ways to tap into available resources. It will be important to make sure future usage also follows a sustainable path. With renewable energy demand growing in the EU, the sustainable approach to North American wood energy becomes additionally important for the North America as well as the EU.

REFERENCES

1. Aguilar, F. (2014). "WOOD ENERGY IN DEVELOPED ECONOMIES: AN OVERLOOKED RENEWABLE." 2015, from http://www.rff.org/Publications/Resources/Pages/188-Wood-Energy-in-Developing-Economies.aspx.
2. Bradley, D. and C. C. Solutions (2006). CANADA BIOMASS-BIOENERGY REPORT. Climate Change Solutions—IEA Bioenergy Task.
3. COPA20. (2015). "FACTS ON CANADIAN ENERGY PRODUCTION, EFFICIENCY, AND INITIATIVES." from http://www.climatechange.gc.ca/default.asp?lang=En&n=4622629B-1.
4. COPA20. (2015). "FACTS ON CANADIAN FORESTS AND CLIMATE." from http://www.climatechange.gc.ca/default.asp?lang=En&n=BA2BB92F-1.
5. FAO. "WOOD ENERGY." Retrieved May 20, 2015, from http://www.fao.org/forestry/energy/en/.
6. Hacker, J. J. (2004). EFFECTS OF LOGGING RESIDUE REMOVAL ON FOREST SITES: A LITERATURE REVIEW, West Central Regional Planning Commission.
7. Jackson, S., T. Rials, A. Taylor, J. Bozell and K. Norris WOODY BIOMASS SUPPLY. Project Personnel**:** 12.
8. Little, M. G., S. Appold, I. Cagiran, C. Primmer and M. Gültekin (2013). NORTH CAROLINA'S ROLE IN THE GLOBAL BIOMASS ENERGY MARKET, Biofuels Center of North Carolina.
9. Perlack, R. D., L. L. Wright, A. F. Turhollow, R. L. Graham, B. J. Stokes and D. C. Erbach (2005). BIOMASS AS FEEDSTOCK FOR A BIOENERGY AND BIOPRODUCTS INDUSTRY: THE TECHNICAL FEASILIBILITY OF A BILLION-TON ANNUAL SUPPLY, DTIC Document.
10. Rooney, T. (1998). LIGNOCELLULOSIC FEEDSTOCK RESOURCE ASSESSMENT, National Renewable Energy Lab., Golden, CO (United States).
11. UNECE/FAO (2013). JOINT WOOD ENERGY ENQUIRY. UNECE/FAO. Geneva.

12. Walsh, M. E. (2008). "U.S. CELLULOSIC BIOMASS FEEDSTOCK SUPPLIES AND DISTRIBUTION." M&E Biomass.
13. White, E. (2010). WOODY BIOMASS FOR BIOENERGY AND BIOFUELS IN THE UNITED STATES-A BRIEFING PAPER, United States Department of Agriculture.

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WOOD-BASED ENERGY GOES GLOBAL

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POSSIBILITIES OF INCREASING RENEWABLE ENERGY RESOURCES IN CROATIA – WOOD PELLET

Andreja Pirc Barčić, Liker Branko, Darko Motik, Maja Moro

ABSTRACT

Energy from renewable sources globally presents very important issue. In order to reduce pollution and greenhouse gas emissions countries promote legislations for renewable energy sources consumption incensement. Croatia has by signing the Kyoto Protocol committed itself to reduce greenhouse gas emissions by five percent by 2020 and promotion of wooden biomass usage, especially wood pellet, presents one of activities to fulfil these obligations. On the other hand, regarding wooden biomass usage Croatia is still at the beginning, and most of this important energy source is exported. Wood pellet is an environmentally acceptable product and its production significantly contributes to rural development and sustainable approach to the management of timber resources, but at the same time this important energy source is neglected in strategic planning and energy policies. Croatian wood pellets producers with a potential production of 260,000 tonnes so far have been forced to export. In 2014, 92% of total Croatian wood pellet production was export to foreign markets. The main reason for this market situation is that Croatian market (public institutions and private persons) is not yet enough informed about scope of wood pellet usage and it advances in the contacts of ecology and green economy. The aim of this paper was to explore how much Croatian households in generally know about wood pellets and what the possibilities of its future consumption incensement are.

Key words: wood industry; wood pellet; renewable energy source; Croatian households

1. INTORDUCTION

Energy from renewable sources globally presents very important issue. In order to reduce pollution and greenhouse gas emissions countries promote legislations for renewable energy sources consumption incensement. For many years the European Union has been one of the world leaders in the promotion of renewable energy trying to change the relations in energy, favoring renewable energy through a series of legal and active implementation of incentive programs and simultaneously providing generous subsidies.

Sooner or later traditional non-renewable energy sources would have to be replaced with alternative energy sources which are already used in developed countries.

Olsson (2002) and Olsson and Kjällstrand (2004) noted that the potential role of wood-pellets in a sustainable biofuel systems presents an important issues when discussing about the ecological and ecotoxicological aspects. Wood-pellet is a renewable fuel with no carbon dioxide emissions contributing to global warming and has the highest potential for carbon dioxide reduction (Wahlund et al. 2004). Croatia has by signing the Kyoto Protocol committed itself to reduce greenhouse gas emissions by five percent by 2020 and promotion of wooden biomass usage, especially wood pellet, presents one of activities to fulfil these obligations.

The aim of this paper was to explore how much Croatian households in generally know about wood pellets and what the possibilities of its future consumption incensement are.

2. WOOD-PELLET MARKETS

2.1. Global wood-pellet market

The supply chains in the industrial and residential pellet markets are becoming more integrated (Dale, 2014). According to *Forest Products Annual Market Review 2013-2014* (2014) in 2013, strong European demand lead to increased imports of industrial and residential pellets from across the UNECE region. EU27 wood pellet consumption exceeded 15.1 million tonnes in 2012, estimating 19 million tonnes in 2013 (Gautier, 2014). The main pellet producers in the EU27 in 2012 were Germany (2.2 million tonnes), Sweden (1.3 million tonnes) and Austria (0.9 million tonnes) (Flach et al., 2013). The United Kingdom (4.5 million tonnes), Denmark (2.5 million tonnes) and the Netherlands (2.0 million tonnes) are the largest consumers of wood pellets in the EU27 (FAO/UNECE, 2014). There was considerable growth in wood pellet imports in the period 2009-2013, with Canada and the US as the main exporters of wood pellets to the EU27. North America supplied 4.6 million tonnes of the 6.2 million tonnes imported by the EU27 in 2013 (FAO/UNECE, 2014). Additionally, it is likely that Germany will become a net importer in the near future. More than 90% of the wood pellets consumed in Italy in 2013 were imported (Paniz and Bau, 2014). The residential pellet market is expected to grow substantially in Spain and Greece. Wood pellet production in the Russian Federation remained at about 1.5 million tonnes in 2013 but could reach 2 million tonnes in 2014 (Glukhovskiy and Hartkamp, 2014 cited by FAO/UNECE 2014). Companies from China, Japan, the Republic of Korea and Sweden are making substantial investments in the Russian pellet market. The EU imported roughly 46% of Russian wood pellet production (about 1.15 million tonnes) of which 53% went to Denmark, 32% to Sweden and 16% to other EU countries (FAO/UNECE, 2014). Canada and the US produced 1.7 million and 4.1 million tonnes of wood pellets, respectively, in 2012 (FAOSTAT, 2014). The volume of wood pellet exports from Canada was reported to be 1.64 million tonnes in 2013, with a value of $253 million (Statistics Canada, 2014). The main destinations for these exports were the United Kingdom (63%), Italy (13%), the US (9%) and the Republic of Korea (7%). Wood pellet exports from the US nearly doubled in 2013, reaching about 2.9 million tonnes, which was an increase of 1.4 million tonnes compared with 2012. The top export partners in 2013 (by net weight) were the United Kingdom (58.7%), Belgium (18.4%), Denmark (6.7%), Netherlands (6.1%) and Italy (5.2%). The trend indicates that many EU27 countries will become net importers of wood pellets in the long term. According to some forecasts, European pellet consumption will reach 35 million tonnes by 2020 (Murray, 2014).

In 2013, in the western Balkans countries the production and consumption of all wood fuel types, mainly in the form of wood pellets and wood chips, continued to expand which also presents an increasingly important source for supplying wood pellets to the major markets within the EU, such as Italy, Germany and Austria. The 2013 production of wood pellets increased by 64% over 2012 in the western Balkans, reaching 648,104 tonnes. The increase was the result of new manufacturing capacity led by Serbia, with a total capacity of 368,000 tonnes (FAO/UNECE, 2014). Glavonjić (2012) noted that in 2013 an estimated capacity of pellet manufacturing facilities in the western Balkans was about 1.1 million tonnes which presented up by 292,000 tonnes from 2012. Such a rapid increase is the result of strong prospects for wood pellet demand in domestic and export markets.

2.2. Croatian wood-pellets market

On the other hand, in the wood biomass usage Croatia is still at the beginning and most of this important energy source is exported. In Croatia wood pellet production significantly contributes to rural development and sustainable approach to the management of Croatian timber resources, but at the same time it presents an important energy source neglected in strategic planning and energy policies.
Croatian wood pellet producers with a potential production of 260,000 tonnes per year have so far been forced to export. In 2014, ninety-two percent of pellet production was placed to foreign markets.

Additionally, Croatian market (private buildings and contracting authorities who are responsible for the heating of public facility) are still not enough familiar with this fuel, its benefits and in particular economic savings. Also, majority of pellet producers have failed in providing all the necessary certificates, without which it is not possible to ensure good market placement in European wood pellet market. According to Motik, Pirc Barčić, and Šimunović (2015) Croatian wood pellets are mainly exported to Slovenia and Italy.

Additionally, in the last few years export share of Croatian wood pellets decreased, indicating a positive trend of increasing pellets use in the domestic market, as a result of a marketing campaign carried out by the *Association of pellets, briquettes and biomass producers* although this trend is still not at suitable level.

3. MATERIALS AND METHODS

The sample frames were random samples of 840 Croatian households whereby the household was represented by one adult Croatian citizen (respondent). The sample frame covered all 20 Croatian counties and Zagreb City (n=40 per county). A telephone survey was the method used for surveying respondents for this study. This approach was selected because according to Roster et al. (2004) by telephone surveys it is possible to obtain a representative national sample. The relative advantages of telephone surveys like, lower cost, less risk of interviewer bias, and avoidance of cluster sampling were additional elements in making decision about data collection method (Berrens et al., 2003).

Based on research objectives, a questionnaire was developed, pre-tested, and finalized based on pre-tested inputs. Straightforward questions and Yes/no, items were used. Furthermore, multi choice item measure was used because according to Thorndike (1967) cited by Lewis-Beck et al. (2004) it can be a superior to a single, straightforward question. At the beginning of telephone interviewing the introducing statement by a researcher, justifying the research study, legitimize him, explaining the recipient's (respondent's) role and convincing that his participation in research is essential (Dillman et al., 1976) was presented to respondent.

The questionnaire consisted of 17 questions and data collection was carried out during March, April, and May 2015. Data were analyzed in MS Excel.

4. RESULTS AND DISCUSSION

As seen in Table1, respondents were asked to indicate their age, education level and gander. Age was classified into three categories, while education was classified into five categories. As shown in Table 1, according to 831 respondents, 62.5% of respondents were male and 37.5% of total number of respondents were female. More than half, 61% are people over 51 years old. According to respondents, 60.2% of total respondent number are high school graduate people, followed by respondents who just have primary school level of education (22.3% of total number of respondents). Only, 17.7% of respondents had some university diploma.

Respondents were asked to define type of area where their households are located. Almost 40% of 834 respondents were living in rural areas, villages and towns with population up to 5000 people. Slightly fewer, 37.1% of respondents, were located in medium-sized and large cities with population over 10000 people, while 23.9% were located in small cities between 5000 and 10000 people.

Respondents were asked to identify number of people with whom they share a household and number of employed persons in their household. Furthermore, respondents were also asked to noted category of total monthly household income where monthly household income presents the total monthly household income reduced by monthly household loans. As seen in Table 2, only 14.3% of 837 respondents noted that their household consist only of themselves. Slightly more respondents, 15.1%, sad that their household consists of 5 persons and more. Twenty-eight percent noted that their household has two persons, 20.1% sad that their house hold consists of 3 persons, and 22.1% households consists of four persons. When asked about number of employed persons in their household, 27.3% of 779 respondents sad that only one person of their household is employed, 28.4% noted two employed persons, while only 11.6% noted that their household has 3,4,5 and more employed members. On the other hand, ¼ of respondents (25%) sad that all their household members are unemployed and/or retired. Of 833 respondents, 40% noted that the household income amount per month earned by its employed members is up to 500EUR. On the other, only 19.7% respondents sad that their household monthly income reach more than 1000EUR.

Table 1. Respondent profile of potential wood-pellets users in Croatia

Gender of respondents (%) (n=831)		Education level of respondents (%) (n=834)		Age groups of respondents (%) (n=836)	
Male	62.5	Primary school	22.3	18 – 30 years old	11.5
				31 – 40 years old	11.0
		High school	60.2	41 – 50 years old	16.5
Female	37.5	University	14.7	51 – 60 years old	21.8
				Older than 60	39.2

Table 2. Household profile of potential wood-pellet users in Croatia

*Number of persons in household (%) (n=837)		Number of employed persons in household (%) (n=779)		**Monthly household income (%) (n=833)	
1	14.3	1	27.3	Up to 500 EUR	38.1
2	28.4	2	36.1		
3	20.1	3, 4, 5 and more	11.6	500 – 750 EUR	26.7
4	22.1	Other (unemployed; retired)	25.0	750 – 1000 EUR	15.6
5 and more	15.1			More than 1000 EUR	19.7

* Children are included in number of persons in household

* *Monthly household income = Total monthly household income – Monthly household loan

Respondents were asked to indicate to which oldness category pertain building in which they live with their household members. Respondents were also asked about: size categories related to the heated space in their households, energy source used for household heating, and the total annual heating costs of their households. Of the 832 respondents, nearly 1/3 (70.8) of them noted that the buildings in which they live are 20 and more years old. Adversely, only 6.5% of respondents reported that they live in relatively new building up to 10 years old, while 22.7% of them said age of their living space is between 10 and 20 years. More than 50% of the 831 respondents stated that heating space in their household makes between 50 and 100 m^2, 28.6% noted that they heath up to 50m^2 of their living space, while 18.1% of them said that heating space in their home building makes between 100 and 200m^2. As seen in table3, wood is still major energy source used for heating between respondents (58.6% of 840 respondents). Of the 824 respondents, 60.3% of them noted that their annual household heating costs amount up to 700EUR. Thirty-seven percent of them said that heating costs of their household amount between 700 and 1400EUR per year, while 4.9% noted that for heating their living space they spend more than 1400EUR per year.

Table 3. Building characteristics and energy information of potential wood-pellet users in Croatia

Age of building (%) (n=832)		*Energy source used for heating (%) (n=840)		Size of space that is heated (%) (n=831)		Annual energy expense for heating (%) (n=824)	
Up to 10 years	6.5	Gas	26.8	Up to 50 m^2	28.6	Up to 700EUR	60.3
10 – 20 years	22.7	Electricity	2.1	50 – 10 0m^2	51.5	700-1400 EUR	37.8
More than 20 years	70.8	Wood	58.6	100 – 200 m^2	18.1	More than 1400 EUR	4.9
		Other	3.6	More than 200 m^2	1.8		

*Multiple response was possible

Do you know who is producing wood-pellet and do you know where you can buy wood-pellets in Croatia was the questions referred to respondents. As seen in Figure 1, more than half (56.5) of the 832 said that they know where to buy and who is producing wood-pellet in Croatia, while between 43.5% respondents that was not found to be case. Furthermore, respondents were asked about usage of wood-pellet in their households. Only, 0.4% percent of the 823 respondents noted that they use wood-pellet for heating their home building, while 99.6% noted that they were not using wood-pellet at all.

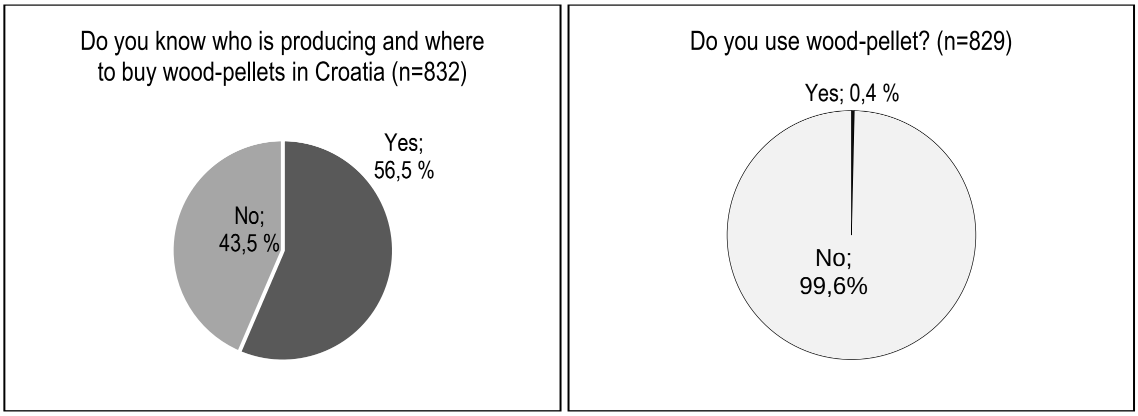

Figure 1. Awareness of wood-pellet presence in Croatian market

Additionally, we wanted to found out do some of respondents in this study plan to start use wood-pellets sometime in the future. Of the 826 respondents, 11.9% said that they are planning to use it in the future. Of these 98 respondents (11.9%) 65% noted that this future time presents 5 and more year's period. When asking respondents about their awareness about subventions related to renewable energy source usage for households financed by Environmental Protection and Efficiency Fund, only 1/4 of 828 respondents (26.6%) said that they are familiar with these facilities.

5. CONCLUSIONS

Wood pellet is required to observe from the economic, ecological and sociological point of view, since due to its pronounced advantages and raw material resources of Croatia it represents the fuel of the future!

Croatian households mainly consists of two to four persons, in1/4 households all members are unemployed and/or retired or only 2 household members are employed who usually generate monthly household income up to 750EUR.

Seventy percent of building are older than 20 years and the majority of this households are using wood as heating energy source, with spending up to 1400EUR for heating costs (95% of respondents).

In Croatia wood pellet usage is still minor and only ¼ of respondents stated that they are familiar with subventions and government programs in which use of renewable energy sources in encouraged.

Croatian market (public institutions and private persons) is not yet enough informed about scope of wood pellet usage and it advances in the contacts of ecology and green economy. Additionally, increased sectorial activates of all sectorial members must be accurate. These activities must necessarily include results of scientific researches and professional studies, which prove that the use of wood pellets represents an economically and ecologically important part of the Croatian wood sector in the first place and of all people living in Croatia.

REFERENCES

1. Berrens, R.P., Bohara, A.K., Jenkins-Smith, H., Silva, C., Weimer, D.L. (2003): The Advent of Internet Surveys for Political Research: A Compariosn of Telephone and Internet Samples. Political Analysis. 11 (1): 1-22.
2. Dale, A. (2014): The medium scale pellet market. Presentation at the AEBIOM Bioenergy Conference, May, 12, 2014, Brussels. http://www.lsta.lt/files/events/2014-05-12_13_AEBIOM%20konf/2014-05-12_Pranesimai/02_A-Dale-AEBIOM-bioenergy-conference-2014.pdf. (Accessed June 25th, 2015).
3. Dillman, D.A., Gallegros, J.G., Frey, J.H. (1976): Reducing refusal rates for telephone interviews. Public Opinion Quarterly. 40: 90-114.
4. Lewis-Beck, M.S., A. Bryman, and T. F. Liao. 2004. Encyclopedia of Social Science Resource Methods. SAGE Publications.
5. Flach, B., Bendz, K., Krautgartner, R. and Lieberz, S. 2013. EU-27 biofuels annual 2012. USDA Foreign Agricultural Service. Global Agricultural Information Network Report NL: 2020.
6. Forest and Timber Section (2014): Forest Products Annual Market Reviwe 2013-2014. United Nations, UNECE/FAO. Geneva.
7. Gautier, G. (2014): Overview of the European pellet market. Presentation at the AEBIOM Bioenergy Conference, May, 13th, 2015, Brussels. http://www.lsta.lt/files/events/2014-05-12_13_AEBIOM%20konf/2014-05-13_pranesimai/Parallel%202/05_14.05.11-European-pellet-market-G.-Gauthier.pdf. (Accessed June, 25th, 2015).
8. Glavonjić, B. 2014. Internal calculations with data from the University of Belgrade Timber Trade Center database, Belgrade.
9. Glukhovskiy, V.M. and Hartkamp, W.L.J. 2014. Analysis of Russian pellet producers (unpublished).
10. Motik, D., Pirc Barčić, A., Šimunović, R. (2015): WOOD PELLET – A possibility for substitution of fosil fuels by renewable energy sources in public buildings in Croatia. Croatain Wood Cluster, February, 2015, Zagreb.
11. Murray, G. 2014. International pellet markets and Canadian pellet industry update. International Bioenergy Conference and Exhibition. June, 13th, 2014, Prince George, BC. http://www.pellet.org/images/2014-06-13_G_Murray_IBCES.pdf. (Accessed June 15th, 2015).
12. Olsson, M. (2002): Wood pellets as low-emitting residential biofuel. Lic. Eng. thesis, Chalmers
13. University of Technology, Göteborg, Sweden.
14. Olsson, M., Kjällstrand, J. (2004): Emissions from burning of softwood pellets. Biomass and Bioenergy 27(6), 607-611.

15. Paniz, A., Bau, L. (2014): Italy, the most important European pellet market. Presentation AIEL, January, 15th, 2014, Gratz. file:///C:/Users/Andreja/Downloads/Paniz_PPP.pdf (Accessed June, 20th, 2015).
16. Roster, C.A., Rogers, R.D., Albaum, G. (2004): A comparison of response characteristics from web and telephone surveys. International Journal of Marker Research. 46 (3): 359-373.
17. Wahlund, B., Yan, J., Westermark, M. (2004): Increasing biomass utilisation in energy systems: A comparative study of CO2 reduction and cost for different bioenergy processing options. Biomass and Bioenergy 26(6), 531-544.
18. ***: FAOSTAT 2014. ForesSTAT. Wood pellets – production. Available at: faostat3.fao.org/faostat-gateway/go/to/download/F/*/E
19. ***: Statistics Canada. 2014. Canadian International Merchandise Trade Database. Ottawa, Canada. Available at: www5.statcan.gc.ca/cimtcicm

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ECO CERTIFICATION OF APPLIANCES FOR BURNING WOOD FUELS

Slavica Petrović

ABSTRACT

The paper[18] presents research results of the most significant eco labels used in Europe for wood fuels burning appliances. Eco certified appliances are characterized by high energy efficiency and low emission of harmful gasses, and these values are significantly stricter than the values permitted in relevant standards for the quality of wood fuels burning appliances. In certain European countries, eco certification of wood fuels burning appliances and possession of eco label is a precondition for receiving subsidies for purchasing new appliances for wood fuels burning.
Key words: eco certification, wood fuels, boilers, stoves, efficiency, emission

1. INTRODUCTION

Procedure of eco certification is a voluntary certification system which confirms that a certain product or service within a special product and service category has better environmental characteristics than the other products or services in this category (Petrović, S. 2012). Since we live in the ages when climate changes are getting increasingly expressed, the issue of ecology is gaining more attention. Thus, in previous years, eco certification schemes have been developed in Europe for a significant number of product groups, including wood fuels burning stoves and boilers. Apart from burning appliances, the eco certification procedure is also conducted for wood fuels in Europe (Petrović, S. 2012).

Apart from direct impact on ecology, eco certification procedure is in certain European countries also directly connected with the subsidies allocated for installing wood fuels burning stoves and boilers.

2. METHODS

For the needs of the research the results of which are presented in this paper, adequate methodological basis is adopted consisting of general scientific methods, such as the method of analysis, namely content analysis and comparative analysis, as well as the methods of induction and deduction. Content analysis is used in the paper for studying and understanding the matter given in the instructions defining the requirements based on which the procedure of eco certification is carried out. Comparative analysis in the paper is used for the purpose of determining similarities and differences between adequate performances of wood fuels burning appliances key for conducting the procedure of eco certification, as well as for determining the similarities and differences between the analyzed types of eco certification. By applying inductive and deductive method, adequate conclusions are made on the use of the most significant eco certificates in Europe for wood fuels burning appliances.

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3. RESEARCH RESULTS AND DISCUSSION

Due to the trends on the market in the field of ecology, in previous decades, certain European countries have developed advanced technologies for the production of stoves and boilers for burning wood fuels, characterized by extremely low emission of harmful gases originating from the combustion process as well as high level of energy efficiency. These two characteristics in particular, emission of gases and energy efficiency, are the main characteristics tested during the procedure of eco certification of stoves and boilers. However, the first condition which wood fuel burning boilers and stoves have to fulfill in order to be subjected to eco certification is that they are produced pursuant to the requirements of adequate European standards for quality. This means that wood fuel burning boilers have to be produced pursuant to the standard EN 303-5:2012[19]: *Heating boilers - Part 5: Heating boilers for solid fuels, manually and automatically stoked, nominal heat output of up to 500 kW - Terminology, requirements, testing and marking*, wood pellet burning stoves have to be pursuant to the standard EN 14785:2011: *Residential space heating appliances fired by wood pellets - Requirements and test methods,* and firewood burning stoves have to be pursuant to the standard EN 13240:2001: *Roomheaters fired by solid fuel - Requirements and test methods*.

3.1. European standards for wood fuels burning boilers and stoves

Pursuant to the requirements of the standard EN 303-5:2012, boilers burning solid fuels, including wood fuels, are categorized into three classes depending on energy efficiency:

- Class 3 whose energy efficiency is determined according to the formula:

$$\eta_k = 67 + 6 \log Q, \text{ where Q is up to 300kW;}$$

- Class 4 whose energy efficiency is determined according to the formula:

$$\eta_k = 80 + 2 \log Q, \text{ where Q is up to 100kW and}$$

- Class 5 whose energy efficiency is determined according to the formula:

$$\eta_k = 87 + \log Q, \text{ where Q is up to 100 kW.}$$

Symbols in the formulae have the following meaning:

- η_k – efficiency in %; Q – heat output in kW.

Pursuant to this standard, depending on the value of the emission of CO, organic gaseous carbon (OGC) and dust originating from fuel combustion, boilers are divided into three classes, the third class being the lowest quality class, i.e. with the highest values of emission (“the dirtiest”), while the boilers of the fifth class are of the highest quality with the lowest values of emission (“the cleanest”) (table 1). The Standard does not set limit values for the emission of oxides of nitrogen.

Since certain European countries produce boilers for burning wood fuels characterized by higher values of energy efficiency than the values set in the standard EN303-5:2012 and by significantly lower emissions of gases than the values given in table 1, this standard contains Annex C setting the requirements for these two characteristics of the boilers which are applicable only in certain European countries. Pursuant to the requirements set for the Austrian market, wood fuels burning appliances, automatically and manually stoked, are divided into three groups according to energy efficiency, where the required minimal values for this characteristic are higher than the values set in the general text of the standard EN303-5 (table 2).

[19] Standards adopted by the European Committee for Standardization have EN mark, and after the member states of the Committee endorse these standards and proclaim them as national standards, they obtain a special prefix in the mark (Austrian standard is marked by ÖNORM EN, German by DIN EN and Serbian by SRPS EN).

Table 1. Emission limits for CO, OGC and dust according to standard EN 303-5:2012 for wood fuels boiler

Nominal heat output	Emission limits (mg/m³ at 10% O_2)								
	CO			OGC			Dust		
	Class 3	Class 4	Class 5	Class 3	Class 4	Class 5	Class 3	Class 4	Class 5
Automatically fired boiler									
< 50	3000	1000	500	100	30	20	150	60	40
> 50 ≤150	2500			80			150		
> 150 ≤ 500	1200			80			150		
Manually fired boiler									
< 50	5000	1200	700	150	50	30	150	75	60
> 50 ≤150	2500			100			150		
> 150 ≤ 500	1200			100			150		

Source: Standard EN 303-5:2012

Table 2. Requirements for efficiency of central heating used for wooden fuels according to the nominal heat output on Austrian market

	Heat output (kW)	Minimum efficiency (%)
Manually loaded boiler	up to 10	79
	10 – 200	$(71.3 + 7.7 \log P_N)^*$
	> 200	89
Automatically loaded boiler	up to 10	80
	10 – 200	$(72.3 + 7.7 \log P_N)^*$
	> 200	90
$^*P_N$ is the nominal heat output.		

Source: Standard EN 303-5:2012, Annex C

Table 3. Emission limits for CO, NO_x, OGC and dust of small burners for solid fuels manually loaded on Austrian market

Parameter	Emission limits (mg/MJ)	
	Room heaters	Central heaters
CO	1100	500
No_x	150	100
OGC	50	30
Dust	35	30

Source: Standard EN 303-5:2012, Annex C

Table 4. Emission limits for CO, NO_x, OGC and dust of small burners used for solid fuels automatically loaded on Austrian market

Parameter	Emission limits (mg/MJ)		
	Wood pellets (Room heaters)	Wood pellets (Central heaters)	Other wooden fuels
CO	500	250	250
Nox	100	100	100
OGC	30	20	30
Dust	25	20	30

Source: Standard EN 303-5:2012, Annex C

Annex C sets the values for the emission of gases for only one quality class of appliances for room and central heating with nominal heat output manually and automatically loaded for the market in

Austria (tables 3 and 4). Values of emissions set for the market in Austria are expressed in mg/MJ unlike the general text of the standard EN303-5, where the values are expressed in mg/m^3 per 10% O_2.

For German market, the annex sets the requirements only for the emission of CO and dust for various types of wood fuels (table 5).

Table 5: Requirements for the emission of gases for wood fuels burning boilers applied on the market in Germany for appliances installed after 31.12.2014

Type of fuels	Nominal output range (kW)	Dust g/m^3	CO g/m^3
Split logs, wood chips, brush wood and cones, saw dust, shavings, abrasive dust, bark, wood pellets	≥ 4	0.02	0.4
Coated, varnished or laminated wood as well as remains, as far as no wood preservative has been applied or is contained due of a treatment and the laminates do not contain halogens in organic bonding or heavy metals; Plywood, chipboard, fibreboards or otherwise glued wood as well as the remains, as far as no wood preservative has been applied or is contained due to a treatment and the laminates do not contain aforementioned fuels	≥ 30 ≤ 500	0.02	0.4
	> 500	0.02	0.3

Source: Standard EN303-5:2012, Annex C

Pursuant to the requirements of the standard EN 14785:2011, energy efficiency of wood pellet burning stoves (based on net calorific value) should be at least 75% at nominal heat output and 70% at partial heat output. According to the requirements of the standard, CO concentration in fumes at 13% oxygen content shall not exceed 500 mg/m^3 at nominal heat output and 750 mg/m^3 at partial heat output. Limit values for the emission of oxides of nitrogen for wood pellet burning stoves are not set in the standard.

3.2. European eco labels for wood fuels and wood fuel burning appliances

The most significant eco labels used in Europe for wood fuels burning boilers and stoves are the following: Nordic “SWAN”, German “Blue Angel” and Austrian “UZ 37”. The same types of eco certification are also used for wood fuels (Petrović, S. 2012).

Nordic eco label is awarded for boilers with heat output up to 500 kW burning biofuels primarily firewood, wood pellets, briquettes, chips and straw, stoked automatically or manually and wood fuels burning stoves with heat output of 3-15 kW.[20] This type of eco label is used in Denmark, Sweden, Norway, Finland and Iceland. Values for the emission of CO and organic gaseous carbon pursuant to the Nordic eco certification for manually stoked appliances are twice lower than the values set in the general text of the standard EN303-5:2012, while this value for dust is 33% lower. At the same time, for automatic boilers the value of the emission of CO and organic gaseous carbon pursuant to the Nordic eco certification is twice lower than the value set in the general text of the standard EN303-5:2012, while the value for dust is the same (table 6).

Table 6: Threshold values for Nordic Ecolabelled boilers tested at 10% O_2

	CO	OGC	Particles	NOx
	mg/m^3	mg/m^3	mg/m^3	mg/m^3
Manually fired boiler	350	15	40	200
Automatically fired boiler	250/250	10/10	30/40	200/200

Source: Nordic Ecolabelling of Boilers for solid biofuel, Version 3.0

[20] Requirements which are presently valid for the procedure of Nordic eco certification of wood fuel burning appliances are valid until 30 June 2019.

Nordic eco certification defines two quality classes for energy efficiency of appliances up to 100 kW and over 100 kW respectively, manually and automatically stoked and the set values are higher than the values defined in the general text of the standard EN303-5: 2012.

Table 7: Values for energy efficiency of wood fuel burning boilers according to the Nordic ecolabel

Manually fired boiler up to 100 kW	nk=87 + log (output), where output is the stated output at nominal load of the boiler.
Manually fired boiler more than 100 kW	nk is always 89%.
Automatically fired boiler up to 100 kW	nk = 88 + log (output), where output is the stated output at nominal load and low load of the boiler (30% of nominal load).
Automatically fired boiler more than 100 kW	nk is always 90% (at nominal load and low load).

Source: Nordic Ecolabelling of Boilers for solid biofuel, Version 3.0

Energy efficiency of manually stoked wood fuel burning stoves at nominal heat output according to the requirements of Nordic eco certification has to be at least 76%, i.e. 87% for wood pellet burning stoves. Limit values for the emission of gases for wood fuel burning stoves according to the Nordic eco certification are given in table 8. The set value for CO emission is 2.5 times lower than the value set in the standard EN14785.

Table 8: Threshold values for emissions from Nordic Ecolabelled fireplaces tested with 13% O_2 (nominal load)

	OGC	CO	Particles
	mg/m^3	mg/m^3	g/kg
Manually operated stove (valid from 1.7.2014 to 30.6.2017.)	100	1250	3.0 (mean value for up to 4 loads) 6.0 for each loads
Manually operated stoves (valid from 1.7.2017 to 30.6.2019.)	100	1250	2.0 (mean value for up to 4 loads) 5.0 for each load
	mg/m^3	mg/m^3	mg/m^3
Pellet stove	10	200	15

Source: Nordic Ecolabelling of Stoves, Version 4.0

Apart from gases emission and energy efficiency, it is required for the process of Nordic eco certification that the boilers and stoves have to meet certain additional requirements, such as obeying regulations for energy consumption, not using of chemical substances in surface coating which have the characteristics of dangerous substances as well as five years guarantee for the body of the boiler. Requirements for Nordic eco certification define which heavy metals and compounds must not be contained in glues, varnishes, colors, sealants and degreasers used in the production and for surface coating of boilers and stoves burning wood fuels. Substances used for surface coating of boilers and stoves shall have the maximum of 60% of organic volatile components. Producers also have to give instructions to the consumers concerning the installation of the boiler, namely whether it has to be installed by a certified installer, about annual servicing and about the manner and location where the consumers can get spare parts for the product in the period of ten years after the end of the production of such boiler model. Each boiler or stove with ecolabel is distributed on the market with operation and maintenance instructions. According to these instructions, firewood with moisture content up to 18% and diameter up to 10 cm has to be used in stoves. Because of such expanded requirements which do not refer only to environmental characteristics manifested in the values of gases emission, Nordic ecolabel is also considered as a quality mark, which gives it a special status on the markets in Nordic countries.

Figure 1: Logo of Nordic ecolabel

After the procedure of eco certification, producer of appliances for burning wood fuels has the right to place the mark and the number of eco certificate on the product and the accompanying documents (figure 1).

German ecolabel "Blue Angel" is given for boilers burning wood pellets and wood chips with heat output up to 500 kW and wood pellet burning stoves with heat output up to 15 kW. Directive RAL UZ 112[21] defines the requirements pursuant to which the German ecolabel is issued for boilers fired by wood pellets and chips, while the Directive RAL UZ 111 defines the requirements for wood pellet burning stoves.

According to the instructions for German ecolabel, in wood pellet burning stoves and boilers it is desirable to use pellets produced pursuant to the requirements of the standard EN 14961-2 (class A1), ENplus (class A1) or DINplus, i.e. wood chips with quality DIN EN 14961-4 and ONORM M 7133.
Energy efficiency of appliances with heat output up to 12 kW (including 12kW) shall not be less than 90% at nominal load and 89% at partial load (30% of the nominal load). For appliances with heat output over 12 kW, efficiency shall not be less than 90% at nominal and partial load. Values for the emission of gases pursuant to the requirements of the German ecolabel for boilers fired by wood pellets and chips are given in tables 9 and 10. Because of different division of boilers according to heat output and fuel types used in them, requirements for emission of gases set in German eco certification are not comparable with the values set in Annex C. Values for gases emission defined in the requirements for German eco certification are expressed for oxygen content of 13%, while the values set in the standard EN303-5 are defined for oxygen content of 10%.

Table 9. Requirements for CO emission pursuant to the German ecolabel for boilers fired by wood pellets and chips at 13% O_2

Boilers fired by wood pellets and chips with nominal heat output up to 50 kW		Boilers fired by wood pellets and chips with nominal heat output of more than 50 kW up to and including 500 kW	
at nominal load	at part load conditions (30% of nominal)	at nominal load	at part load conditions (30% of nominal)
mg/Nm^3			
< 80	< 180	< 70	< 150

Source: RAL-UZ 112.

Table 10. Requirements for the emissions of NOx, OGC and dust pursuant to the German ecolabel for boilers fired by wood pellets and chips at 13% O_2

Parameter	Wood pellet boiler		Wood chips boiler	
	at a nominal load	at part load conditions (30% of nominal)	at a nominal load	at part load conditions (30% of nominal)
	mg/Nm^3			
NO_x	150	--	190	--
OGC	5	5	5	5
Dust	20	40	30	40

Source: RAL-UZ 112.

Pursuant to the requirements of the German eco certification, energy efficiency of stoves shall not be less than 90% at nominal and partial load, while the values of emission of gases are at 13% O_2 as in table 11. According to the requirements of the German eco certification, CO value for wood pellet burning stoves at nominal load is 3.1 times less than the values set in the standard EN14785.

[21] Directive RAL UZ 112 is presently being revised.

After the procedure of eco certification, producer of appliances for burning wood fuels has the right to place the mark and the number of eco certificate on the product and the accompanying documents (figure 2).

Table 11: Limit values for the emission of gases pursuant to the requirements of the German ecolabel for wood pellet stoves

	NO_x	CO	OGC	Dust
	mg/Nm^3			
Wood pellet stove				
- nominal load	150	160	8	25
- partial load conditions		350	13	55

Source: RAL-UZ 111.

Figure 2: Logo of German eco-label

The procedure of Austrian eco certification is conducted for boilers with heat output up to 400kW fired by wood pellets, briquettes, chips and firewood automatically or manually stoked. Requirements for Austrian eco certification of wood fuels burning boilers and furnaces are defined in the Directive UZ 37 enacted by the Ministry of Agriculture, Forestry, Environment and Water Management.

The Directive recommends using wood fuels certified pursuant to the requirements of the Directive UZ 38 in boilers and stoves fired by wood fuels, i.e. to use wood pellets produced in accordance with the requirements of the standard *ÖNORM* EN14961-2 and *ÖNORM M7136*, while the quality of wood chips shall be in accordance with the requirements of *ÖNORM* EN14961-4. According to the requirements of Austrian eco certification, efficiency of automatically stoked boilers and stoves fired by wood fuels shall be 90% (at nominal heat output), and 80% for manually stoked stoves, while the efficiency of manually stoked boilers is calculated according to the formula:

$$71.3 + 7.7 \log Q_N$$

Values for emission of gases and dust according to the Austrian ecolabel for automatically and manually stoked boilers and stoves are given in tables 12 and 13. In Directive UZ37, the strictest requirements for the emission of gases are set for wood pellet burning boilers and stoves, where the value set for CO emission is 4.2 times lower than the value set in Annex C, emission of organic gaseous carbon is 6.7 times lower, while the allowed value for dust is 25% lower than the value set in the Annex.[22] Pursuant to the requirements of Austrian eco certification, allowed values for the emission of gases for wood chips burning boilers are slightly higher than for wood pellet burning boilers (table 12).Value for CO for wood pellet stoves is 4.2 times lower than the value set in the Annex C, while the value for the emission of organic gaseous carbon is five times lower and for the dust it is 20% lower.

Requirements for the emission of gases set in the Directive UZ37, for manually stoked stoves and boilers are not so rigorous as the values set for automatically stoked boilers. According to the Directive UZ37, value for CO emission for boilers is twice lower than the value set in Annex C, while the values for dust and organic gaseous carbon are the same as in the Annex (table 13).

[22] Compared to nominal heat output.

Table 12. Limit values for the emission of gases and dust for automatically stoked stoves and boilers according to the Austrian eco certification scheme at nominal load

Parameter	Type of fuels	Boiler	Stove
		mg/MJ	
CO	- wood pellets - wood chips	60 150	120
NO_x	- wood pellets - wood chips	100 100	100
OGC	- wood pellets - wood chips	3 5	6
Dust	- wood pellets - wood chips	15 30	20

Source: Directive UZ37

Table 13. Allowed values for emission of gases and dust for manually stoked stoves and boilers fired by wood fuels according to the Austrian eco certification scheme

Parameter	Boiler	Stove
	mg/MJ	
CO (nominal load)	250	700
NO_x	120	120
OGC (nominal load)	30	50
Dust	30	30

Source: Directive UZ37

Eco certification is very well accepted on the market in Austria and this is confirmed by the fact that there are the total of 93 models of certified stoves fired by firewood and wood pellets on the market available to the consumers as well as the total of 384 models of boilers fired by firewood, chips, pellets and the combination of these fuels (May, 2015) (http://www.umweltzeichen.at/cms/home/produkte/gruene-energie/content.html?rl=26). After eco certification, producers of wood fuel burning stoves and boilers are entitled to put Austrian ecolabel on the certified products (figure 3).

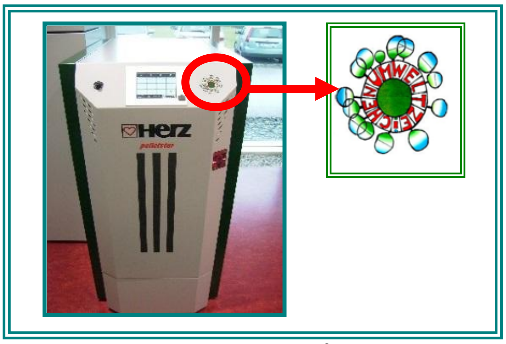

Figure 3. Austrian ecolabel for wood pellet boilers, Petrović, S., 2013

Pursuant to the Directive UZ 37, eco certification of wood fuel burning stoves and boilers in Austria is a precondition for obtaining certain state, province and municipal subsidies (Petrović, S., 2014). State subsidy, for which eco certification is the precondition, is awarded from the Climate and Energy Fund and it is intended for households for appliances with heat output up to 50kW, namely, 2,000€ is given for the replacement of boilers fired by fossil fuels and electricity with the boilers fired by wood pellets and chips, 800€ is given for the replacement of old boilers fired by wood fuels (at least 15 years old) with the boilers fired by wood pellets or chips and 500€ is given for the installation of new wood pellet stoves. Also, eco certification is the precondition for giving subsidies in certain provinces and these provincial subsidies can be fixed or variable (Klima-und Energiefonds, 2015).[23] The amount of fixed subsidy for installing wood pellet boilers ranges from 2,300€ to 3,000€ depending on the province, for wood chips boilers from 2,300€ to 4,500€

[23] Concerning fixed subsidies, their amount does not depend on the amount of investment costs for stoves and boilers, while for variable subsidies this amount varies and is defined as a percentage of the investment costs which is reimbursed with the subsidies.

and for firewood boilers from 1,200€ to 2,600€[24]. Amount of variable subsidies for installing wood pellet boilers is 20-30% of the investment costs, depending on the province, which is the maximum of 2,600€ in terms of money (proPellets Austria, 2015, http://www.propellets.at/de/foerderungen/landesfoerderungen/).

5. CONCLUSION

Because of expressed care about ecology, eco certification of stoves and boilers for the combustion of wood fuels has become very significant in the last several years in certain European countries. In Europe, Nordic "SWAN", German "Blue Angel" and Austrian "UZ 37" eco certifications are used most for wood fuel burning appliances. Stoves and boilers have to be produced in accordance with general quality requirements set in adequate standards, namely EN303-5:2012 for boilers, EN14785:2011 for wood pellet stoves and EN13240:2001 for firewood stoves in order to be subjected to eco certification. In the procedure of eco certification, two main characteristics of wood fuel burning stoves and boilers are tested, namely emission of gases and energy efficiency. Values of these two performances set in the requirements of the respective eco certifications are much more rigorous than the values set in adequate standards for the quality of stoves and boilers. Generally, all analyzed eco certifications are characterized by the strictest requirements for CO emission, followed by dust, while the values for volatile organic carbon are frequently the same as in the relevant standards. It was not possible to compare the values for the emission of oxides of nitrogen for wood fuel burning stoves and boilers because these values are set in the requirements for eco certification but they are not set in the standards for the quality of these appliances.

Results of the comparative analysis of the values for gases emission defined in the general text of the standard EN303-5 and Annex C with the values set in the analyzed types of eco certification show that all types of eco certifications set lower allowed values of emissions than the values defined in the standards. By comparing the values of gases emission set in the requirements of the analyzed eco certifications, it can be concluded that Austria and Germany have very strict requirements because they allow a low content of CO, oxides of nitrogen, gaseous organic carbon and dust. Also, according to the requirements of all analyzed eco certifications, wood fuel burning appliances need to have higher values of energy efficiency than the values set in the relevant standards in order to obtain eco certificate. This is very important for the producers of wood fuel burning appliances from Serbia to know if they plan to export their products onto the Austrian market, on which eco certification is a precondition for getting certain kinds of subsidies for installing wood fuel burning stoves and boilers.

REFERENCES

1. Klima-und Energiefonds (2015): Leitfaden, Holzheizungen, Eine Förderaktion des Klima-und Energiefonds der österreichischen Bundesregierung, Version 2015, Wien, Austria, https://www.klimafonds.gv.at/assets/Uploads/Downloads-Frderungen/Holzheizungen/LF-Holzheizungen-2015.pdf, accessed on: 19.05.2015.
2. Nordic Ecolabelling of Stoves, Version 4.0, 11 June 2014 - 30 June 2019, the Nordic Council of Ministers, http://www.nordic-ecolabel.org/criteria/product-groups/?p=2, accessed on: 25.06.2015.
3. Nordic Ecolabelling of Boilers for solid biofuel, Version 3.0, 11. June 2014 - 30. June 2019, the Nordic Council of Ministers, http://www.nordic-ecolabel.org/criteria/product-groups/?p=2, accessed on: 25.06.2015.

[24] Austria has 9 provinces which do not have harmonized politics, i.e. the requirements and amounts of subsidies allocated for wood fuel burning appliances, thus the conditions and amounts of the subsidies are different in every province.

4. Petrović, S. (2012): Eco Certification of Wood Fuels and its Contribution to the Climate Change Mitigation, International Conference Wood and Furniture Industry in Times of Change - New trends and Challenges, pp. 72-80, 6-8.06.2012., Faculty of Mass Media Communication, 978-80-8105-374-0
5. Petrović, S. (2014): Tržišni potencijali i ekonomski efekti održivog korišćenja drvnih peleta kao biogoriva u Srbiji, doktorska disertacija, Šumarski fakultet, Beograd
6. RAL-UZ 111: Basic Criteria for Award of the Environmental Label for Wood Pellet Stoves, February 2011, the Environmental Label Jury, https://www.blauer-engel.de/en/products/energy-heating/wood-pellet-stoves/wood-pellet-heaters, accessed on: 09.09.2015.
7. RAL-UZ 112, Basic Criteria for Award of the Environmental Label, Wood Pellet and Wood Chip Boilers, February 2011, The Environmental Label Jury, http://www.blauer-engel.de/en/products/energy-heating/wood-pellet-boilers-and-wood-chips-boilers/wood-chips-boilers, accessed on: 09.09.2014.
8. Richtlinie UZ 37, Holzheizungen, Bundesministerium für Land - und Forstwirtschaft, Umwelt und Wasserwirtschaft, Version 5.2, Ausgabe vom 1. Jänner 2015, http://www.umweltzeichen.at/richtlinien/Uz37_R5.2a_Richtlinie_Holzheizungen_2014.pdf, accessed on: 25.06.2015.
9. Standard EN 303-5:2012: Heating boilers for solid fuels, manually and automatically stoked, nominal heat output of up to 500 kW - Terminology, requirements, testing and marking, European Committee for Standardization, Brussels, Belgium
10. Standard EN 14785:2011: Residential space heating appliances fired by wood pellets - Requirements and test methods, European Committee for Standardization, Brussels, Belgium
11. Standard EN 13240:2001: Roomheaters fired by solid fuel - Requirements and test methods, European Committee for Standardization, Brussels, Belgium

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OPTIMIZATION OF ECONOMIC PARAMETERS OF DISTRICT HEATING SYSTEMS THROUGH THE CHANGE OF FUEL BASE TO BIOMASS AND NATURAL GAS

Martin Jankovský, Josef Drábek, Július Jankovský

ABSTRACT

In this study we focused on the problem of heat supply in district heating systems in the situation, which occurred after new legislation (Directive of the European Parliament and Council 75/2010/EU) on industrial emission was passed. The directive enforces more strict emission limits for energy plants with output of 50 MWth or more. The methods applied are verified on a case study of reconstruction of the district heating plant in Zvolen. The low utilization of installed output (under 30%) and operating an unnecessary steam distribution system cause loss of competitiveness of the district heating plant. Through inefficient energy conversion the plant lost about €6.3m in comparison with an optimally designed and operated plant. By selecting a suitable reconstruction alternative, eliminating the energy and economic losses, the reconstructed district heating plant could be effectively operated. The selected investment alternative is based on co-firing biomass and natural gas and ensures a Net Present Value of €41m, Internal Rate of Return of 9.77% and Discounted Payback Period of seven years and two months at capital expenditures of €60.5m, 300 thousand MWh of heat supply and 166 thousand MWh of power supply.

Key words: woodchips, heating plants, combined heat and power plants

1. INTRODUCTION

Operation of a district heat and power plant in Zvolen started to have economic problems after Slovakia joined the European Union and the emission limits were made stricter. The plant could not comply to the then new limits with the systems they operated at that time, so a complex reconstruction of the heat and power plant was planned. The reconstruction took place during 2005 to 2008 and was based on exchanging the fuel base from Slovak lignite to a mix of low sulphur brown energy coal and biomass. The reconstruction was designed so that the plant would meet all requirements of the effective legislation. Sulphur oxide (SO_2) emissions, nitrous oxide (NO_x) emissions, and the particle matter emissions were under the emission limits.

The European Parliament and Council passed new, stricter, legislation regarding emissions emitted by industry in 2010 (Directive of the EP and C n 2010/75/EU). According to the directive, existing energy and industrial polluters have until January 1st 2016 to meet the requirements of the new legislation, otherwise the operation of these plants will be terminated. Other legislation that affects the operation of combustion plants with thermal output of 50 MW or more (LCPs) in Slovakia are act n. 309/2009 Coll. On the support of renewable energy resources and high efficiency combined heat and power generation, act n. 656/2004 Coll. On Energy sector, which determines the system of support for using renewable energy resources and combined heat and power generation in Slovakia, and act n. 657/2004 Coll. On heat generation, which dictates a requirement to devise a concept of municipal development regarding energy utilization.

The aim of this paper is to evaluate an alternative of the Zvolen's LCP reconstruction where brown coal would be exchanged for biomass and natural gas, and the nominal thermal output of the LCP would be optimised for the decreased needs of the Zvolen's district heating network. The reconstruction should enable to operate the LCP in the conditions of the new legislation (compliance to the emission limits) and enable to generate heat and power with lower total costs.

2. MATERIALS AND METHODS

2.1 Object of study

The studied object was a district heat and power plant in Zvolen, with input power exceeding 50 MW (Large Combustion Plant – LCP). The plant supplies generated heat the district heating network according to the needs of the network. Heat is generated by combusting fuel in an integrated combustion system. The regulation system has to adjust the output of the boiler so that the needs of the heating network, own consumption and electricity generation are safely met. Monitoring of emissions released into the air is continuous.

2.2 Data sources and data gathering

The paper was elatorated based on study of current and future legislation, regulations, orders, and strategic studies, etc.

The evaluation of designs of the LCP and supportive energy systems, such as fuel supply system, material supply system, heat and power offtake, waste disposal, etc., was based on the operation regulations, technical standards and documents for safe operation of energy plants. We took advantage of the long-term personal knowledge of the co-author with managing municipal and industrial energy plants for technical estimations.

The calculations were based on the knowledge of the physical effects, thermodynamic calculations, diagrams and tables, balances of energy and mass, and on empirical data on specific indicators, normatives of fuel balancing and energy transformations in the plant and heat and power distributors (Karafiát 2001).

2.3 Evaluation and interpretation of results

A methodical approach was designed, applicable for any LCP, for selecting the optimal alternative of LCP reconstruction. The approach was based on comparison of key components of reconstruction and was composed of the following steps:

1. Analysis of the customers and determining the demand for heat,
2. Creation of the annual diagram of the heating needs of the district heating network,
3. Coverage of the diagram of the heating requirements by the basic and peak heat sources,
4. Possibility to use combined heat and power generation,
5. Evaluation of the technical solution of the LCP according to set parameters and the needs of the consumers regarding the heating medium – selection of a design that meets technical requirements,
6. Optimization of the heat output of the LCP from the view of electricity generation and overall energy efficiency, the need to meet the requirements for high efficiency combined heat and power generation (HE CHP),
7. Optimization of the fuel base,
8. Evaluation of the technical solution and the fuel base of the LCP from the view of possible subsidies according to current and future legislation,

9. Possibilities of financing the reconstruction of the LCP and elaboration of a feasibility study using dynamic methods of evaluation of investment projects – selection of an economically optimal design of the LCP reconstruction,
10. Environmental effects of the LCP on the region – recommendation on the selected design of LCP reconstruction.

Numerous of technical designs was available when assessing them without technical, technological, environmental, economic, and other restrictions. The first stage of evaluation was to exclude technically unfeasible designs according to previously set criteria. The second stage of evaluation was to select the optimal design from the technically, and technologically feasible designs through dynamic methods of evaluation of investments, such as net present value (NPV), internal rate of return (IRR), discounted payback period (DPP) and other methods. The calculations were carried out according to Drabek and Polách (2008). The third stage consisted of evaluation of the environmental effects of individual designs and recommendation to the investor.

3. RESULTS AND DISCUSSION

In this study we approached the problem of supplying heat in district heating networks. The problem originated from passing a new directive of the European Parliament and Council (EP and C) n. 75/2010/EU on industrial emissions. The EP and C passed stricter emission limits for LCPs.

3.1 Optimization of the fuel base

Variable costs of LCP's were highly dependent on the fuel costs of the plant. Almost 50% of the operating costs were linked with fuel. Selection of appropriate fuel base also affects the revenues of the plant, because state subsidies for electricity production differ for individual fuel types (fossil fuels, biofuels, renewable resources, etc.). This made optimization of the fuel base an essential component of LCP reconstruction. The basic requirements for fuel base selection were: acceptable purchase price, subsidies of generated power, and low capital and operational costs connected with the reconstruction of heat and power generation, minimization of the costs of purchase of CO_2 emission quotas.

Using biomass as fuel enabled intensification of heat and power generation by drying wood chips through low potential heat, thus improving their characteristics and increasing the share of utilized heat.

3.2 Determination of the optimal alternative for LCP reconstruction

The basic requirements for reconstruction feasibility were:

1. Sufficient heat input to cover the needs of the district heating network,
2. Using heating medium compatible with the requirements of the energy consumers,
3. Environmental effects compatible with tolerable ecological loading of the area (emissions, imissions, ash production, emission quotas, etc.),
4. Return of invested capital at market or regulated prices of electricity,
5. Return of invested capital at heat prices competitive in the area.

The capital needed for the reconstruction is specified in Table 1. The most expensive part of the reconstruction was installation of a new turbo generator, followed by construction of a new stationary fluidization boiler with output of 65 MW_{th}. The boiler is able to combust biomass and use natural gas as a stabilization fuel for when the biomass is of suboptimal quality. If stabilization fuel was not be used, the burning process would be inconsistent, resulting in decreased efficiency of the boiler and excessive emission production. Another costly part of the reconstruction was the reconstruction of the steam and hot-water distribution pipelines. The currently installed pipelines are old and in substandard state, meaning higher heat losses during distribution of products to the consumers.

Table 1 Capital expenses for the reconstruction of the LCP to biomass and natural gas fuel base

Item	Price (€)
Boiler construction - stationary fluid	11 000 000
Turbo generator construction	30 000 000
Denitrification system	2 500 000
Reconstruction of electrostatic separators	1 000 000
Reconstruction of product pipelines	13 000 000
Reconstruction of other systems	2 000 000
Construction of heat distribution system	1 000 000
Total	60 500 000

After the reconstruction the LCP will supply about 300 thou. MWh of heat to the district heating network and about 140 MWh of electricity to the electrical grid. The price of heat in the region is 10.39 €/MWh and the government regulated price of electricity supplied to the electrical grid is 128.77 €/MWh. Together with revenues for other sold products (such as demineralized water, grid regulation support services, etc.) supplying heat to the district heating network and electricity to the electrical grid will generate about 36.60 mn. € annual revenues. The annual operational costs of the reconstructed LCP are presumed to be cca 26.41 mn. €, the biggest share of which cosists of fuel costs (16.16 mn. €/year), amortization (6.80 mn €/year), and services (1.10 mn. €/year).

The total revenues for the projected period (15 years) will be cca 549.04 mn. €, total operational costs will be cca 397.84 mn. €. The gross operational profit for the 15 year period will therefore be about 151.20 mn. €. Compared to the current state of the LCP the reconstructed LCP will generate about 196.32 mn. € in gross operating profit, because the unreconstructed LCP will generate a total loss of 45.12 mn. € for the whole projected period. The development of net cash flow and cumulated net cash flow is depicted in Fig. 1. Fig. 2 shows the development of discounted cash flow and cumulated discounted cash flow.

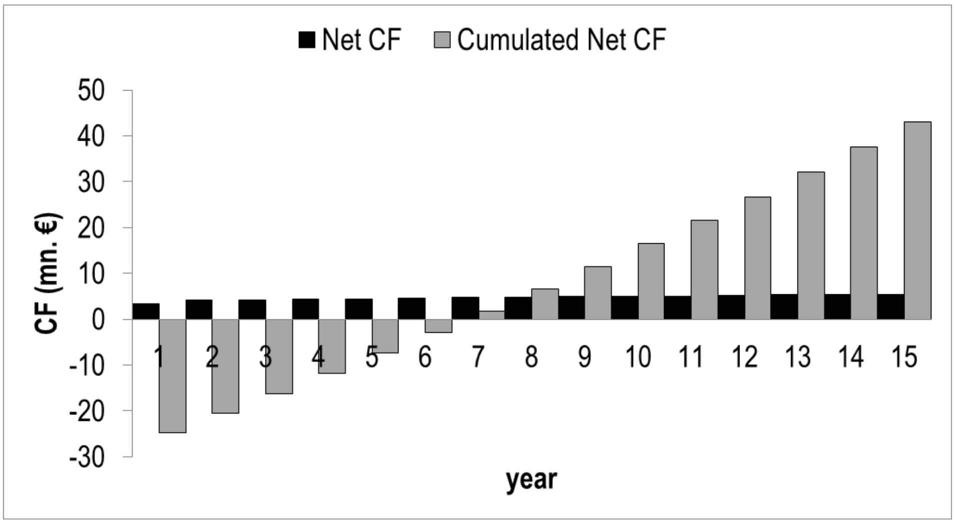

Figure 1 Net cash flow and cumulated net cash flow development throughout the projected period of reconstructed LCP operation

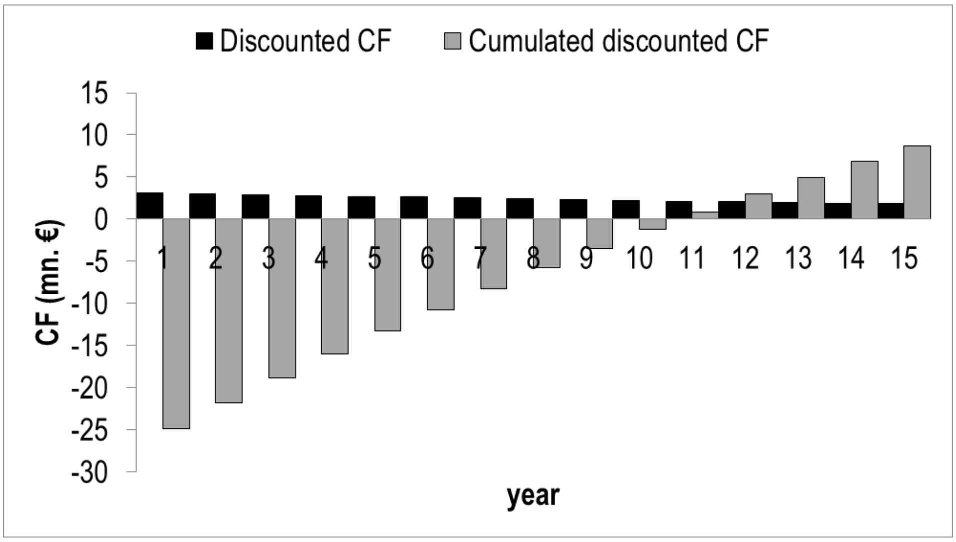

Figure 2 Discounted cash flow and cumulated discounted cash flow development throughout the projected period of reconstructed LCP operation

Dynamic methods of investment plans evaluation show that the reconstruction is viable. Net present value of the project is 41.77 mn. €, internal rate of return was 9.77 %, discounted payback period is about nine years.

The reconstruction of the LCP to biomass and natural gas fuel base meets all requirements set by current and future legislation. After the reconstruction, wood chips consumption will increase by cca 100 000 t year^{-1} compared to consumption reached in 2012.

4. CONCLUSIONS

The aim of this study was to determine the optimal alternative of Zvolen's LCP reconstruction. The best alternative was to reconstruct the LCP using biomass and natural gas co-firing. Partial goals were to create the annual diagram of heating needs of the district heating network. The heating needs of the district heating network will be covered by a boiler with 65 MW_{th} output, operated 8 000 h year^{-1} (all year round, with the exception of the summer low season). The rest of the heating needs will be covered by peak and auxiliary heating plants during the summer low season and the winter high season. The output of the condensation part of the turbo generator was designed with regard to optimization of revenues for electricity supply. The most problematic parts were the balance circuits of machine room, own heat consumption, and the heat lossess in the primary heat distribution network.

The present nominal output of 273 MWt_{th} compared to the needs of the district heating network of 80 MW_{th} (efficiency of output utilization of cca 30 %) is the main reason why the LCP cannot compete with other means of heat and power generation in the region. Annual losses caused by ineffective energy transformation are 6.3 mn. € when compared to an effectively designed and operated LCP. By selecting a suitable reconstruction design, the company could finance the reconstruction and effectively operate the LCP. Our calculations prove that reconstructing the LCP to a lower output and changing its fuel base to biomass and natural gas would be a viable solution. The project would enable future operation of the plant and give opportunity to utilize local, safe, and environmentally friendly fuel.

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REFERENCES

1. Drábek, J., Polách, J. (2008): REÁLNE A FINANČNÉ INVESTOVANIE FIRIEM (REAL AND FINANCIAL INVESTMENTS IN ENTERPRISES). Zvolen – Zlín: Technická univerzita vo Zvolene. 271 pp.
2. Act n. 309/2009 Coll. ON THE SUPPORT OF RENEWABLE ENERGY RESOURCES AND HIGH EFFICIENCY COMBINED HEAT AND POWER GENERATION. 15 pp. [online] 1. July 2015. Available at: <http://www.zbierka.sk/sk/predpisy/309-2009-z-z.p-33084.pdf>.
3. Act n. 656/2004 Coll. ON THE ENERGY SECTOR. 41 pp. [online] 1. July 2015. Available at: < http://www.zbierka.sk/sk/predpisy/656-2004-z-z.p-8267.pdf>.
4. Act n. 657/2004 Coll. ON HEAT GENERATION. 14 pp. [online] 1. July 2015. Available at: < http://www.zbierka.sk/sk/predpisy/657-2004-z-z.p-8268.pdf>.
5. European Parliament and Council (2010): DIRECTIVE 2010/75/EU OF THE EUROPEAN PARLIAMENT AND COUNCIL ON INDUSTRIAL EMISSIONS (INTEGRATED POLLUTION PREVENTION AND CONTROL). 103 pp. [online] 1. July 2015. Available at: <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010L0075&from=EN>.
6. Karafiát, J. (2001): TEPLÁRENSTVÍ (DISTRICT HEATING). In: Vladimír Valenta (ed) Topenářská příručka (Handbook of Heating). 2432 pp.

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A CASE-STUDY OF ELECTRICITY GENERATION FROM PINE NEEDLES IN UTTARAKHAND, INDIA

Anand Mishra, Richard Vlosky

ABSTRACT

Access to reliable electricity is critical to human-welfare and income generation opportunities for households. A significant proportion of Indian rural population is energy poor resulting from insufficient economic and energy resources. There is a growing realization that the gap in energy access cannot be bridged exclusively by conventional energy resources like coal, oil, and gas. Therefore, renewable energy resources have recently been in focus as a potential source for mitigating energy poverty. This paper studies the potential of pine needles as a biomass feedstock for electricity generation through a gasifier plant situated in a remote mountainous region in Uttarakhand, India. We evaluate the project within a framework that spans policy, economic, and social issues.

1. ACCESS AND AFFORDABILITY OF ELECTRICITY IN DEVELOPING COUNTRIES

A key objective of developing countries is to provide its population affordable access to electricity in order to boost economic and social development, business sector, and individuals. Access to reliable electricity is critical to human-welfare and income generation opportunities for households. The related literature includes studies on the role of electricity in development of a country. Toman finds energy in general and electricity in particular to be a component in production functions and a productivity enhancing factor (Toman & Jemelkova, 2003). Other studies indicate that energy, together with other factors such as income levels, education, health, and literacy rates, positively contribute to the welfare categories such as : health service, education, income generation, and leisure (Mapako & Afrane-Okese, 2002);(Cowan & Mohlakoana, 2005); (Qase & Annecke, 1999).Cleaner energy results in health related benefits such as reduced smoke exposure, clean water, food-refrigeration , and higher productivity (Winkler et al., 2011). Electricity provides greater flexibility in time allocation through the day and evening as well as better conditions for education, lower transportation and communication costs, greater market access, and more access to information (Toman & Jemelkova, 2003). Therefore, energy is a necessary condition for development, even though energy on its own is not sufficient.

1.1. Dynamics of rural energy access in India

A significant proportion of Indian rural population is energy poor. India is constrained by insufficient economic and energy resources, therefore unable to build adequate infrastructure to provide access to electricity to rural population. Moreover, India's rural population also suffers under income poverty. Thus, for India, "unaffordability" because of poverty and "inaccessibility" because of inadequate infrastructure are the root causes of the lack of access to modern energy. The lack of energy access has major implications for economic development, livelihoods, and environmental sustainability. Access to energy has strong links with poverty reduction through income generating opportunities and other development indicators such as education, health and the environment. (Saghir, 2005).

Studies on rural electrification in India use the term energy-access in the context of the extent of access (percentage of households) population has to electricity, petroleum products, and modern bioenergy. Therefore, conversely, the data on energy access also connotes the extent of population's reliance on traditional energy resources like fire-wood, crop-waste, cattle-dung, kerosene, and vegetable oils for meeting its cooking and heating needs and candles for lighting. That India is facing a serious challenge in ensuring availability of reliable electricity to the majority of its predominantly rural population is borne out in the findings of the National Sample Survey (NSS), 67th round (NSS, 2009),which indicates that although 74% of the Indian villages are electrified; only 54.9% of the households had access to electricity, and the remaining depend on kerosene lamps for lighting. With respect to access to modern fuels for cooking, only 9% of the rural households have access to liquefied petroleum gas (LPG) and about 84% still depend on biomass for their cooking energy needs with only 1.3% having access to kerosene (see Table 1).

The estimates based on NSS data and Indian energy statistics (MOSPI, 2009) (Table 2) show that only 55% of the rural households use electricity for lighting and 44% of the households have access only to low quality kerosene lighting. The situation is worse for the low income households where about 61% of the households use kerosene for lighting. The status improves with the rise in income levels. Both physical access and affordability are the main factors influencing these low access levels.

1.2. Traditional resources for electricity production in India

There is a growing realization that the gap in energy access, especially that of electricity, cannot be bridged exclusively by conventional energy resources like coal, oil, and gas. India's sustained economic growth-rate range of 6-7% in recent years has placed additional demand on its conventional energy resources. On the supply side, India imports about 80% of its crude oil (GoI, 2011)

Table1. Rural households using a particular energy carrier as a primary fuel for cooking (in millions)

Income Groups	Biomass	LPG	Dung	Kerosene	Coal	Electricity	Others	Total
Low income	44.3 (83.4)	0.4 (0.7)	5.0 (9.5)	0.2 (0.3)	0.5 (0.9)	0.0 (0.0)	2.7 (5.1)	53.1 (100)
Middle income	59.7 (77.2)	5.2 (6.7)	7.3 (9.5)	1.0 (1.3)	0.6 (0.7)	0.03 (0.05)	3.3 (4.3)	77.3 (100)
High income	10.5 (47.2)	7.5 (33.8)	1.5 (6.9)	0.8 (3.7)	0.2 (0.8)	0.04 (0.2)	1.5 (6.5)	22.3 (100)
Total	114.5 (75)	13.1 (8.6)	13.9 (9.1)	2.0 (1.3)	1.2 (0.8)	0.1 (0.1)	7.5 (4.9)	152.7 (100)
Note: Figures in brackets give the percentage of households.								

(Balachandra, 2011)

Table 2. Rural households using a particular energy source as primary fuel for lighting (in millions).

Income Groups	Electricity	Kerosene	Others	Total
Low income	19.6 (37.8)	31.8 (61.4)	0.4 (0.8)	51.8 (100)
Middle income	46.8 (59.2)	31.5 (39.9)	0.7 (0.9)	79.0 (100)
High income	17.6 (80.5)	3.8 (17.6)	0.4 (2.0)	21.9 (100)
Total	84.0 (55.0)	67.2 (44.0)	1.5 (1.0)	152.7 (100)
Note: Figures in brackets give the percentage of households.				

(Balachandra, 2011)

The sustained economic growth will necessitate enormous rise in crude oil imports creating serious problems for India's future energy security Other sources of electricity such as: hydro, gas, and nuclear have also not kept pace with the growth in power demand. Popular protest against large hydro power and nuclear power installations has made similar new projects commissioning impossible.

1.3. Renewable Energy Resources in India

Because of supply constraints in conventional energy resources, renewable energy resources have recently been in focus as a potential source for mitigating energy poverty. Moreover, renewable resources based rural electrification systems are considered as cleaner and environment friendly alternatives to the traditional fuel based systems. These systems are suitable for remote areas and help provide access to electricity while keeping environmentally harmful emissions in check. India is quite rich in natural resources. Many of these resources have a great potential for energy production. However, the potential of renewable energy resources has not been sufficiently tapped, in spite of India having one of the largest programs in the world for deploying renewable energy products and systems. Even though, the Government of India has set up an exclusive ministry for renewable energy development, the Ministry of New and Renewable Energy (MNRE), renewable sources contribute only about 5% of the total power production in India.(MNRE, 2013)

Large parts of India, especially North India, may not be suitable for wind and solar power projects. Hence technologies other than wind and solar should be harnessed for electricity production in those areas. Biomass based electricity is one such option. Because India is an agriculture based economy, and with large tracts of land covered with forests, availability of biomass feedstock is not a constraint. (Buragohain, Mahanta, & Moholkar, 2010)

1.3.1. Biomass as a renewable electricity source

Approximately 70% of population of India is dependent on agriculture for their livelihood, therefore the potential of various kinds of biomass availability exists in Indian villages (Balachandra, 2011). The biomass that can be used for energy generation include: forest residues, sugarcane, corn, sugar beets, and some grains (Kumar, Kumar, Kaushik, Sharma, & Mishra, 2010).When compared to renewable energy generation from biomass with the other sources such as hydro, solar and wind, the biomass option is economical as it requires less capital investment and has competitive per unit production cost.

2. A CASE-STUDY OF ELECTRICITY GENERATION FROM PINE NEEDLES IN UTTARAKHAND, INDIA

Uttarakhand is a Himalayan state in North-India. Rural regions of the state, although connected to the state electricity grid, suffer from frequent power outages. The state lies in seismically sensitive Himalayan zone therefore large hydro-power, nuclear energy, or thermal power projects are considered unsafe. The region is not suitable for wind energy farms, and as regards solar energy, only minor solar energy based applications such as -solar cooker, household water heating, housetop solar panel, solar lighting- can be deployed. However, these solar energy applications are not very useful during monsoon and winter months of the year. A small locally available biomass power plant can help alleviate the problem of inconsistent electricity supply.

2.1. Project description

Electricity can be generated from biomass in multiple ways. The conversion is typically done in two stages; the first stage converts biomass into intermediate fuel using one of three processes- biological processes, chemical processes , thermal process. A gasifier with the generator coupled to an IC engine is the focus of this study because this technology is well suited for small power plants in the range of 10 kW to 150 kW using locally available biomass materiel.

AVANI, a small bio energy company has been running 9 KW gasification system using pine needles as feed stock in Uttarakhand for the past five years. AVANI has considerable experience in working the gasifier system based on pine needles. It also has considerable experience in working with village communities, developing village level organizations and income generating enterprises based on natural resources of region following principles of sustainability. The base-line data for our case study comes from AVANI's experience in running the 9KW gasifier .Our study evaluates a hypothetical 120KW downdraft gasifier using pine needles as feedstock.Pine-needles gasification is partial oxidation at elevated temperature in the presence of steam or low air/oxygen in a gasifier releasing producer gas. Producer gas is then used as fuel in an IC engine to generate electricity(Figure 1).

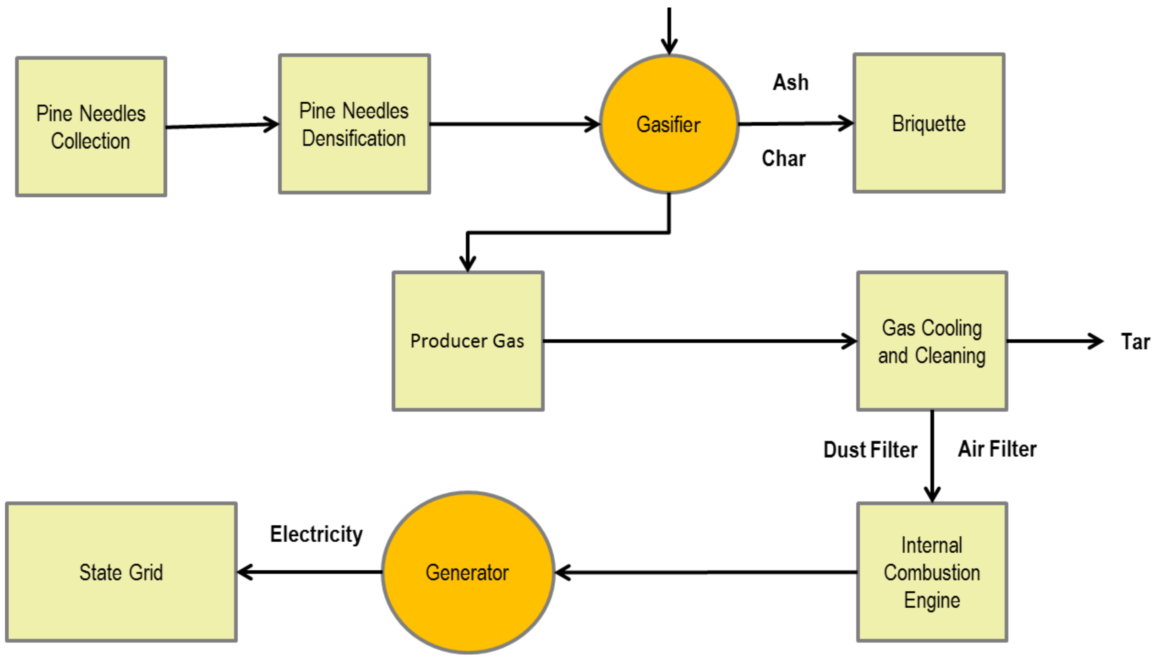

Figure 1. Pine needles to electricity process

2.2. Project evaluation

The key legislation that governs the development of renewable energy in India is the Electricity Act, 2003. The Electricity Act 2003 mandates the Central Electricity Regulatory Commission (CERC) and State Electricity Regulatory Commissions (SERCs) to promote generation of electricity from renewable sources by providing measures for connectivity with the grid and market for generated electricity. The National Tariff Policy, 2006, directs various state SERCs to purchase electricity from renewable based units certain minimum percentages of total electricity purchased from various generating units. There are multiple agencies involved in the renewable energy sector in India. At the central level, the Ministry of New and Renewable Energy (MNRE) is the nodal ministry of the Government of India (GoI).The MNRE provides grants to state agencies for their recurring and non-recurring expenditure. Financial assistance to renewable energy projects is provided through the Indian Renewable Energy Development Agency (IREDA) — the financial arm of the MNRE — which provides loans and also channels funds and other initiatives to promote renewable energy.(Krithika & Mahajan, 2014)

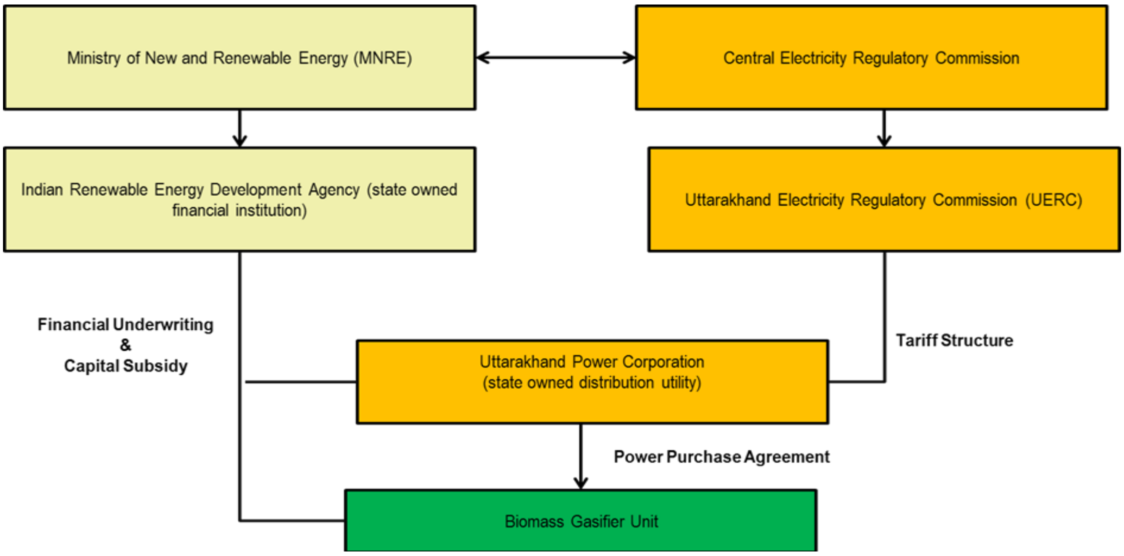

Figure 2. Policy and regulatory framework for renewable energy in India

A few important components of the pine needles power plant that underlie our approach to evaluation of the project are represented in Figure 3.In this section we briefly describe salient issues involved with each component of the evaluation. All our assumptions are in keeping with Uttarakhand Electricity Regulatory Commission's (UERC) guidelines.

2.2.1. General Principles

UERC notification 2013 (UERC, 2013) defines a biomass gasifier based power project as : "The project shall qualify to be termed as a biomass gasifier based power project, if it is using new plant and machinery and having a Grid connected system that uses 100% producer gas engine, coupled with gasifier technologies approved by Ministry of New and Renewable Energy(MNRE)."

The MNRE promotes multifaceted biomass gasifier based power plants using locally available biomass resources including forest residue and agro-residues in rural areas. The gasifiers approved by MNRE include the tail end grid connected power projects up to 2 MW capacities such as the one this paper refers to. As the state owned Uttarakhand Power Corporation Ltd (UPCL) is the only electricity distribution utility in Uttarakhand, an electricity generation facility will have to enter into a "Power Purchase Agreement (PPA)"- a long term agreement between a generating company and UPCL, containing the terms and conditions for supply the power at the tariff determined by the UERC

- Tariff Period**-**The Tariff Period for Renewable Energy power projects shall be equal to useful life of the project-20 years.
- Control Period- The tariff at which electricity is fed into the grid is to be reviewed every five years.
- Tariff Structure- The tariff at which the gasifier sells electricity to the state owned electricity distribution entity is a two part structure: fixed cost component and fuel cost component. The fixed component takes multiple factors in account: Return on equity; interest on loan capital, depreciation; interest on working capital; operation and maintenance expenses. The fuel cost component considers Wholesale Price Index (WPI), indexed biomass feedstock cost, and

transportation cost if any. The three components of the fuel cost component have been assigned weightages 20%, 60% and 20% respectively.

- Tariff design- The front or back loading of tariff is an important consideration for viability of a gasifier project. The current view in the industry and the ministry is that post tax weighted average cost of capital is the best way to determine levellized tariff.

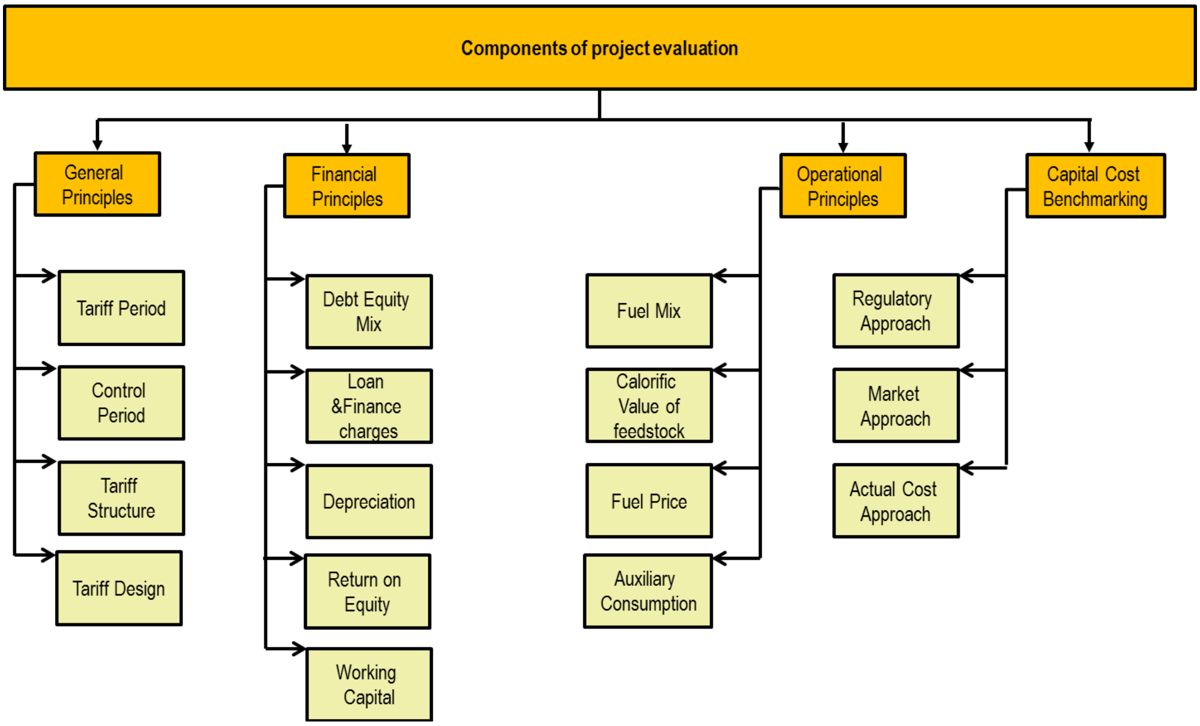

Figure 3. Principles underlying a biomass gasifier project evaluation

2.2.2. Financial Principles

- Debt equity mix- We have assumed a 70:30 debt equity ratio in evaluation. UERC treats excess of equity over 30% as normative loan in power purchase agreement.
- Loan and finance charges- We have used State Bank of India's (SBI),India's largest public sector bank, base rate prevalent during the first six months of the previous year plus 300 basis points.
- Depreciation- Depreciation per annum is based on 'differential depreciation approach' over loan tenure and period beyond loan tenure over useful life computed on 'straight line method'. The salvage value of the asset is considered as 10% of the capital cost.
- Return on equity- For the purpose of determination of tariff, pre-tax 20% per annum for the first 10 years and pre-tax 24% per annum 11th year onwards have been used.
- Working Capital-We have considered fuel cost for four months, operational maintenance expenses for one month, and receivables of two months from electricity sale for estimating the requirement of working capital.

2.2.3. Operational Principles

- Fuel Mix- The gasifier uses only pine-needles as feedstock. Pine needles are abundantly available in large tracts of pine forest around many villages in the North Himalayan states. Based on AVANI's experience with the 9KW unit, we estimate that pine needles collected from an area within the radius of 1.5 kilometres can sustain a 120 kW gasifier system. The pine needles can be collected from February till June and stored to be used as feedstock for the gasifier for the entire year. We further estimate that 1.20 kg of pine needles is required for generating one unit of electricity, therefore, for a 120 kW gasifier system; about 1300 tons of pine needles would be required annually. The advantage of a small catchment area around the gasifier plant is in reduction of transportation cost of pine needles to the storage facility. As village population in the region has traditionally been extracting and carrying fuel-wood and cattle fodder as headloads over longer distances from the adjacent forests, individuals employed from the nearby villages can collect and manually bring the needle stacks as headloads.

- Caloric value of feedstock- Pine needles is a great feedstock for biomass gasifier systems because of their high resin content and high calorific value.

Table 2. Pine needles combustion properties

Heating Value	18-20 MJ/KG	Comparable to sawdust
Volatile Content	74.20%	Similar to sawdust
Carbon Content	24.10%	Higher than sawdust
Ash Content	20.40%	Lower than sawdust

(Fang & Hane-Weijman, 2011)

- Fuel price- We estimate that final cost of pine needles ready to be fed into the gasifier is .017 US $. This estimation is based on the data from AVANI's 9KW gasifier.
- Auxiliary consumption-. A 120 kW system would use 14 kW of auxiliary power to run the gasifier system. The net output of 106 KW can be fed to an interconnection point of the state electricity grid lying within a range of 10 kilometres from the gasifier plant-site via a step down transformer from 11 KV to 440 V.

2.2.4. Capital cost benchmarking

UERC recommends a capital cost of around 900,000 US $ per MW, our estimate for the project is close to 1,000,000 US$ per MW (UERC, 2013).

2.3. Summary results

We find that a 120 KW pine needles based power plant can generate NPV of US$ 10,545, IRR at 29.7%, and Profitability Index at 4.55. We calculate operating margin for the plant to be in the range of 40 to 58%, EBITDA margin in the range of 40 to 48% in a twenty years life span. Average Profit after Tax for the life period of the project is 28%. We present a financial snapshot of the gasifier. The capital expenditure considers all installation costs including expenses involved in connecting the gasifier to the grid.

2.4. Social and environmental impact of the project

Removal of pine needles for local energy markets would create jobs in collection of pine needles, running of gasification systems and general management of the enterprise. Local people at all levels stand to economically benefit from this project. We estimate that a typical household in the neighborhood engaged in pine needles collection activity can potentially enhance the household income by 110%. Pine needles are collected from April to July (120 days) .Our observations of the AVANI's operations suggest that a household can collect 300kg pine needle per day. At US $ 0.02 for each kg of pine needles works out to $6 per day and $720 in 120 days. As the median per capita income in the region according to National Sample Survey is US$ 710, this extra income represents a significant increase in household income.

Table 3. Capital expenditure (USD) for1 20KW plant

Components	
Gross power (kW)	120
Net power (kW)	106
Pine needles consumption (kg/hr)	144
Total plant capex	$63,704
Total grid connection capex	$23,333
Total foundation and connection cost	$20,000
Total	$107,037
Subsidy on capex	$31,800
Net capex	$75,237

Table 4. Annual Profit and Loss statement

Revenue			**Costs**	
Price per unit of electricity (USD/KWh)	$0.06		Pine needles consumption (Kg/KWh)	1.5
Revenues from sale of electricity	$47,140		Pine needle collections (kg/year)	1,325,600
Charcoal produced (kg p.a.)	127,734		Landed cost of pine needles	$0.02
Revenues from briquette sales	$10,499		Pine needles cost (USD/year)	$24,235
			Total plant employee cost (USD/year)	$5,999
			Total maintenance cost	$1,061
Total revenues	**$54,757**		**Total costs**	**$33,903**

Moreover, the gasification process produces about 10% residue, which is a high quality charcoal that can be used for cooking in a village household. A 100-120 KW system can produce enough charcoal briquettes for 80 to 100 households at 3 to 4 kg charcoal consumption level per family per day. The use of charcoal briquettes in cooking can reduce the time spent in gathering fuelwood for cooking purpose and provide smoke - free homes. At least one member of the household in the region has to walk almost 5 hours daily for gathering fuel-wood. The quality and the health of women, the prime collector of fuel-wood, will improve as a result of cooking in a smoke – free environment and will see a reduction in the respiratory related health problems.

As the winter months give way to summers every year, villagers in the region become increasingly apprehensive about the forest fires. Chir Pines shed needles during the dry summer months. A large volume of pine needles on the ground increases the risk of forest fire. The lower ranges of Himalaya in the state of Uttarakhand smoulder with forest fire on annual basis, destroying forests, eco-system and impairing livelihood of villagers. National Remote Sensing Agency (NSRA) Hyderabad reports that in 1997, in a major fire around 22.64% (5,086.6 sq. km) forest area was burnt and additional 1,225 sq. km was severely affected. In addition to the destruction of the flora and fauna of the region, the forest fires affect the livelihood of over 7 million people living close to the forests. The devastating fire diminishes their access to fuel-wood, water, and other life support systems. Removal of pine needles from the forest bed would reduce the risk of forest fire and enhance bio-diversity and help improve water recharge cycle of soil. . Regeneration of biodiversity and moisture regimen would help agricultural crops by way of improved moisture and humus availability on agricultural land which, in the area, are often at the base of degraded slopes and depend on hill forests for nutrients flowing downstream with rainwater.

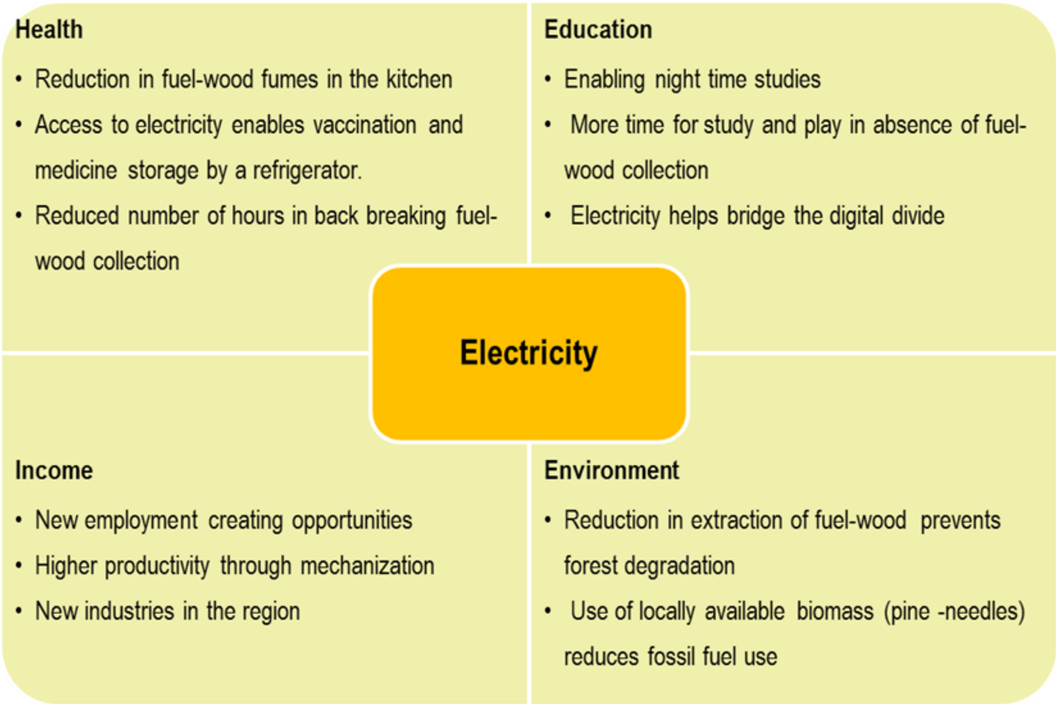

Figure 4. Socio-economic impact of pine needles gasification project

3. CONCLUSION

On the basis of our evaluation, we believe that an electricity generating gasifier using pine needles as feedstock has tremendous potential for social and economic value addition in remote mountainous region such as Uttarakhand where extension of conventional electricity grid is prohibitively expensive. Households collecting pine needles for the project can enhance their income. Non-participating households also benefit from reliable access to electricity and availability of better cooking fuel in charcoal briquettes. At a more general level, entire region benefits from improved biodiversity and water and soil nutrient cycle, and reduction in risk of forest fire.

REFERENCES

1. Balachandra, P. (2011). Dynamics of rural energy access in India: An assessment. *Energy, 36*(9), 5556-5567.
2. Buragohain, Buljit, Mahanta, Pinakeswar, & Moholkar, Vijayanand S. (2010). Biomass gasification for decentralized power generation: The Indian perspective. *Renewable and Sustainable Energy Reviews, 14*(1), 73-92. doi: 10.1016/j.rser.2009.07.034

3. Cowan, B., & Mohlakoana, N. (2005). Barriers to modern energy services in low-income urban communities: Khayelitsha energy survey, 2004. *Energy Research Centre, University of Cape Town, South Africa*.
4. Fang, Liane Jessica, & Hane-Weijman, Caroline M. (2011). *Characteristics of pine needle combustion in a semi-gasifier burner.* Massachusetts Institute of Technology.
5. GoI. (2011). *Strategic Plan for New and Renewable Energy Sector for the Period 2011-2017*. GOI.
6. Krithika, PR, & Mahajan, Siddha. (2014). Background paper Governance of renewable energy in India: Issues and challenges.
7. Kumar, Ashwani, Kumar, Kapil, Kaushik, Naresh, Sharma, Satyawati, & Mishra, Saroj. (2010). Renewable energy in India: Current status and future potentials. *Renewable and Sustainable Energy Reviews, 14*(8), 2434-2442. doi: 10.1016/j.rser.2010.04.003
8. Mapako, MC, & Afrane-Okese, Y. (2002). *Experiences and lessons in the implementation of solar home systems from Zimbabwe.* Paper presented at the Conference Proceedings, DUEE, Cape Technicon, Cape Town, South Africa.
9. MNRE. (2013). Ministry of New and Renewable Energy.
10. NSS. (2009). NSS Survey Report. 2015, from http://mospi.nic.in/Mospi_New/site/inner.aspx?status=3&menu_id=31
11. Qase, N., & Annecke, W. (1999). Energy provision for the urban poor: South African country case study. *EDRC Report*.
12. Saghir, J. (2005). Energy and Poverty: Myths. *Links, and Policy Issues, Energy and Mining Sector Board, World Bank Group, Washington*.
13. Toman, M.A., & Jemelkova, B. (2003). Energy and Economie Development: An Assessment of the State of Knowledge. *The Energy Journal*, 93-112.
14. UERC. (2013). *Tariff and other terms of supply*. Uttarakhand State Government Retrieved from http://www.uerc.gov.in/Draft%20documents/2014/Amendment%20to%20RE%20Regulations,%202010%20&%202013/Statement%20of%20Reasons%20for%20Amendment%20in%20RE%20Regulations,%202010%20&%20RE%20Regulations,%202013.pdf.
15. Winkler, Harald, Simões, André Felipe, Rovere, Emilio Lèbre la, Alam, Mozaharul, Rahman, Atiq, & Mwakasonda, Stanford. (2011). Access and Affordability of Electricity in Developing Countries. *World Development, 39*(6), 1037-1050. doi: 10.1016/j.worlddev.2010.02.021

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RESOURCES OF SOLID BIOFUEL IN THE CENTRAL URALS AND PROCESSING VARIANTS

Roy Damary, Yuri Yuriev, Natalia Pryadilina

ABSTRACT

Solid biofuel resources available in the Sverdlovsk region were studied. Various types of wood debris considered the main resources and different variants of manufacturing wood biofuel were thoroughly examined. Different ways of processing raw materials to better their combustibility as solid biofuel were compared. Various means to achieve homogeneity of raw materials and efficient preliminary drying were analysed, and a key conclusion drawn as to the best drying technology.
Keywords*:* solid biofuels, wood debris, combustibility, preliminary drying.

1. INTRODUCTION

Using non-merchantable wood of low quality as solid bio- fuel improves the overall economics of a forest industry complex. In Sverdlovsk Region wood bio-fuel resources could provide power generation of 2500 MW. The replacement of mineral fuel by bio-mass significantly the greenhouse effect.

2.AN EXAMPLE TO SHOW WOOD FUEL RESOURCES

As an example a wood enterprise [1] located in the Sverdlovsk Region was taken. Its annual timber scaled and billed equals to 100 ‘000 m3 and typical taxation indices of the wood material base include:

- stand composition.. ....4C2E2B2Oc;
- average volume per tree, m3.......................... ....0,44;
- timber volume per hectare, m3 .... 180;
- breast height mean diameter, cm…………........................ ....23,7;
- mean butt diameter, cm……………………………............................ ………………………29,6;
- mean height, m and height class…………………… ....………………….. 21,9/ III;
- “bonitet” (Forest Yield Capacity).. ....III, 4.

The annual output of timber assortments is calculated bases on the production capacity of the enterprise. The species structure of the raw material for bucking (sawing into logs), as well as the mean diameter, the yield of forests and the average height class are defined based on the resources of the felling-area.

Moreover the volume balance structure for bucking is defined. The volumes of round timber resources bucked from sound and low-quality wood are calculated by the respective regression equations of the maximum yield coefficient.

The economics of the overall operation are improved by complementing the efficient use of merchantable wood with use of mill culls (saw timber and case timber) and low-quality wood, including:

- soft-wooded broadleaved species with small-sized and medium-sized converted wood of 8-20 cm diameter

- fireplace wood
- bucking debris
- bonus wood debris

Once resources of wood assortment output are defined, the volume of the raw material for different manufactures available in the industrial log depot can be assessed.

Table 1 presents the CTL stand composition estimation [2] with the basic data including:

- annual cut 100,000 m3;
- species composition … ....4C2E2B2Oc.

Table 1 Forest stand composition

Resources	Pine		Fir		Birch		Aspen		All Species		
	%	'000 m3	%	'000 m3	%	'000 m3	%	'000 m3	Conif-erous	Deci-duous	Total
1	2	3	4	5	6	7	8	9	10	11	12
1. Industrial Wood including:	86	34.4	84	16.8	57	11.4	44	8.8	51.2	20.2	71.4
Sawtimber	55	18.9	53	8.9	6	0.7	20	1.8	27.8	2.5	30.3
Building Log	19	6.5	10	1.7	-	-	-	-	8.2	-	8.2
Sleeper Timber	5	1.8	2	0.3	-	-	-	-	2.1	-	2.1
Case Timber	-	-	-	-	10	1.1	23	2	-	3.1	3.1
Pit-prop	11	3.8	7	1.2	-	-	-	-	5	-	5
Veneer Stock	-	-	-	-	43	5.0	-	-	-	5	5
Matchlog	-	-	-	-	-	-	20	1.8	-	1.8	1.8
Barrel Log	-	-	-	-	-	-	20	1.8	-	1.8	1.8
Ski Log Assortment	-	-	-	-	15	1.7	-	-	-	1.7	1.7
Pulpwood	10	3.4	28	4.7	10	1.1	5	0.4	8.1	1.5	9.6
Turnery Wood	-	-	-	-	6	0.7	4	0.3	-	1	1
Wood Wool	-	-	-	-	10	1.1	8	0.7	-	1.8	1.8
Total Industrial Wood	100	34.4	100	16.8	100	11.4	100	8.8	51.2	20.2	71.4
2. Short Pulpwood	-	-	-	-	10	2	-	-	-	2	2
3. Process Feedstock	1	0.4	3	0.6	11	2.2	23	4.6	1	6.8	7.8
4. Fire Wood	1	0.4	3	0.6	11	2.2	18	3.6	1	5.8	6.8
5.Debris (Bark)	12	4.8	10	2	11	2.2	15	3.0	6.8	5.2	12
Total	100	40	100	20	100	20	100	20	60	40	100

Analysis of the data from Table 1 leads to the conclusion that the amount of timber assortments sawn at the wood enterprise with comparatively small timber harvesting is so great as not to make good economic sense.

It is therefore reasonable to reduce the assortment. Low-grade sawing raw materials, as well as case timber, barrel logs and building timber, with limited distribution, can thus be directed to biomass. The same applies to match logs (owing to the dramatic decrease in production of matches) and short-length pulpwood. Other timber assortments should be dispatched to customers in the round.

Under these conditions in felling and log storage place operations, and in timber working shops (see Table 2) shared resources of lump wood debris and real resources are formed for their power production ('000 m3) utilization.

The shared resources do not include such debris like stumps, roots and green mass. Anyway, it is not necessary to extract all the biomass from the felling site. A part of it should be ground up and left on site in order to prevent the soil fertility depletion.

Table 2 Lump Wood Debris Resources

Debris Resources	Felling Operations	Log Storage Place Operations	Timber- Working Shops	Total at the Enterprise
Total	18.5	4.5	12.3	35.3
Including: Coniferous	11.1	2.7	7.4	21.2
Deciduous	7.4	1.8	4.9	14.1

Biofuel from wood debris has the environmental advantage over mineral with regard to the greenhouse effect. The main point of this advantage is that the amount of CO2 eliminated during combustion is the same as when the wood is left to decay in the forest. Furthermore, the trees newly growing instead of the fallen will reabsorb carbon dioxide.

One of the problems, arising in manufacturing solid biofuel, is that of transporting debris of low density.

S. Gliadiaev [3] believes that chips that should be taken away. Particularly, within short distances the most efficient way is to take the chips and logging residues by "cats"; and to use articulated lorries for long hauls.

V. Baklagin [4] suggests that for long distances (over 100 km) it is more efficient to process the wood into chips just near the boiler facility, and to use John Deer 1490 wood pac for transporting. This technology is specific that the firewood and logging residues are loaded on the vehicle layer by layer. The first layer boarding the solid deck of firewood, the second is the layer of logging residues, and further on they take turns [5]. But for small enterprises it is more efficient to transport chips made at the felling site.

3.DRYING THE WOODCHIPS

V. Golubev notes [6] that high moisture content in wood fuel reduces its combustion stability and increases thermal losses via exit gases. The dependency diagram of thermal losses and primary fuel humidity is shown in Picture 1.

Y-Axis: Percentage loss of heat in flue gases

X-Axis: Effective moisture content of fuel

The diagram is calculated for the exit flue-gases temperature of 150°C and the air excess factor 1.5. At a humidity of over 40 - 60% the thermal losses increase dramatically.

The optimum moisture content of drying wood before its combustion in boilers is 20 -25%. Technological schemes and engineering solutions for low-cost modernization of the current boiler-furnace equipment were also examined to facilitate including wood debris into the fuel balance for combined combustion of both wood and coal (with 40% incorporation of wood in the fuel balance).

The technology of manufacturing fuel briquettes or fuel-wood pellets from non-merchantable birch wood necessarily includes seasoning, i.e. additional drying of the ground wood.

Currently existing variants of convective seasoning in pneumatic, flash, cylindrical dryers, as well as in fluidized bed dryers solve the problem of removing moisture from wood to some extent, thus meeting the process requirements. Drying to moisture levels of 20 to 25% does not cause any difficulties. However, in drying to 5 - 10% moisture content, necessary for producing briquettes or pellets, the process enters the pore-diffusion phase, and the rate of drying dramatically decreases.

Using the pneumatic drying tubes for these purposes requires extremely long tubes (30-50 m), because of the short stay of the material in the apparatus. Subsequently the hydraulic resistance of the apparatus grows, i.e. energy demands and metal consumption increase. Much more often for deep drying of ground wood, flash dryers are applied, which create favourable conditions for the pore-diffusion stage of drying due to the circulation of participles in the apparatus. Nevertheless it is impossible to maintain the same hydrodynamic operating regime in each chamber of a multi-chambered flash dryers, since with a reduction of the heat carrier temperature the speed in the neck drops, and the rate of drying and specific moisture removal decreases.

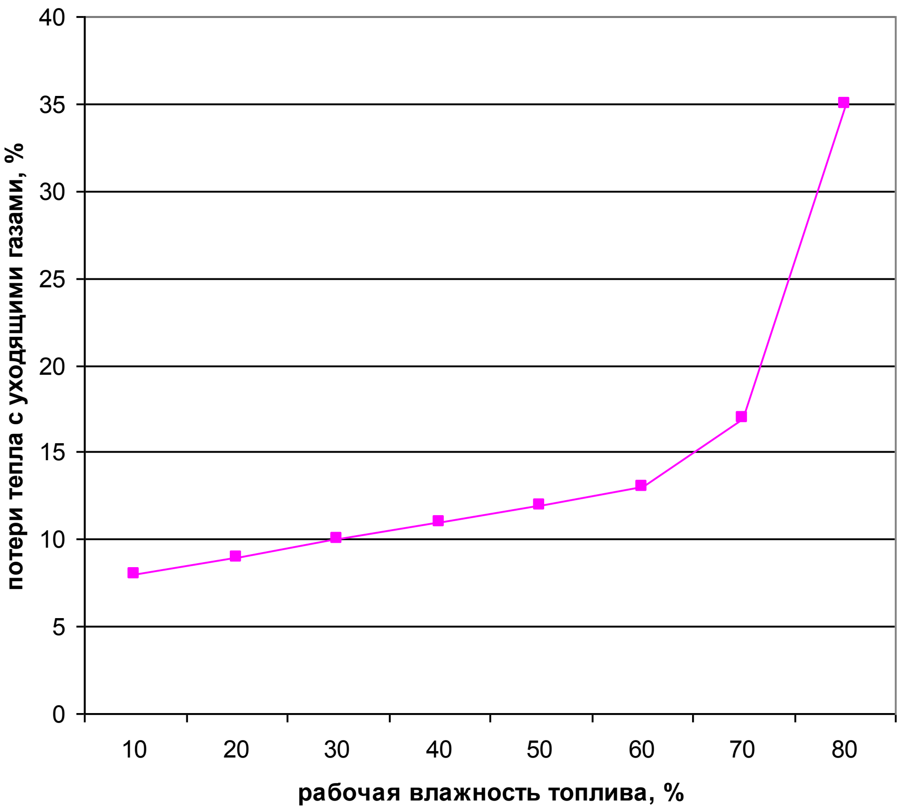

Diagram 1. Dependency of the thermal losses via exit gases on the wood fuel operating humidity.

Thus, the application of simple non-combined dryers for deep drying of ground wood does not allow their potential to be fully used, viz., high speed moisture removal in a pneumatic tube dryer, and significant residence time of the particles in the flash dryer.

Comparative calculation of the process of drying ground wood in three types of dryer- tube, flash and combined (tube + flash dryer) is shown in Tables 3, 4. The heat-carrier temperature of 250 ^{0}C was chosen as the transient temperature at the transition of the tube dryer into the body of the flash dryer.

Table 3 Heat-Carrier Parameters

Dryer Type	Temperature, 0C		Consumption, kg/s	Speed, m/s
	Intake	Outlet		
Tube Dryer	600	100	0.32	10
Flash Dryer	400	100	0.54	10
Combined Dryer	600/250	250/100	0.54	10/8

All the parameters (specific moisture removal, total volume of the dryer, sizes) prove demonstratively advantageousness for the combined dryer. In the first stage of drying (tube dryer) intensive removal of surface moisture takes place. In the second stage (the cone of the flash dryer) owing to significant residence of the participles, pore- diffusion takes place.

Table 4 Dryer Characteristics

Dryer Type	Specific Moisture Removal, kg/(m3*h)	Dryer Volume, m3	Length, m	Diameter, m
Tube Dryer	80	2.43	34	0.4
Flash Dryer	120	1.62	8.5	0.35
Combined Dryer	240/80	0.65/0.48	9.2/2.5	0.4/0.4

Forecasting operating variables of drying at the entrance to the second stage of the process is essential for calculating combined dryers. The criteria equation:

$$Nu = 0.62\ Re^{\ 0.5vit}$$

was used to calculate the mass transfer coefficient during the first stage of drying.

This equation works from 1.5 - 2 mm (**s**awdust) to a size of 4×5×0,3 mm (woodchips). The process speed coincides well with experiment data for the participles within the range, being a part of **Reynolds** number, which was chosen according to the industrial data (8 - 9 m/s). Basing on the linear decline of moisture content in the material during the first stage of drying, the humidity was calculated at the entrance to the second stage of the process for different lengths of the working area in the tube dryer. The tube length from the delivery point of the heat carrier being 4 - 5 m, the relative moisture of the material decreases from 42-46% to 22-24% thus approaching the critical moisture content, ≈20% for wood. Consequently, the linear variation of moisture content in the first stage of the drying process, along with the significant variation range was demonstrated. So the distance from the delivery point of the heat carrier to the second stage of drying (5- 6 m), determined empirically, was confirmed by the calculation. The lower unit of the drying machine (tube dryer) serves as a feeder for the upper part (the cone of the flash dryer).

Next comes forecasting the parameters of drying between the cones of the flash dryer, if, as per calculation, there are more than one. In this case only experimental data can be used, as the speed of drying at the second stage does not have valid mathematical expression.

The model of combined dryer under consideration was designed and made for one of the enterprises using dried woodchips in the technological process. The operational indicators gave good convergence with the calculated ones. The combined dryer, as was believed, is capable of drying material steadily to a moisture content much lower the critical one along with a high index of specific moisture removal [7].

4.CONCLUSIONS

The wood biofuel available in the Central Urals can provide power of 2500 MW.

For small enterprises it is more efficient to transport the chips prepared in the harvesting area.

If woodchips can be used within a moderate distance of the felling site, it is more economical to use them as fuel on chip form (mixed with coal) than to convert them to pellets or briquettes.

The optimum moisture content in the seasoned wood before combustion is 20 - 25%. For making fuel briquettes and pellets the moisture content in the wood must be reduced up to 5 - 10%.

A combined dryer (tube and flash) is capable of drying material steadily to a moisture content much lower the critical one, along with a high index of specific moisture removal.

BIBLIOGRAPHY

1. YL Yuriev Thermochemical processing of wood in a timber enterprise / Yu.L.Yurev, A.V.Soldatov // "Forestry Journal". -2005. - №3. - P. 113-118
2. Anuchin NP Assortment and trade tables /N.P. Anuchin. - 7 th ed., Rev. and add. - M .: Forest Entreprises, 1981. - 536 pages.
3. Glyadyaev, S.O. More efficient use of wood waste timber by the production of these fuels for gas plants: ... author of a dissertation as candidate of engineering sciences: 05.21.01 / Sergei staring Olegovich.- Arkhangelsk, 2009, 21 p.
5. Baklagina, V.N. Justification of technological solutions that enhance energy efficiency chips appointment to the cutting area: dissertation as candidate of engineering sciences: 05.21.03 / Baklagina Vyacheslav. - Petrozavodsk, 2011, 181pages.
6. I.R.Shegelman, O.N.Galaktionov, A.V.Demchuk, V.N.Baklagin, P.V.Budnik. A method of harvesting and hauling firewood and logging residues from forest areas to the boiler / - Application № 2013129540/13; appl. 27/06/2013; publ. 01/10/2015.
7. Golubev, V.A. Justification and ways of improving the energy use of plant waste. Dissertation as candidate of engineering sciences: 01.04.14, 05.14.14 / Vadim A. Golubev. - Barnaul, 2014 21
8. VP Orlov Choice of rational types of convective dryers for ground wood / V.P.Orlov, Yu.L.Yurev // "Forestry Journal". - 1991. - №4. - S. 123.

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ENERGY STABILITY AND WOOD FUEL CONSUMPTION IN KOSOVO

Alicia English, Michael Waschak, Jim Myers

ABSTRACT

The importance of traditional energy sources is critical as economies develop and transition. In Kosovo, there is a long-standing debate on the future of electricity generation, the reliability of the energy system and the relative costs for most consumers. However, wood fuels are still a critical and important source of energy for most households. Survey data show that Kosovo households are consuming 2.05 million cubic meters on average, when sustainable harvests are closer to 1.3 million cubic meters[1,2]. Survey data from rural household's that are in the low-payment and low-service quality areas of Kosovo suggest that the importance of wood fuels in these areas is even more critical, with households consuming 10.46 m^3, more than the 8.2m^3 average for rural households. This very high demand for wood fuel places an unsustainable burden on Kosovo's forest resources. This paper estimates the elasticity of demand for wood fuels in Kosovo and to determine how a change in price might alter the demand from households for wood fuels. This information is useful to know which factors of consumption may be altered in order to decrease harvests to sustainable levels. To answer this question this paper uses household energy consumption survey data from 2013 and 2015 and market prices.

Keywords: Forestry, Energy, Development, Kosovo

1. INTRODUCTION

Kosovo's forests are a critical part of the domestic energy balance with the resources and their ecosystem services are traded-off with economic, security and energy demands. Economically, cheap wood fuels coupled with high unemployment rates decrease the economic burden of household heating. However, as resources become scarcer or alternatives increase in cost, dependency on the forest will increase and conflicts are likely to become more prevalent. Regionally, cross-border conflicts over forest resources contribute to ongoing political tensions between countries [3–7]. The implications of using these resources on the environmental quality of the country are equally important. Although pollution is significant for the country and Kosovo's forests may be older, they are critical to the carbon sequestration process. Newer growth can act as an offset to pollution created by energy produced from the country's lignite-powered plants and consuming the old growth will be an additional source of greenhouse gas emissions.

Current wood harvest rates are unsustainable - approximately 720,000 m^3 over the recommended annual levels is being cut. Harvests are above the annual growth rate of forests due in part to illegal and irregular logging driven by household demand. According to the Census, 88% of dwellings surveyed use wood fuels as their primary energy source for heating. Which extends greater influence in rural environments, with 78% of urban households and 95% of rural households using wood fuels for heat[8].The socio-economic impact of energy demand, illegal logging and ineffective permitting structures makes the unsustainable harvest rate a critical issue, not just for Kosovo but, for the overall stability of the region. The objective of this paper is to analyze the demand for wood fuels as an energy source in relation to other energy sources, expenditure and income. The analysis will look at areas that are specifically low rates of payment for electricity and that have unreliable electricity supply. These areas are likely to be the relatively lower income areas of Kosovo, and expenditure on energy sources has implications on household budgets. The elasticity of demand for energy sources has not been calculated prior to this work and will be useful when considering the energy sector investments and pricing for alternatives.

2. DATA

The sample for this study was drawn from households within areas in Kosovo that had either low payment, or low electric service quality (LPLS). This stratification was identified as two priority areas of the electrical distribution company who also identified and preselected the list of villages surveyed. These households were selected in order to better understand how to meet the electric needs of the consumers, while minimizing the costs of supplying these households, and to better understand how to minimize disconnections.

A sample size of 605 households was chosen for this survey, which represents 4.8% of the customers in the selected population of low income households. In order to make the sample robust to other statistics collected in the country, the sample was stratified twice, once to population in the municipality and the second to the number of customers per substation to get a representative sample to the general population and then within the troubled areas. A total of 40 villages were visited in 17 municipalities throughout Kosovo between April and May 2015. The data from this surveying effort was compared to the 2013/14 data on rural wood fuel consumption, that looked at 1,160 households throughout Kosovo[25]. The results will mostly cover the LSLP dataset, as a more diverse set of questions on income and expenditure were asked.

3. Background

When considering the price of wood fuels, the price ranged from 15 to 43 €/m^3. Estimates of the energy equivalent value of wood fuels are usually between 1,400 and 2,000 kWh, the energy content depends on tree species and drying time to get to an optimal 20% moisture content[9]. Likely given the short time between purchase and the heating season (70% surveyed purchased less than 2 months ahead), for the oak and beech typically harvested in Kosovo, the moisture content is likely around 60%[26]. Assuming the following rates of conversion[27], 1 m^3 of fuel wood is approximately between 734 kWh of electricity for wood fuels in Kosovo. Additional factors that would impact the efficiency of the wood to kWh conversion would be the condition and age of the stove and the need for maintenance. Multiplying the market price for wood fuels by this conversion rate indicates that the wood equivalent price is between €0.02 to €0.067 per kWh. When compared to electricity tariffs for the winter months in lower block tariffs[28], consumption of wood is more expensive than electricity at market prices above €39.5 per m^3. However, this price analysis does not include wood fuels that are used for multiple activities (e.g. heating and cooking) which would increase the relative value of the wood fuels.

To calculate the amount of wood that is consumed for the winter heating months, two adjustments were made. For households that purchased their wood, the reported amount was adjusted by a standard factor of 0.69 to get the solid wood amount[12], as there are losses in cutting and stacking for both datasets. Households that harvested their own forests the amount was not adjusted. Additionally, households that use wood year round average 2.08 m^3 less than the households that only use during the heating season, to get the winter amount for these homes, the quantity was decreased by this amount. On average per household, 9.76 m^3 of solid wood fuels consumed for the entire season.

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[25] Both investigations were done through the RIT/AUK Center for Energy and Natural Resources (CENR) with support from the Kosovo Electricity Distribution Company (KEDS) and the United Nations Food and Agricultural Organization (UNFAO).

[26] Green Oak is estimated to have a moisture content of 75-80%, to get to the 20% in which the kWh equivalents would be higher, would take approximately a year, with low ambient humidity. [10]

[27] 1 cubic meter = 0.3531 metric ton; 1 metric ton fuelwood = 0.3215 tons of oil equivalent (toe); 12 MWh toe;

[28] The average winter tariff for electricity in Kosovo in 2015 is 0.042 for the block of 0-200 kWh per month consumed, 0.058 for the block of 200-600 kWh per month consumed and 0.084 for greater than 600 kWh per month consumed, which can be found on the back of any KEDS bill or in [11]

Households that were in the low-payment areas of the survey are slightly more likely to also be those homes that use wood fuels year round. The average amount consumed for these households is 10.35 m^3. Households that just experienced low-quality service had winter only average consumption of wood fuels at about 9.2 m^3 (Table 10).

The UNFAO and CENR work estimated that the amount of wood fuels consumed annually in households was approximately 2.05 million cubic meters annually (an average of 8.24 m^3)[2]; sustainable harvest limits are estimated to be about 1.3 million cubic meters annually[1]. For the forest sector to be sustainable, the energy system and efficiency efforts would displace the difference 0.75 million cubic meters or a minimum of 62.8 MW of capacity. Though most households use wood fuels for space and water heating and cooking simultaneously, which means the conversion to electricity would likely be higher than this estimate. Of the sample households surveyed only 480 used wood fuels for heating without electricity heating devices. This equates to an average difference of 1,040 kWh of energy per month displaced by wood fuels in the winter for households that do not use any electric heating devices. For households that substituted some of their heating with electric devices, the amount of energy displaced by wood fuels was 961 kWh monthly. This indicates how little electricity is used for heating. If the wood fuels were properly dried there could be several impacts to the additional heat available. However, the outcomes on household welfare may be less clear, given that most households are not satiating their energy demand and additional heat may still be wasted given the lack of isolation in households. Most homes only heat 41% of their space, are often in the 15 year age range and 367 households have neither roof nor wall insulation.

Regardless of the rest of the energy sector, it is likely that many of these households would not switch completely away from using wood fuels. Price and income are important decision variables, but additional issues with risk and culture may be critical in the decision. The share of wood fuels in terms of total kWh consumed for the sample can be found in Figure 7. The curvature patterns in the shares indicate an increase in the composite of other consumption factors (e.g. number of people, income, etc) leads to a greater share of wood fuels consumed with diminishing marginal returns. The average share of wood fuels was 61% with a standard deviation of 18%. Almost all of 605 households used wood fuels as an energy source, sans 8 homes that did not know the quantity or price of wood fuels purchased. When considering the income and the effects of energy source consumption, electricity is relatively flat whereas, wood fuel demand increases with income (Figure 9). Income and expenditure are closely related in Kosovar households, as 56% of the houses surveyed expend more than 10% of income on energy, so typically only one of the factors is considered

Theory would dictate that the choice of energy source would be dependent on the next available source and price [13,14]. Unexpectedly, the unit price per m^3 of wood fuels was not distributed based on the time before the harvest (Figure 8). There was also no particular pattern with respect to village, quantity or if the wood was cut, to explain the lack of price variation in the season. When price signals are not strong in the market, other factors become more important in the purchase decision. The average amount of time before the heating season that wood was harvested or purchased was 1 to 2 months (70% of the sample). The source of wood fuels was mainly from traders (n: 410) or from own forests (n:143) or a combination of both (n:29). Those that harvested from their own forests indicated often that there would be no price at which they would switch from wood, as they were getting the wood for free (often excluding the costs of harvest, and likely not replanting).

Wood fuel purchases are done prior to the heating season for most households, wood fuels present a sunk cost to households when making the electricity consumption decisions month by month. However, if the house runs out of fuel wood, the cost of electricity is the highest of the year, representing a significant premium on wood fuel management. One significant issue is that the usage-costs for alternatives to electricity are fixed prior to the heating season, as the stock of wood fuels and lignite is pre-purchased and prices don't follow demand fluctuations. Perhaps one alternative to compete is to give households a flat consumption rate, where slightly higher bills in the summer subsidize winter consumption. The rates could be set based on previous years of consumption and balanced at the end of the season.

4. ELASTICITY OF DEMAND FOR WOOD FUELS

Theoretically, as household income increases, the more energy the household will consume to the point at which it becomes more cost-efficient to invest in energy efficiency and the more modern energy services that would be consumed. However, if it holds that households are maintaining net expenditure but substituting for cheaper energy sources it is likely that households won't invest in efficiency, until something constrains choice of the cheaper sources. Elasticity measures at what rate in percentage terms that households will switch energy sources based on prices, quantities, expenditure and other factors.

In order to model the household consumption, the following assumptions are used: 1) separability, as in the proportion of expenditures on other goods and services will not change as the share of income goes to energy changes, 2) that the transition between energy sources is smooth and bi-directional, meaning that a change in prices for wood would increase the quantity of electricity consumed and vice versa in the same amount. These assumptions could be relaxed with multi-period data collection and information on other expenditures, both are not covered in this paper.

Using a Working-Lesser consumption model[15,16], these assumptions will be inherent in the household elasticity measures. The shares equations are estimated for all energy sources using the Heckman two-stage estimation technique. This technique is used because several households do not consume all the different sources of energy and potentially biases the estimates. This modeling framework is explained at length in Chern et. al[17].

In order to capture the characteristics that lead to one of the energy sources chosen, the first stage, a probit regression is computed in order to estimate the probability that a given household consumes the energy source in question. This equation provides an estimate for the inverse Mills ratio for each household, which is then used as an instrument in the second regression. The inverse mills ratio is calculated by using a binary right hand side variable (I_i), for whether or not the energy source is used and regressed on the same parameters as the Working-Leser model. The inverse mills ratio calculated as part of this estimation adjusts the expected value of the coefficients by what would be otherwise lost if the zero-consumption households were not accounted for.

$$\begin{cases} I_i = \boldsymbol{\beta_0} + \boldsymbol{\beta_1} \ln(\boldsymbol{E}) + \boldsymbol{\Sigma_j \beta_{ij}} \ln(\boldsymbol{q_{ij}}) + \boldsymbol{\Sigma_j \beta_{3j}} \ln(\boldsymbol{p_j}) + \boldsymbol{\Sigma_k \gamma_{ik} H_k} + \ u_i \ if \ w_i > \ 0 \\ 0 \ otherwise \end{cases} \quad (1)$$

In the second stage, the initial Working-Leser model with the inverse Mills ratio is estimated. The Working-Leser model for the share equations are specified as,

$$\mathrm{w_i} = \beta_0 + \beta_1 \ln(E) + \Sigma_j \beta_{ij} \ln(q_{ij}) + \Sigma_j \beta_{3j} \ln(p_j) + \Sigma_k \gamma_{ik} H_k + \theta_i \lambda_i + \epsilon_i \quad (2)$$

Where

w_i are the monthly shares measured in kWh of the different energy sources (wood, electricity, lignite, natural gas) from the total

q_i are the quantities of wood (w, m^3), Ave winter Electricity (e, kWh), lignite (l, tons) and Natural gas (G, Liters) consumed monthly

p_i are the relative prices of the different energy sources

E is the expenditure on energy (€)

H is a vector of household related characteristics

λ_i is the inverse Mills Ratio

Taking the natural log of the prices and quantity shares allows for looking at the % changes instead of the level changes. The coefficients for the two stage Heckman model can be found in Table 11. From the results we can see that the key factors in determining whether or not a household uses wood fuels is the price of coal, the amount of income spent on energy sources, the surface area of the household heated and the quantities of electricity and coal consumed as substitutes. In the second stage, the interpretation is a percentage change in the alternative energy source price leads to a change in the share of wood fuels used. For the other factors, the interpretation is by the value of the factor and its impact on the share of wood fuels consumed in the household. Coal prices, expenditure, surface area are still significant, but we add the additional factor of the number of people in the household, which increases the share of wood fuels consumed by approximately 1% per additional person. As expected from the undiscernible variation in prices, own-price elasticity is not significant.

Since the household is substituting fuel resources, the interesting variable is the rate at which these factors are substituted. In order to calculate the elasticity measures for prices and expenditure, the following Using the estimated coefficients, the conditional price elasticities of demand for the energy sources, their respective prices and income in percentage terms can be estimated by,

$$\mathrm{e_i} = -\boldsymbol{\delta}_{\mathbf{ij}} + \frac{\beta - \psi_i \omega_i \{\Gamma_i \omega \lambda_i - \lambda_i^2\}}{\overline{w_i}} \qquad (3)$$

The kroncker delta (δ_{ij}) is equal to 1 when i=j. When looking at the expenditure elasticity, the delta is positive and equal to 1. The additional terms in the numerator adjust the beta coefficients by a factor related to the inverse mills factor (λ_i), the initial probit estimates (ω_i), the adjustment for the inverse mills parameter in the second equation (ψ_i), and the distribution of observations (Γ_i) for each household i, evaluated at the mean of the sample.

Interpreting the elasticity measures indicate that a 1% increase in the variable will result in a increase or decrease in the share of electricity consumed in the household. For the price of electricity given the block tariff structure, the electricity price will be based on the next unit of energy consumed at the high tariff for the block (e.g if the, household is at 250 kWh, the price will be 7.32 euro cents, sensitivity analysis may be done at a later point for low/high rates). The results give the key elasticity measures as the expenditure, the price of electricity and the quantities of wood and lignite (Table 12).

As total expenditure on energy resources increase by 1% it will result in the proportion of household energy demand met by wood fuels to increases by 35%. The average share for wood fuels in the LPLS households is 61% (or 9.76 m^3 of solid wood), so a 35% increase of 2.08 m^3 over the entire season. This is almost equal to the response from households when the price of electricity moves from one tariff block to the next higher, as the elasticity for electricity price is 36%. This implies that households will substitute to electricity when prices are stable and expected, but that the €0.02 and €0.03 increases between tariff blocks, impacts the overall consumption of wood fuels more.

Lignite is a net compliment for wood fuels. As the quantity of lignite increases and its price, it indicates that homes will decrease the share of wood fuels in a similar fashion as electricity. As the price of lignite increases by 1%, the share will decrease consumption by, 3.1%. Natural gas, however, is a compliment to wood fuel consumption, as can be seen with a 1% increase in natural gas prices will result in 1.7% decrease in the share of wood fuels. The reasons behind this are likely because when households were asked why they used the different energy sources, wood fuels were used for both heating and cooking (n:577), and less just one activity or the other (cooking, n:6; heating n:11). Whereas, lignite was mostly used for heating (n:44) and both activities (n:34), and rarely just for cooking (n:5); and natural gas was mostly used for cooking (n:71), then occasionally heating (n:13) and rarely for both (n:3).

5. CONCLUSIONS

The population of people that was considered in this study will typically be more dependent on wood fuels as the situation of substitution away from wood is either less reliable or there are issues in terms of the costs of alternatives relative to income. The demand response may be compared in the future to households in other areas of Kosovo that have greater access to reliable energy sources or even to alternatives like centralized building heating or district heating. As the elasticity of demand is relatively low for these households to switch to other sources of energy, this will have an impact on other important aspects of the energy sector and related policies. For example, the consumption of lower cost fuel sources may alter the payback periods on improving energy efficiency in terms of heating or in parallel with the costs of isolation of the exterior of the home. When energy consumption increases, these households will be likely to consume more wood fuels over electricity, given the current tariff system, further straining the unsustainable forest system.

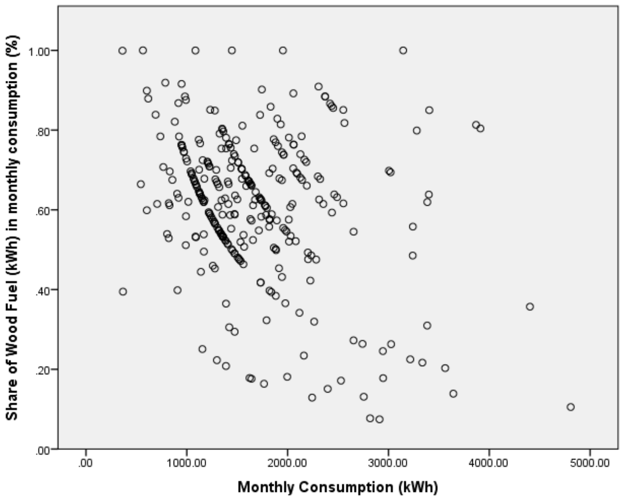

Figure 7. Scatter plot of the Share of Wood Fuels (kWh) for digital meter consumer by their total monthly consumption

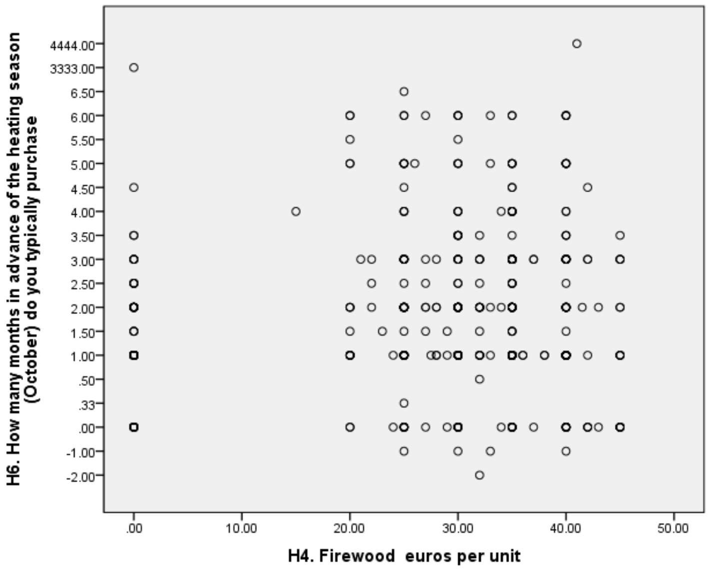

Figure 8. Seasonal prices of wood fuels

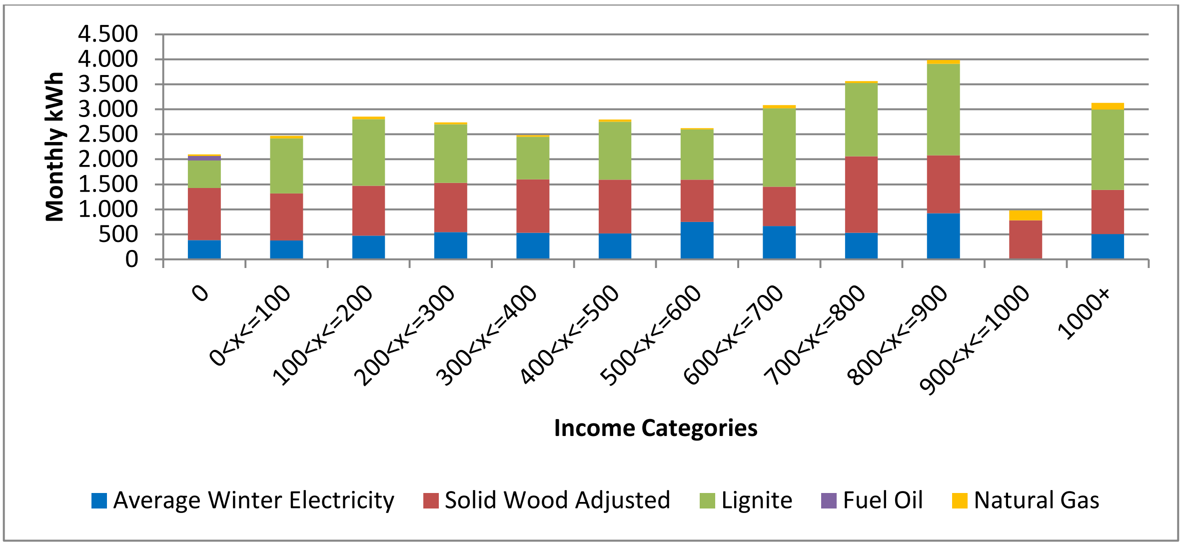

Figure 9. Energy Consumed by income category

Table 10. Descriptive Statistics of Wood fuel Consumption

Question		Unit	N	Mean	Median	Min	Max
When do you use wood fuels (LSLP)	All year round	(solid m³)	392	10.46	10.00	2.76	34.50
	Only the Heating Season	(solid m³)	210	8.47	6.90	1.38	69.00
When do you use wood fuels (Rural/UNFAO)	All year round	(solid m³)	590	8.88	8.28	34.50	0.00
	Only the Heating Season	(solid m³)	568	7.61	6.90	34.50	0.00
Low-Payment		(solid m³)	292	10.35	9.83	2.76	34.50
Low Service		(solid m³)	292	9.20	7.59	1.38	69.00
Monthly ekWh for wood for the winter season (adjusting off 2 m3 for those using all year)	Those that don't' use an electric device for heating	(kWh)	480	1,040.84	868.22	144.7	7235.14
	Those that use an electric device for heating	(kWh)	125	961.34	867.92	289.1	3145.42

Table 11. Estimation Output for the Heckman two-stage estimation

```
--------------------------------------------
Tobit 2 model (sample selection model)
2-step Heckman / heckit estimation
302 observations (135 censored and 167 observed)
37 free parameters (df = 266)
Probit selection equation:
                         Estimate Std. Error t value Pr(>|t|)
(Intercept)              -3.5008874 5.1755845 -0.676  0.4994
price.implg_wood_p        0.1060640 0.0876947  1.209  0.2276
price.implg_ele_p        -3.0596023 1.6733828 -1.828  0.0686 .
price.implg_coalp        -0.0180803 0.0485952 -0.372  0.7101
price.implg_NG_p          0.0436847 0.0512568  0.852  0.3948
E                        -0.5330725 0.2998146 -1.778  0.0765 .
HC1_BldgType_House_YrC   -0.0009365 0.0016457 -0.569  0.5698
HC2_Surface              -0.0088587 0.0020477 -4.326 2.15e-05 ***
```

HEle_Heat	-0.0560802	0.3500284	-0.160	0.8728	
HAge	0.0048415	0.0093263	0.519	0.6041	
HEmployed	0.1985591	0.1601264	1.240	0.2161	
HTotPeople	-0.0110857	0.0460617	-0.241	0.8100	
HEDU_HH	-0.1967628	0.2048673	-0.960	0.3377	
HF5_Inc_E	0.1948241	0.4221889	0.461	0.6448	
qty.imp.wwAve_kWh_Ele_Winter	0.0045858	0.0006163	7.441	1.38e-12	***
qty.imp.wwH4_CoalQty	0.0016582	0.0006660	2.490	0.0134	*
qty.imp.wwH4_NatGas_Qty	0.0004144	0.0006607	0.627	0.5311	

Outcome equation:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	1.493e+00	2.539e-01	5.879	1.23e-08	***
price.implg_wood_p	-1.182e-03	7.198e-03	-0.164	0.86965	
price.implg_ele_p	1.354e-01	9.734e-02	1.391	0.16546	
price.implg_coalp	-1.005e-02	3.495e-03	-2.877	0.00434	**
price.implg_NG_p	-3.941e-03	3.600e-03	-1.095	0.27466	
E	-1.183e-01	3.287e-02	-3.599	0.00038	***
HC1_BldgType_House_YrC	-5.759e-05	5.719e-05	-1.007	0.31479	
HC2_Surface	7.153e-04	2.575e-04	2.777	0.00587	**
HEle_Heat	-1.677e-02	2.435e-02	-0.689	0.49148	
HAge	-3.344e-04	6.856e-04	-0.488	0.62609	
HEmployed	1.284e-03	7.206e-03	0.178	0.85870	
HTotPeople	1.247e-02	3.153e-03	3.954	9.85e-05	***
HEDU_HH	1.610e-02	1.511e-02	1.065	0.28772	
HF5_Inc_E	1.881e-03	2.792e-02	0.067	0.94634	
qty.imp.wwAve_kWh_Ele_Winter	-2.902e-04	9.678e-05	-2.999	0.00297	**
qty.imp.wwH4_CoalQty	9.933e-05	4.215e-05	2.357	0.01916	*
qty.imp.wwH4_NatGas_Qty	-1.860e-06	4.347e-05	-0.043	0.96589	

Multiple R-Squared:0.4758, Adjusted R-Squared:0.416

Error terms:

	Estimate	Std. Error	t value	Pr(>|t|)
invMillsRatio	-0.05944	0.07013	-0.848	0.397
sigma	0.11537	NA	NA	NA
rho	-0.51522	NA	NA	NA

Table 12. Elasticity measurements for price and expenditure

Elasticity	
e_Ln(wood_p)	-0.997
e_Ln(ele_p)	0.363
e_Ln(coalp	-0.031
e_Ln(NG_p)	-0.017
e_e	0.359

6. References

1. Norwegian Forest Group, N. *Kosovo National Forest Inventory 2012*. (2013). at <http://www.nfg.no/userfiles/file/Kosovo/Kosovo%20National%20Forest%20Inventory%202012.pdf>
2. UNFAO, U. N. F. and A. O. & CENR, C. for E. and N. R. *Wood Fuel Consumption in Kosovo Households*. 85 (In Press).
3. Miriam Bensky, Tess Bone, Maricarmen Hinojosa, Abha Parekh & Jingchao Wu. Losing the Forest for the Trees: Implications of Illegal logging in Post-Conflict Kosovo. (2013). at <http://www.cicr-columbia.org/wp-content/uploads/2012/10/Kosovo-2013_Full-Copy_Final-.pdf>

4. 24sata. Illegal logging along the administrative line. (2012). at <http://arhiva.24sata.rs/m/vesti/aktuelno/vest/ilegalna-seca-sume-duz-administrativne-linije/51537.phtml>
5. E-novine. Wounded member of the Žandarmerija succumbs to injuries. (2014). at <http://www.e-novine.com/srbija/vesti/108464-Ranjeni-pripadnik-andarmerije-podlegao-povredama.html>
6. Balcanicaucaso. Macedonia: Six Killed in Police Raid in around Tetovo. (2007). at <http://www.balcanicaucaso.org/eng/Regions-and-countries/Macedonia/Macedonia-Six-Killed-in-Police-Raid-in-around-Tetovo-39306>
7. Green Horizons. Macedonian police operation thwarts illegal logging. (2014). at <http://www.greenhorizon-online.com/index.php/Former-Yugoslav-Republic-of-Macedonia/macedonian-police-operation-thwarts-illegal-logging.html>
8. KSA, K. S. A. Kosovo Population and Housing Census 2011: Final Results. (2011). at <http://esk.rks-gov.net/rekos2011/repository/docs/Final%20Results_ENG.pdf>
9. Biomass Energy Center. Fuel costs per kWh. (2014). at <http://www.biomassenergycentre.org.uk/portal/page?_pageid=75,59188&_dad=portal>
10. USDA, U. S. D. of A. *Wood Handbook: Wood as an Engineering Materials*. (1987). at <http://naldc.nal.usda.gov/download/CAT10324726/PDF>
11. ERO, E. R. O. *2014 Tariff Rates for Kosovo*. *ERO Code: V_638_2014* (2014). at <http://ero-ks.org/Vendimet/English/2014/V_638_2014_final_eng.pdf>
12. UNECE, U. N. E. C. for E. Forest Product Conversion Factors: Project Overview and Status. (2009). at <http://www.unece.org/fileadmin/DAM/timber/meetings/forest-products-conversion-factors.pdf>
13. IEA, I. E. A. The Transition to modern energy services. *International Energy Agency* (2012). at <http://www.worldenergyoutlook.org/resources/energydevelopment/thetransitiontomodernenergyservices/>
14. Hosier, R. in *Encyclopedia of Energy* (Elsevier Science & Technology, 2004). at <http://search.credoreference.com.ezproxy.rit.edu/content/entry/estenergy/energy_ladder_in_developing_nations/0>
15. Leser, C. E. V. Forms of Engel Functions. *Econometrica* **31,** 694–703 (1963).
16. Deaton, A. & Muellbauer, J. An almost ideal demand system. *Am. Econ. Rev.* 312–326 (1980).
17. Wen S. Chern, Kimiko Ishibashi & Kiyoshi Taniguchi. Analysis of the food consumption of Japanese households. (2003). at <http://www.fao.org/docrep/005/y4475e/y4475e07.htm>

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THE ROLE OF THE CROATIAN WOOD CLUSTER IN WOOD AND BIOMASS PROMOTION

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ABSTRACT

Clusters can have a strong influence on the creation of a national development platform for the application of innovation and smart technologies, which will ensure the future of the sector in the long term period, with an emphasis on coordinated EU competitiveness policies. Application of innovations in the sector is the key to a better positioning of the companies in foreign markets.
Key words: cluster, wood processing, biomass, South East Europe, wood promotion

1. INTRODUCTION - WHAT IS CLUSTER?

1.1. Purpose of the Croatian Wood Cluster

The Cluster is a group of connected companies. The type of activities determines the connecting of companies in the Cluster because most of them are involved in the activities in the field of forestry, wood processing, furniture production and similar activities. The Cluster is focused on applying of innovations and strengthening the impacts of different types of education, but also other functions that are interesting to cluster members.

The reason for establishing of the Cluster arises of the need of Croatian companies that are registered for the activities in C16 and C31 (National classification of economic activities) to gather in structured, organized and integrated way. The goal is to improve the sustainable competitiveness of wood processing sector, especially regarding the encouraging and promoting inter-sectoral and trans-sectoral cooperation.

1.1.1. Mission of the Croatian Wood Cluster

Creating of long term sustainable business model for strengthening competitiveness of wood processing sector by encouraging the activities in the field of research, development of technology, applying and commercialization of innovation and encouraging of investments.

1.1.2. Vision of the Croatian Wood Cluster

To build a strong and sustainable cluster which will gather and credibly represent wood processing sector on all levels, including participation of leading companies, members of research and development sector and representatives of public sector.

1.1.3. Common Cluster Values

Cooperation, innovation, integrity, ethical activities, responsibility, excellence, teamwork - those are some of the key values of the Cluster. The process of building the trust has its dynamic because the activities, quality, credible work and building of common values create the confidence of members, as well as of broad business and social community. The Cluster is trying to identify these values by bringing them into communication and to inform about it all interested sides.

The Cluster performs various and numerous activities, which must be in accordance with the founding documents, statute and regulations, primarily in accordance with the Law on Associations. Cluster gathers different and heterogeneous companies: small and large wood processing companies, primary processing and finalists, domestic and foreign investors, producers of wood pellets, as well as designers of furniture, etc. In these multiple activities the Cluster integrates the whole sector to work together and to cooperate and strengthens joint operations. Every activity is documented.
The novelty in the work relates to the calculation of VAT as the Cluster entered in the register of VAT payers in January 2015. The Cluster receives incomes from membership fees and other (donations, income from participation in the projects, income from the organization events, publishing, etc...), while expenses are related to salaries of employees, operating expenses and office costs of printing and promotion.

1.2. The Cluster Strategical Background

The Cluster intends to contribute to the accomplishment of the goals of the wood processing sector, set down in the national and EU strategic documents in the period for 2015-2020. In order to achieve this aim, the Cluster has adopted the strategy together with the Operational Plan.

The Strategy is based on two national and the EU documents:

- Strategic guidelines for the development of the wood processing industry sector 2013-2020 (Ministry of Economy)
- Overview of the situation in the wood processing sector (support project for cluster development, IPA 2013)
- Proposal of a new European forestry strategy (the European Commission, 2013)

The main downsides of the wood processing sector are:

- Low sectoral cooperation
- Longstanding problems and inconsistency in training
- Low level of investment in research and development and transfer of technology
- Lack of common branding and marketing in foreign markets

At the same time, the strategy identifies not just the shortcomings but also the numerous possibilities for further development of the sector, mainly in the areas of innovation and technology, and in greater use of available resources in the field of bio-economics and rural development.

Promising areas for development of the sector:

- Furniture design - new product development
- The concept of eco-design
- The concept of greater use of wood in the construction of sustainable buildings
- Renewable energy sources (use of wood biomass)
- The use of wood in bio-oriented societies
- Sustainable forest management
- The utilization of KET technologies in the wood processing sector

There are many opportunities for improvement. Cooperation with economic diplomacy is very important because it can lead to more significant export business and it can make a major contribution to our better international positioning. Exports to overseas markets are important for our sector and the high share of the sector of over 10 percent of total Croatian exports confirms its good international competitiveness. Foreign markets are interesting and attractive to us, but are often very complex and challenging and it takes a lot of effort, knowledge and innovation to retain a position in them, and especially to open up new jobs.

2. WOOD PROCESSING IN CROATIA

2.1. Overview of the Sector

The Croatian wood processing sector has a long tradition. The first water-powered sawmill was founded in 1428, and the first furniture factory in 1884. At the beginning of 1790s, forestry and craft sawmills' owners began to accumulate logs to provide a secure fiber resource for the manufacture of lumber and panels. Down the years, a large number of sawmills were opened across the region, and sawn timber was often, due to its quality, exported to the countries in Europe, South America and the Middle East. The best known products were oak planks from Slavonian sawmills, which was the most attractive product on the market. In the mid-19th century, the first signs of industrialization became visible and the first furniture factories were set up in South East Europe. The first furniture factory in Croatia was established in 1884. After World War II wood and lumber were one of the most important export products in the former Yugoslavia. The forest cuts (felling of forest trees) for exporting were intended to provide financial resources for restoring the country and its industrialization (around 80 percent of the exported timber came from Croatian forests).

2.2. Green Economy Potential

The financial yield from the wood and forest industry was meagre in the beginning of the 1990s. As a result, companies started to search for ways to improve profits. Many of them discontinued old production (mostly furniture production for the internal market of the former state) and set up sawmill activities. This shifted capital away from complex production process to lower-cost sawmills production. The investments were visible in other lines of production as well, such as parquet production. Both directions allowed companies to produce more lumber for the global market and enter into new niche markets. The old models were abandoned and companies with new strategic approaches were established. Small and medium-sized companies started to develop rapidly. In addition to this the FSC[29] certificate was given to the state owned company Hrvatske Sume (Croatian Forest Ltd.[30]) in 2002. This created a good basis for the certification of private wood processing companies, which resulted in increased profits through exports of certified wood products (FSC CoC)[31]. Wood processing companies are showing considerable interest in acquiring international certificates, which act as verification of sustainable forest management to final customers (ecologic, social and economic standards). More than 150 wood processing companies have obtained the FSC-CoC certificate.

2.3. Market Structure

The Croatian wood processing sector produces sawn wood products of all types and sizes, veneer and veneer sheets, particleboards, parquet, floorings, wall linings, carpentry and other products

[29] The Forest Stewardship Council (FSC) is an international not for-profit, multi-stakeholder organisation established in 1993 to promote responsible management of the world's forests. This offers customers around the world the ability to choose products from socially and environmentally responsible forestry.

[30] Hrvatske sume, limited liability company, is a legal successor of "Hrvatske sume", public enterprise for forest and woodland management in the Republic of Croatia, p. o., Zagreb, founded on the basis of the Amending Forestry Act (NN 41/90), with the beginning of function on January 1st 1991.

[31] Certification for Wood and Paper Products in order to assure customers that wood and paper product meet the world's most stringent environmental, ethical, and economic sourcing standards with Forest Stewardship Council Chain-of-Custody (FSC CoC) certification.

from wood, cork and plaited material, wooden packaging, briquettes, pellets and different type of furniture. Because of the historical production model (typical socialistic economy), which included all stages of production (from sawmills to final product), even today most of the companies have their own sawmills. However lately, primary wood-processing is becoming frequently less popular (i.e. sawmill industry), because production of the compound final wood products is considered to be of higher value added.

The main types of wood used in the Croatian wood industry are: beech, oak, fir, ash, hornbeam, aider, maple and other types of, mainly non-coniferous wood. The Croatian oak (Quercus Robur) is one of the most famous types of oak in the world. Although wood is the traditional furniture-making raw material, there are a growing number of non-wood materials, which are being used in the production of furniture in order to improve and accentuate its individual characteristics and design.

In 2010, the wood processing sector in Croatia, counted 3,127 companies that employed over 25,000 workers, generating total revenues of approximately 1 billion EUR, while export sales generated 600 million EUR. The export figures show that the wood-processing industry represents almost 7 percent of Croatian manufacturing exports. The export trend is positive since level of exports rose by more than 11% in 2011 compared to 2010. In 2012 it is expected that exports from the wood processing industry will remain at the same level as in 2011.

A common forestry policy is on the agenda, since Croatia will very soon enter the EU. Special attention is being given to the monitoring of the Croatian forests with environmental focus at the regulatory level.

A lumber market for private forest owners does not exist in an organized form since the regulation of this area is not covered by the existing legislative framework. The only institution which was envisaged to act as facilitator of development was abolished in 2010 (State agency for management of privately owned forests).

The wood processing industry in every country in the process of EU accession is obliged to meet a series of legal requirements in the area of product safety, health safety and environmental protection. It is estimated that currently over 60 percent of the wood-processing companies in Croatia do not meet at least one of the EUs accession requirements (particularly in the primary production area). At the same time, Croatian wood-processing companies do not have any insight into the aspects of adaptation to the upcoming legal framework, which is threatening to cause difficulties resulting in high penalties in the event of failure to meet these legal requirements.

On the positive side, industry representatives recognized the purchase of logs, certification as well as competition from the informal sector (black market), as their main problems in conducting business. These topics have been addressed in the framework for the new law proposal.

2.4. Market Trends

The current state in the sector is very positive, and some themes like energy efficiency or better valorisation of energy from wood deserve special attention. The growth of export is the speciality of this sector and recognizable mark because it has grown for almost 300 percent from 2003 to 2015.
Regarding developments in market trends, it is significant that the majority of indicators recorded mostly positive signs. In 2013 the industry produced 106,679 m3 of sawn conifer timber, 610,445 m3 of sawn hardwood timber. In the category of furniture the greatest production was of chairs and seats: 1.2 million units, representing 53.9 percent of the total amount of furniture. Products in the field of wood in construction are still important.

Unlike the rest of the Croatian economy, the wood processing and furniture industries have stabile and positive trends. Accor- ding to unofficial data for 2014, the sector has achieved a significant increase in exports, and especially good news is the growth of furniture exports by about 17 percent. These are good indicators in spite of the deteriorating trends in the domestic industry and the decline in GDP. In 2014 the sector ended the year with the exports of over USD 1.1 bil. (unofficial figures) and that is higher than in the pre-crisis year of 2008. Thanks to the great efforts of sector companies, agile sectoral marketing, new product development and the export orientation of the companies, the sector has turned into a real hero of domestic exports, which, unfortunately, is not mirrored in financial support or other forms of encouragement for export and production.

2.5. Important Subsectors

Sawmilling is one of the sub-sectors that have witnessed the most rapid growth. In spite of substantial demand for sawmill products, most of the Croatian sawmills have difficulties in acquiring raw material. Because of that, local sawmills in Croatia are also facing great difficulties in product placement on the global market. Therefore they cannot rely solely on selling sawn timber since it is considered to be a low value-added product. At the same time, there is strong competition from other European markets since most hardwood is produced in Turkey and Romania. These countries represent the biggest competition for Croatia in the exports of hardwood.

All products for the construction sector have become an important sub-sector, following trends from abroad, above all Austria, Finland and other countries that invest a lot into promotion campaigns for sustainable construction (green building)[32]. Wood materials are now very commonly used as construction material in order to meet the requirements set by the sustainable construction concept. Therefore is hoped that the wood processing sector in Croatia will exploit this opportunity and engage more intensively in the process of manufacturing wooden elements for the construction sector.

Wood biomass has large potential. Overall the potential of wood biomass in the production of energy and heat is immense and it could contribute significantly to increased utilization of renewable energy resources (RES[33]) in Croatia. The implementation of RES projects using biomass will contribute on the one hand to rural development (since most of the projects will be implemented in rural areas) and on the other to meet the Kyoto protocol requirements. It should be underlined that through higher utilization of wood biomass the environmental and biological balance will not be endangered since the wood management process is conducted in accordance with very strict rules in Croatia. Currently most of the wood biomass raw material ends up in exports. More than 40 trucks of biomass are exported every day from the Slavonia region to Slovenia, Austria, Italy and Hungary. There are only two wood biomass co-generation projects[34] active in Croatia (Hrast Strizivojna and Lika Energo Udbina) whilst, according to the registry of the Ministry of Economy, more than 70 projects are waiting for implementation to begin because the of the burdensome and complicated administrative procedures which are slowing down the implementation of the RES investment projects. In respect to the wood processing industry in Croatia, many plants have a pending plan for the installation of cogeneration facilities, primarily for their own purposes, with the possibility of selling excess electricity to electricity suppliers. In addition to this, the wood pellet[35] industry in Croatia has been developing quickly over the past number of years.

In the last decade domestic parquet production has shown greatest growth. Croatia witnessed an increase in the production of windows, doors and parquet. At the same time Croatia became world's

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[32] Green building (also known as green construction or sustainable building) refers to a structure and using process that is environmentally responsible and resource-efficient throughout a building's life-cycle: from sitting to design, construction, operation, maintenance, renovation, and demolition.

[33] Renewable Energy Source projects - Renewable energy is energy that comes from natural resources such as sunlight, wind, rain, tides, waves and geothermal heat. About 16% of global final energy consumption comes from renewable resources, with 10% of all energy from traditional biomass, mainly used for heating, and 3.4% from hydroelectricity. New renewables (small hydro, modern biomass, wind, solar, geothermal, and biofuels) accounted for another 3% and are growing very rapidly.

[34] Cogeneration (also combined heat and power, CHP) is the use of a heat engine or a power station to simultaneously generate both electricity and useful heat.

[35] Wood pellets are a type of wood fuel, generally made from compacted sawdust or other wastes from sawmilling and other wood products manufacture, but also sometimes from sources such as whole-tree removal or tree tops and branches leftover after logging and which otherwise help replenish soil nutrients.

fourth largest producer of solid wood parquet. The European Federation of the Parquet Industry (FEP[36]) recognized Croatia as an important market player. Croatian manufacturers mostly produce solid wood parquet, multilayer parquet and so-called ''country flooring''. Parquet and wood flooring represent 8 percent [37] of the overall wood processing industry exports. In the last few years the global financial and economic crisis has made quite an impact on the Croatian parquet industry since a number of companies lost their long-established markets. Some manufacturers, despite the crisis, turned towards new markets, such as Russia and the Middle East in order to compensate the loss.

Furniture manufacturing lost its dominant position on the domestic market, but gained a rather important position abroad (Germany, UK, France and Scandinavia markets). In recent years, most of the furniture in Croatia has been imported since foreign retail chains control the trade. As a tool for the strengthening of domestic production potential, the expected arrival of the IKEA Group[38] could be perceived as a positive development since it presents opportunity for manufacturing companies to become suppliers. Entry into the supply chain however can be difficult due to the very strict quality and pricing requirements and standards set by IKEA.

Furniture manufacturing in Croatia in general can be divided into three main groups:

- solid wood furniture;
- chipboard furniture;
- composite materials furniture.

The most attractive mass market products are chipboard products which are under huge pressure from Chinese and Polish competitors.

Solid wood furniture, especially, made from Slavonia oak, is a highly demanded Croatian export product in Scandinavia, Great Britain, France and Germany. Chair manufacturing was a trademark of the industry 20 years ago when chairs were mostly exported in the USA. Nowadays, there are only a few serious chair manufacturers left, and they export more than 85% of their production. The largest Croatian manufacturer of chairs is the company Klana d.d. from Primorsko-Goranska county with the manufacturing capacity of more than 1,5 million chairs per year.

3. THE CLUSTER ROLE IN PROMOTION AND NEW MARKET OPPORTUNITIES

3.1. Active Support in all Levels

In order to be successful, any cluster has to be supported at all levels. In Croatia the wood processing cluster has successfully organized a number of activities: visits to specialized trade shows abroad, joint visits of diplomats to the factories in our area as well as support through the partnership in EU projects. The Cluster also supported us during lobbying activities for financing the competence center. This center will ultimately support local companies but also wood processors in the wider Slavonia region and in neighbouring Hungary. It should be noted that the cluster scene at the national level is being more and more active; therefore in Croatia is active National Competitiveness Cluster at the Agency for Investments and Competitiveness.

3.2. New Markets Opportunities

[36] The European Federation of the Parquet Industry (FEP) reunites European national parquet federations, parquet manufacturers and suppliers. Its main task is to protect the interests of the European parquet industries.

[37] Source: Croatian Chamber of Economy

[38] IKEA is the world's largest furniture retailer.

The Russian market, together with the Middle Eastern countries, are the most promising markets for Croatian wood processing manufacturers. However, cooperation is very complex, because models of conducting business in these countries are different than in the rest of Europe. It takes a significant amount of effort to introduce a new product to the Russian market. Without a local presence it is practically impossible to seal the deal with Russian entrepreneurs. This market requires a diametrically opposite marketing strategy to the strategy used for the traditional European markets since local presence is a necessity. One of the possible ways of entering into the Russian market is through cooperation with Serbian producers since they have duty-free access into the Russian market (Serbia has a valid free trade agreement with the Russian Federation).

There are a lot of opportunities to approach new markets and facilitate exports of furniture and other wood based products in the new markets. A group of producers wants to set-up a wood-processing industry representative office in the new markets (of the Gulf Area). CBRD (HBOR) announced that they are intending to launch programs specially dedicated to the funding of setting up trade offices abroad. The government could help further through provision of specific grants as well in order to facilitate trade in that respect.

Possible Export Cooperation; Apart from the exports of wooden products, the Croatian wood processing sector is continuously engaged in various investment projects and cooperation arrangements with foreign partners. Mostly in manufacturing with a specific focus on wooden products supplied to foreign clients, forest management and wood biomass facilities. The companies are looking for strategic investors who will be able to share market experience and contribute to the creation of a common strategic approach in order to penetrate non-traditional markets (the Russian Market, Gulf States and Asian markets).

Fairs; Supported by the Croatian Chamber of Economy (CCE) and the Ministry of Agriculture, the Croatian wood processing companies actively participate in international wood fairs throughout the world. Croatian parquet producers are well known in international markets and traditionally participate at numerous international fairs such as Domotex, the world's leading show for floor coverings in Hannover and BAU fair in Munich. Croatian furniture manufacturers regularly participate at international fairs in Cologne (IMM Cologne) and Milan (Eurocucina, Salone Internazionale del Mobile), Valencia, (Maderalia), Belgrade (Furniture Show) and Moscow (Mebel). The CCE program supports the participation of its members in the regional markets of Serbia (Belgrade), Bosnia and Herzegovina (Zenica, Sarajevo), Montenegro (Budva) and Albania (Panair, Tirana).

The world's second largest economy-China; has continued its strong growth. Therefore demand for European logs, semi-finished wooden products and components imported from Croatia is significantly high.

Traditional European markets; Over 70 percent of the Croatian lumber export goes to European economies. There is huge potential in lumber market export growth once Croatia joins the EU due to the fact that the quality norms will be aligned with the EU quality after the accession (this was natural obstacle for export of sawn lumber products). The stability of the existing customer base and positive economic developments in Germany could lead to an increase of exports in the area of furniture products as well.

The Austrian representatives of the wood processing sector (Pro:Holz) have a very optimistic approach to the potential of larger utilization of wood in Southeast Europe. Western Balkan Countries have almost 50 % of their territory covered by forests. However wood is not often used as a building material since on average less than 0.05 m3 of wood is used per capita. At the same time, all countries export raw material in significant volumes. In order to change the perception the Austrian company Pro Holz began a „Building with Wood „campaign in Southeast Europe. They have launched several successful promotional campaigns in recent years, particularly in the field of education of target subjects, such as architects, for whom dozens of seminars have been held in Slovenia, Croatia, Bosnia and Herzegovina and Serbia on the utilization of wood as a raw material. It is expected that those campaigns could result in some positive reactions among local entrepreneurs in the Balkans.

Positive trends for pellets, the market (domestic to a lesser degree) shows an increasing interest in wooden briquettes and pellets in the context of enforcing the environmental and energy policy for promoting large-scale use of renewable energy sources.
South East Europe Region, Croatia has a great export opportunity; it is already the main import partner for some countries like Bosnia and Herzegovina. Cooperation is especially effective in the field of placement of final products. 87 percent of production in the countries of the SEE Region is sold outside the SEE Region, while only 23 percent of products are the subject of mutual trade. Huge potential lies in the area of additional increase of exports of final products (furniture), because of the positive image of Croatian products with regard to quality. This region has an important economic dimension, since the wood processing industry together with the forestry employs over 130,000 people.

4. INTERNATIONAL INTER-CLUSTER COOPERATION

4.1. Support from the Austrian and Italian Clusters

Clusters are created in Harvard classrooms when the model of Italian industrial districts in which the word cooperation was very realistic is being studied. The whole district (a specialized production zone in a geographical area) generated intense cooperation, which remains a great challenge for all wood processing clusters in the world. It is common for such cooperation to happen spontaneously because the companies associated in a cluster show great interest in topics such as custom-made education, unified transportation, custom machine construction, specific offers from designers or strategies for foreign markets. Synergy is achieved in all these areas and all the associated companies jointly address the key challenges.

Important support for the work of the Croatian Wood Cluster comes from partner clusters by exchanges of best practices. One of the best experiences is related to the activities with the Holzcluster Steiermark, but also very worth mentioning are the colleagues from the Slovenian Wood Cluster, the Habic cluster of Bilbao in the Basque Country and communication with German and French clusters.

4.2. Concerns Also Exist at the Global Level

Clusters still arouse great doubts in Croatia and globally. Some distinguished professors from American universities today criticize the model of clustering as unworkable in practice. But advances in cluster theory, expanding the term competitiveness to nations or industrial sectors, the observed effects of German and French meta-clusters, the fact that American cluster mapping achieved success - all these are reasons for economic and political circles increasingly to appreciate the results of clustering processes.

5. CONCLUSION

The Clusters seek to increase relations and business activities with manufacturing companies, which are crucial to increasing exports and facilitating innovation. The Croatian Wood Cluster continues to support export activities as well as investments made by the Croatian companies in the SEE Region. As the Croatian companies are more developed and competitive than many regional counterparts, they are able to bring improved business practices along with investment capital to the Western Balkans markets. Where appropriate, the Cluster will provide marketing assistance to local companies through participation at fairs and exhibitions. At the same time, the clusters strengthen their own capacity to promote and support foreign direct investment into the wood sector, which brings the required capital, new ideas, new technologies, improved ways of doing business and access to foreign markets.

One of the largest problems is that the wood processing and furniture manufacturing companies in Croatia have still an unclear perception about the concept of clustering as a mutual and multi-beneficial concept. This lack of clarity hinders the successful formulation and implementation of collaborative cluster plans and reduces their effectiveness in dealing with competition in the international market and with the growing challenges in the domestic market.

The Croatian Association of Pellet, Briquette and Wood Biomass Producers has a close cooperation with the Croatian Wood Cluster, with whome initiated a campaign for a greater promotion of wood pellet use in Croatia during 2013-2014. Both Association have common goals and often jointly represent and defend the interests of the sector, as well as its members, towards the policy makers. Also with the support of the Croatian Wood Cluster, the Association became a member of the European Biomass Association (AEBIOM) in May 2015.

RESOURCES

1. The Croatian Wood Cluster (2015): ANNUAL REPORT 2014, Zagreb.
2. Ministry of Economy (2013): STRATEGIC GUIDELINES FOR THE DEVELOPMENT OF THE WOOD PROCESSING INDUSTRY SECTOR 2013-2020, Zagreb.
3. Kavran, M., Lovrencic, M. (2013): CROATIAN WOOD PROCESSING SECTOR OVERVIEW, Zagreb.

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THE INDUSTRY LOBBYING IN BRUSSELS

Marijan Kavran

ABSTRACT

This work introduces the lobbying procedure related to the most powerful industrial associations' players in the EU capital, Brussels, home to one of the highest concentrations of political power in the world. This work also explains the EU lobbying process, the multiple ways – some controversial - in which the lobbyists work to steer decisions to their advantage, and the often-serious impacts this has on people across Europe and in the rest of the world. As the power of the EU institutions has grown, Brussels has become a magnet for lobbyists, with the latest estimates ranging between 15,000 and 30,000 professionals representing companies, industry sectors, farmers, civil society groups, unions and others, along with those representing big business. Some areas of industrial activity are very well represented, such as environmental protection, agriculture and forestry, the energy and automotive industries.

Key words: lobbying, the EU Transparency Register, forestry, wood processing, RES

1. INTRODUCTION

1.1. Industrial lobbying in Brussels

Why lobbying? International trade is more and more important and new emerging-market nations take a significant position, including in the EU. Why do the main global firms expand across Europe and what is the current phase of globalization in the EU market[39]?

It is now commonplace for large numbers of firms, national associations, regions, and political, economic and legal consultants to have Brussels offices – and many more entities are frequent commuters to and from Brussels. European, national, and regional political processes are now closely intertwined. In response, interest groups and social movements have come to participate more or less regularly in EU the making and implementation of EU policy.

1.2. Lobbying: definition

Lobbying is influencing legislation, typically by reducing regulation and compliance costs in highly regulated sectors like finance, engineering or utilities, usually in return for payment. Corporate lobbying in Brussels has long passed the one billion euro mark in annual turnover, which makes the city the world's second biggest center of corporate lobbying power, after Washington DC, world lobbying center with 3.21 billion USD spent in 2013.

Lobbying is also the "strategic communication of specialized information" (M. Nilsson, L. Nilsson, Ericsson 2009: 4455). Several terms are used in the research literature to describe the activities of interest groups, like "lobbying" (e.g. Mazey and Richardson 1993; Coen 1998), "representation" (e.g. Greenwood 1997; Grant 2000) and "mobilization" (Marks 1992). However, both terms, "lobbying" and "mobilization", are very controversial and suggest too much. The word "lobbying"

[39] Growing demand in emerging markets makes them magnets for European business, but dynamic growth in these economies is creating important and significant local companies and big players with global aspiration. They usually want to export their own business and products in Europe.

has acquired negative connotations (Charrad 2011) and usually for the general public means some negative or problematic actions, related with corruption or dealing with public authorities. The terms “interest representation” is more sophisticated and has no problematic connotations.

1.3. The Importance of Industrial Associations

A professional association is usually a non-profit organization seeking to further a particular profession, the interests of the individuals engaged in that profession, and the public interest. It is a body that acts "to safeguard the public interest". An industrial or trade association, also known as an industry trade group, business association or sector association, is an organization founded and funded by the businesses that operate in a specific industry.

Associations may offer other services, such as producing conferences, networking or charitable events or offering classes or educational materials. Many associations are non-profit organizations governed by law and directed by officers, representatives of members.

One of the primary purposes of a trade group is to attempt to influence public policy in a direction favorable to the group's members. Industrial and trade associations represent the largest lobbying subcategory in Brussels, and they began registering much earlier than companies, which comprise the second largest lobbying group. “Interest representatives” in the EU Register are all parties except individual persons that are engaged to interest representation activities.

Empirical data confirm that today’s firms prefer direct political action where possible (Coen 1997). Generally speaking, it is possible to establish the relative importance of the Brussels institutions against the other national channels.

1.4 . Description / Lobbying History and Structure

Lobbying in Brussels was born in the late 1970s. The fragmented nature of the EU's institutional structure provides multiple channels through which organized interests may seek to influence policymaking. Lobbying takes place at the European level itself and within the existing national states. The most important institutional targets are the Commission, the Council and the European Parliament. The Commission has a monopoly on initiatives in Community decision-making. Since it has the power to draft initiatives, it makes it ideally suited as an arena for interest representation.

Many large companies, NGOs and trade associations, either have dedicated public affairs people, or outsource lobbying to consultancies active in Brussels and member states. After the 2004 accessions, the industry exploded as more businesses and their stakeholders came under the auspices of EU law, resulting in over 2600 special interest groups now active. Their distribution was roughly as follows: European trade and industry federations (32 per cent), consultants (20 per cent), companies (13 per cent), NGOs (11 per cent), national associations (10 per cent), regional representations (6 per cent), international organizations (5 per cent) and think tanks (1 per cent) (Lehmann, 2003).

The Brussels lobby scene is populated by a bewildering variety of different organizations and individuals engaged in lobbying. Most are “in-house” lobbyists, employed by corporations and industrial associations to represent their employers’ interests directly to policy and decision makers. Five hundred large corporations have their own lobbying offices in Brussels, including BASF, Siemens, BP, Vodafone, Rolls Royce, E.ON and many others, often in high profile locations. Almost every industry imaginable has its own trade lobby group in Brussels.

1.5. Problem Description / Lobbying Scandals

The public opinion in Belgium, and especially in Brussels, can be said to have a negative approach to lobbying due to the concentration of international pressure groups and as a result, there is a high level of awareness concerning this domain. In the last 10 years, politicians, academics, the business elite and the European public have become worried that lobbying in the European Union exacerbates issues of unequal access to the political institutions. Considering general theories of lobbying there are a number of reasons for concern.

In March 2011 came one of the biggest lobbying scandals in EU history, with three MEPs who had agreed to table amendments to change the EU law in return for promised payments being exposed. The scandal sent shockwaves through the European Parliament and started a debate about corruption and the Parliament's weak rules around financial interests and relations with lobbyists.

2. EU LOBBYING IN EXISTING LITERATURE AND ACADEMIC CONTEXTS

2.1. Overview And Types Of Available Literature

EU interest representation and lobbying have been studied extensively in recent years (Andersen and Eliassen 1993, 1995; Greenwood 1997; Greenwood and Aspinwall 1998; Mazey and Richardson 1993; Panebianco 2000; Pedler and Van Schendelen 1994). According to several researchers, there is now a greater variety of cleavages in EU policy-making and groups that mobilize opinion around ideas and norms have increased in importance.

Many authors also discuss the relation between lobbying and protest. The reason for the absence of environmental protest in Brussels might have to do with the possibility that lobbying EU institutions is by far more adequate and effective than the kind of unconventional protest action that is so common at national and subnational levels' (Rucht 2001).

EU institutions seek information, and interest groups seek influence. If they want to take influence, they have to provide information (Pappi and Henning 1999; Bouwen 2002; Michalowitz 2002). Some authors emphasize on other aspects of 'European route' like the complexity and informality of EU decision-making (Peterson 1995) and describe the activities of actors as a "hustle" (Warleigh 2000).

2.2. Academic Contexts

Critical political economy theories suggest that European integration promotes transnational neo-liberalism and spurs a new transnational dynamics of European capital. From a different perspective, centered on the EU decision-making processes, it is not clear who wields the influence: it is contested whether European integration enhances the influence on public policy of state institutions or that of interest organizations.

Sometimes the views of major European institutions in charge of European integration are opposed and incompatible. Until the early 2000s, the Commission was against the accreditation of pressure groups, as in their opinion, this would cause a problem for open access to EU policy-makers hampering their much needed information and expertise (McLaughlin and Greenwood, 1995).

Bender and Reulecke summarize the kinds of lobbying relating to policy process. They differentiate between 3 kinds of lobbying: "lobbying as prevention", "lobbying as reaction" and "lobbying as action" (Bender and Reulecke 2003). According to the authors, the most difficult one is preventive lobbying which aims to prevent or to postpone particular legislation before the call for legislative action exists. Lobbying as reaction means that the legislative proposal already exists and lobbying reacts to the legislative process.

3. EU LOBBYING - RESULT OF PERSONAL RESEARCH

3.1. Data Collection

In order to get into the subject and obtain relevant information about the situation in the lobbying sector, I had interviews with important people in the field of lobbying in Brussels. I selected in Brussels the following target interlocutors:

- two journalists from the field of energy and environmental protection
- one representative from the NGO sector, with the functions of advisor for the EU institutions
- one officer from DG Enterprise and Industry
- one member of the European parliament

Meetings were held during the special terms, which are set aside for interviews, or during some other public events that daily bring many officials and lobbyists together. On this occasion, I was engaged in writing notes, and my interlocutors often suggested to me some literature or media releases that helped me better understand the process of lobbying in Brussels.

Secondary data collection involved conducting an in-depth literature review in one of several specified areas of lobbying. Also used were all the available EU lobbying databases and statistical techniques for analyzing data and interpreting results and identifying the relevant conclusion.

3.2. Descriptions of Results

Results from interviews are very much as expected, because the selected professional five experts come from renewable energy sectors. Their answers confirm the intensive lobbying activity in the European energy area in last decade, and especially in RE. There is a strong lobby presence in Brussels called The Green 10, including among others, Greenpeace and Friends of Earth, large environmental groups with some inherent weaknesses due to their size.

NGO lobby can also be very influential, especially when it comes to open issues of disclosure of corruption or disclosure of some unfavorable details in the new legislation. If carbon emissions are limited below a certain percentage and before a certain year, catastrophic climatic changes will be averted. This topics means there is a very large audience for this lobbying group, because climatic changes area global political and socio-economical problem. A strong RE lobby should reframe the central carbon frame because presently it aligns too well with conventional energy systems. Analyzing different lobbying situations we can ask a simple question: do NGO lobbyists do enough or is their work sometimes insufficient to produce some common social benefit?

3.3. Main Industrial Lobbying Area

Industrial interests, especially connected with strong industrial players from the energy, chemical, IT or pharmaceutical sectors dominate throughout industrial lobby activity in the EU and this inhibits the development of a more progressive industrial policy. Capital investment in new technologies and innovation is a crucial EU orientation for future industrial development, in contrast with the high operating costs of conventional industries like the shipbuilding industry.

LOBBYING FOR RENEWABLE ENERGY

Energy is one of main economic tools for EU economy. At the same time, the environmental non-governmental (ENGO) RE lobby in the EU is very strong and visible. Conventional energy systems burn fossil fuels for energy (coal, oil, natural gas; and uranium), releasing green-house-gases (GHGs) into the atmosphere as a byproduct; other related problems are securing fossil and uranium energy and building massive infrastructure projects to support fossil fuel pipelines. There are environmental problems associated with conventional energy systems. The ENGO lobby disadvantages lobbying for RE because it remains entrenched in the carbon framework, its size limits its power, and its focus remains on the environmental frames.

LOBBYING IN THE INDUSTRY (AUTOMOTIVE, WOOD PROCESSING AND FORESTRY SECTOR)

Among the many sectors of corporate lobbying operating within the European Commission, the automotive industry is particularly emphasized. It is one of the most globalized sectors in the world. There are also other important industrial sectors; wood industry with following important professional organizations operating in the forest based sector:

- CEI BOIS (the European Confederation of Woodworking Industries) – It is the main body representing and defending the interests of the European woodworking and furniture industries towards the European Union.
- EOS (the European Organisation of the Sawmill Industry) – It is the main body representing and defending the interests of the European sawmill industry towards the European Union.
- EPF (the European Panel Federation) – It is the main body representing the particleboard, fibreboard and OSB industries with the supra-national authorities.
- EUSTFOR (the European State Forest Association) – Represents commercially oriented, state-owned forest companies, enterprises and agencies towards the European Union.
- CEPF (the Confederation of European Forest Owners) – It is the umbrella organisation of national forest owner organisations in the European Union. Their main goal is representation of the interests of forest owners in Europe.

3.4. Register of Interest Representatives

In order to bring some more transparency in the lobbying processes, the European Commission has set up a Register of interest representatives (Commission's policy paper of 21st March 2007). At the moment the Register is still voluntary but there are many initiatives to make it mandatory. This was the main opinion of the Secretary General of one influential Brussels NGO[40] in our interview. He recommended that the Commission staff use the Register as a reference point and encourage non-registered entities to register because this is considered an important contribution in raising the level of transparency in the lobbying processes.

As the European quarter is an area of high concentration of political power, it has attracted a thousand lobby consultancies, law firms and PR agencies and has become a heart of lobbycracy, making Brussels a corporate lobbying paradise. Lobbyists are employed by corporations and trade associations directly to represent their employer's interests to policy and decision makers. Two thirds of lobbyists work on behalf of business interests. Around one fifth of the lobbying in Brussels is done on behalf of states, regions and cities. It is estimated that five hundred large corporations have their own lobbying offices in Brussels. There are more than 1,500 industry lobby groups and several hundred 'public affairs' consultancies and law firms that advise and lobby for corporate clients.

The Brussels lobbyists' prime target is the EC – the source of almost all legislation and policy in the EU. But as the powers of the EP have grown, MEPs have also become an important target – with some 4,000 lobbyists registered to hold access badges for the Parliament.

[40] NGO operate in Green-Economy sector

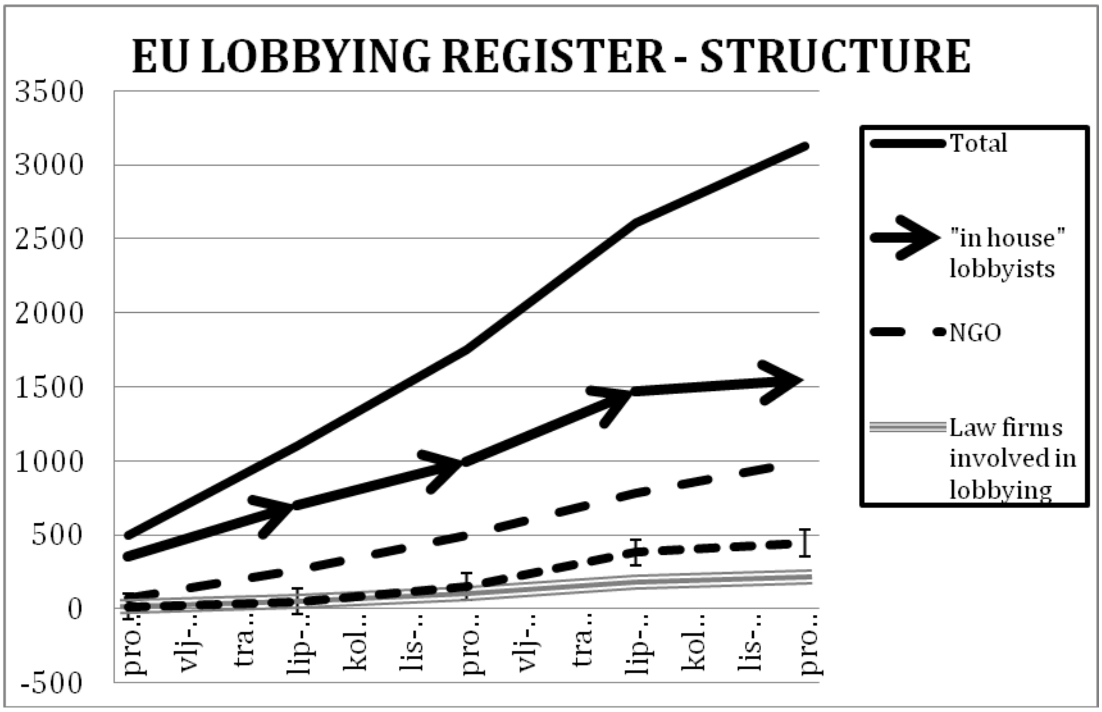

Figure 1. EU lobbying register - structure

3.5. Personal Lobbying Experience in European Parliament

During my professional work, I had the opportunity to participate in the activities of the EP. In the past few years I have been present at many meetings of the committees or inter groups in the EP and also in Commission. Based on my professional experience I was in January 2014 nominated as speaker in the debate about a new European forestry strategy, which the Commission proposed in 2013.

It was a rewarding experience through which I gained an insight into the important work of lobbying power, and I profited through a series of contacts that I made during the said meeting. A large number of different people, with very influential positions showed interest in meeting and holding additional discussions with me. Everyone wanted to get more information about the situation in the SEE countries and the development of Balkan countries' economies, especially regarding the use of wood biomass and renewable energy.

Small countries, or their professional associations are unable to pay the cost of a permanent presence in Brussels, and for this reason, various interest groups have shown interest in more information about the field of investment or strategic partnership.

My presentation in EP was for me a great professional achievement, as well as a tremendous experience that was useful, for my research work on the topic of European industry lobbying. After processing the collected data, I think it is necessary to clarify the main mechanisms and tools of lobbying process, with some recommendations which are also derived from the viewpoints expressed by the people I interviewed.

4. CONCLUSIONS

4.1. Work Summaries

Existing processes of lobbying has the support of most stakeholders. Of course, the non-governmental sector is not satisfied with the results, so it is trying a lot to improve the situation. The decision making process seeks the cooperation of all parties, including lobbyists and political decision-makers. Policymakers need specialized information and lobbyists supply this in the exchange for political influence. One way that lobbyists can articulate this information is through framing policy language. In terms of lobbying, framing refers to the specific language employed to gain the desired policy results.

There is no doubt that by lobbying some good things can be achieved. Lobbying efforts and constant lobbying by various industrial associations and NGOs in Brussels have helped the EU to become the world leader in the economy, human rights, foreign aid and climate change. The Commission registry listed more than 3.900 groups with approximately 80 per cent stemming from business and 20 per cent representing diffuse or public interests.

4.2. Recommendation for Future Research

Lobbying is without any doubt a very important challenge for the EU future, especially in the policy making and legislative area. In same time, corruption is still a big problem. Lobbying is often mixed up with corruption and so people tend to forget that the lobbying processes serve also, for example, for the protection of the interests of minorities and for representing the range of the different positions of all stakeholders that are relevant in the process of European policy-making. So where is then the limit between corruption and lobbying and how could the system be improved? This is one possible challenge and topic for a future researcher.

4.3. Final Conclusions

Over time, the predominant lobbying organizational formats also changed. Initially, EU interest organizations were mainly sectorial or cross-sectorial peak associations of national interest groups. Today many are mixed membership groups that include combinations of national associations, multinational corporations, other interest organizations as well as cities and regions.

During my recent formal and informal education, especially during my last master education on Oxford University (Diploma in Global Business - Said Business School), I discussed with different EU officials and with representatives of Brussels' most powerful NGOs. Many of them also supported more transparency in lobbying activity and showed an interest in raising the level of rules, which would include some other stronger issues. The EU lobbying register should become mandatory as soon as possible, said my chosen interlocutors.

Today, interest groups are an important and highly institutionalized aspect of the EU decision-making process. Generally speaking, the lobbying process in EU is relatively fair, impartial and, most importantly, transparent.

As far as the forest based industry lobbying, it stands out, compared to other lobbying industries, with a strong and unified voice of its interest groups, which operate in a distinctive way by pooling together when it comes to representing and defending the interests of forest based industry, as well as its members, towards the European Union.

In the end, if we take into consideration all the research results, I can see some positive development in the lobbying process. The EU Lobbying Register is an important tool for democratic development in Europe and for future legislative processes. Industrial associations still play a crucial role in the European Quarter, but some NGOs have also became big lobbying players in Brussels, especially in the environment, industry and energy sector. This is also good challenge for future researcher.

REFERENCES

1. Bender, G. and Reulecke, L. (2003). "HANDBUCH DES DEUTSCHEN LOBBYISTEN.", F.A.Z Institut. Frankfurt am Main
2. Bouwen, P. (2002). "CORPORATE LOBBYING IN THE EUROPEAN UNION: THE LOGIC OF ACCESS", Journal of European Public Policy, vol. 9, no. 3
3. Charrad, K. (2005). "LOBBYING THE EUROPEAN UNION." University of Munster
4. Coen, D. (1998). "THE EUROPEAN BUSINESS INTEREST AND THE NATION STATE: LARGE FIRM LOBBYING IN THE EUROPEAN UNION AND MEMBER STATES." Journal of Public Policy
5. Grant, W. (2000). "PRESSURE GROUPS AND BRITISH POLITICS." Basingstoke. Macmillan London
6. Greenwood, J. (1997). "REPRESENTING INTERESTS IN THE EUROPEAN UNION." Macmillan London
7. Greenwood, J. (1998). "EUROPEAN CASEBOOK ON BUSINESS ALLIANCES." London
8. Kavran, M. (2014). "THE IMPORTANCE OF INDUSTRIAL ASSOCIATION IN THE LOBBYING PROCESS IN BRUSSELS." Oxford University. Said Bussines School. Oxford
9. Marks, G. (1992). "STRUCTURAL POLICY IN THE EUROPEAN COMMUNITY." Brookings Institute. Washington
10. Mazey, S. and Richardson, J. (1993). "LOBBYING IN THE EUROPEAN COMMUNITY." Oxford University Press. Oxford
11. Nilsson, M. and Ericsson, K. (2009). "THE RISE AND FALL OF GO TRADING IN EUROPEAN RENEWABLE ENERGY POLICY: THE ROLE OF ADVOCACY AND POLICY FRAMING"
12. Michalowitz, I. (2002). "BEYOND CORPORATISM AND PLURALISM"
13. Panebianco S. (2000). "IL LOBBYING EUROPEO. " Milano
14. Pedler, R. and Van Schendelen, R. (1994). "LOBBYING THE EUROPEAN UNION: COMPANIES, TRADE ASSOCIATIONS AND ISSUE GROUPS." Dartmouth.
15. Peterson, J. (1995). "DECISION-MAKING IN THE EUROPEAN UNION"
16. Rucht, D. (2001). "LOBBYING OR PROTEST? STRATEGIES TO INFLUENCE EU ENVIRONMENTAL POLITICS"
17. Warleigh, A. (2000). "THE HUSTLE: CITIZENSHIP PRACTICE, NGOS AND POLICY COALITIONS IN THE EUROPEAN UNION." Journal of European Public Policy

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