INNOVATIONS IN FORESTRY, WOOD PROCESSING AND FURNITURE MANUFACTURING

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PIRC-BARČIĆ – MOTIK – VLOSKY – KÁNOVÁ – DRÁBEK – OLŠIAKOVÁ – LOUČANOVÁ – CHOBANOVA – GEORGIEVA – WANAT – MIKOŁAJCZAK – CHUDOBIECKI – KUSIAK – PAULIKOVÁ – NOVÁKOVÁ – ŠEFČÍKOVÁ – STASIAK-BETLEJEWSKA – ULEWICZ – KALAMÁROVÁ – PAROBEK – MOLIŃSKA-GLURA – MOLIŃSKI – BISZOF

INNOVATIONS IN FORESTRY, WOOD PROCESSING AND FURNITURE MANUFACTURING

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PREFACE

WoodEMA, i.a. is an international association for economics and management in wood processing and furniture manufacturing establihsed in the year 2007, with members from 14 countries on 2 continents at the moment. Since one of the main goals of the association is to promote science and results of scientific and professional work of its members, Association decided to start issuing scientific books each year. Each scientific book will be dedicated to a different topic and it will be related to a different field of expertize of the Association and its members.

This is the third issue of scientific books and we agreed that the topic for this issue should be dedicated to INNOVATIONS IN FORESTRY, WOOD PROCESSING AND FURNITURE MANUFACTURING. Some of our members, but some non-members as well, who have research activites in fields of expertize related to the main topic are involved in creating of this scientific book. In this issue we have 13 chapters with 23 authors from 4 Central-European countries and USA who presented their research results in the area of innovations related specifically to forestry, wood processing and furniture manufacturing.

Main goal of this scientific book is to stress the problems that forestry, wood processing and furniture manufacturing companies meet in their every day praxis, the way to solve those problems and to improve activities of that industrial branche using scientific methods and models.

This is the third scientific book issued by WoodEMA, i.a. to help collecting some knowledge and transfering that know-how further on. We hope to publish many other books this way providing scientific and professional help to our industrial branch in different menagerial areas of expertize.

Editor-in-chief
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1. INNOVATION IN WOOD INDUSTRY

Andreja Pirc Barčić, Darko Motik, Richard P. Vlosky

1.1 INTRODUCTION

In today's modern business world, the development of innovation and innovation activities is considered to be the key driver of the business success of a particular business unit, whether it is a single business entity of an industry, the industry as a whole or the overall economy of a particular country. The effects of innovation activities and the development of innovation as their results depend on the numerous internal characteristics of a business entity and the external conditions in which it is located. Innovation can occur in three broad domains: products, production processes and business ... innovation is an idea, product or process, system or entity that is perceived as a new to individual, to a group of people or companies, to an industrial branch or to a society or economy as a whole.

Furthermore, in order that innovations would have a value for a business sucess of individual companies, they must meet certain internal and external criteria. For example, if innovation is part of a visible product that a business entity offers on the market then it must be directed towards the customer/consumer. The ideas that do not meet this criterion cannot be defined by innovation. Innovation is not something that can be or should be included and/or turned off in some process when is needed. In order to make innovation fundamental for each business organization, innovations and skills related to innovation should be practiced continuously. In this way, an economic entity will be able to provide a return to the benefit of creating trust, the latest skills and information in the fields of technology and business, which will make the enterprise more innovative and thus more successful in developing new or improving existing products, processes and / or business. Although innovation is immensely needed to create competitive advantage and survival of a business entity, it is an extremely risky activity.

Since the goal of any innovation is to improve business, to increase its competitive position in the rough and merciless market, it is extremely important to investigate which of companies internal characteristics and external opportunities can affect the achievement of innovativeness and the development of a business entity's innovation as a result of innovative activity. In many traditional industries, as well as in the wood industry, domination on the low- technology complexity is present. In the increasingly globalized market, this characteristics makes the wood industry extremely vulnerable. For this reason, in order to maintain its

position on the market, domestic and international, economic entities within the wood industry sectors are increasingly relying on innovative activities that could lead them to improvements in existing and/or new product development, processes and / or business - innovation.

The nature of innovative activities is that they are often very risky; having many uncertain costs in the process of realizing ideas into innovative product, process and/ or business (Christensen, 1997). Economic entities that are close and well-connected with customers, suppliers, research institutions and develop 'healthy' competitive relationships with their competitors are more likely to develop innovation.

It is obvious that tomorrow we'll not do our business, if we do it today as we did yesterday … in that context innovation, although it is not the only way to create new values for consumers and businesses, certainly is one of the best ways to survive on the market!

1.2 INNOVATION

Innovation has become the industry's 'religion,' beginning in the late 20th century. The rapid development of technology and flow of information have prompted many organizations to create innovation, i.e., actively seeking new methods, ideas, and creative solutions to improve and/or develop new products, production processes, and business activities (Tan and Nasurdin 2011). There is a common misconception that the development of innovation is only possible in high-technology industries. However, innovations in low and/or moderately-low technology industries, which include the wood product sector industries, have been developed (Maskell 1996; Mendonca 2009). According to Kirner *et al.* (2009), companies belonging to low-technology industries are able to develop and realize innovation at an equal level as companies belonging to industries with moderate or highly developed technologies. Historically, research on innovation and innovative activities specific to the wood products industry has not been well reported in the literature (Stendahl and Roos 2008). In recent years, work has been focused on both the wood and forestry sectors (Nybbak *et al.* 2009; Pirc *et al.* 2011; Pirc Barčić *et al.* 2016). For example, exploring corporate growth of companies in the European and North American wood industry, Korhonen (2006) divides innovative features of the company into two types: (i) the use or creation of incremental innovation, and (ii) research and the creation of radical innovations. These types complement each other, and it is important to emphasize that medium- to low-technology industries represent an extremely important and large part of the manufacturing sector of member countries of the Organization for Economic Cooperation and

Development (OECD) (Hansen and Serin 1997; Kaloudis *et al.* 2005). These industries show excellent stability and employ a high proportion of the population (Kaloudis *et al.* 2005). Bullard (2002) observed that most important source of change in furniture and many other industries today is ability for suppliers, producers, distributors and consumers to send and receive 'rich' information which includes new information's and communication technologies. The words innovative and innovation are used to describe the flexibility of firms in meeting changes in the business environment (Tyson, 1997).

Innovation has a broad array of definitions (Cao and Hansen, 2006) and Schumpeter in 1911, cited by Cao and Hansen (2006), defined innovation as the motor of economic development. According to Dewar and Dutton (1986) innovation is an idea, practice, or object that is perceived as new to an individual or another unit of adoption. Adapting to changes in competitive markets, innovation is necessary for firms to survive (Bullard and West, 2002). Changes can be made in manufacturing technology, production processes, labor, capital, infrastructure and overall market knowledge. Porter (1998) cited noted that innovation is an important source of competitiveness, by which companies gain advantages through organizing and conducing value-adding activities in a new way.

1.3 WHY IS INNOVATION IMPORTANT?!

To be successful, a paramount task of a firm is to determine the perceptions, needs and wants of the market in order to create products with superior value (Lievens and Moenaert, 2000). Firms should constantly scan the horizon for new opportunities to satisfy their customers, and be capable of innovating to provide solutions to changing market needs (Weerawardena, 2003). The first important source for modern innovation theory is Josef Schumpeter (1934) where he defines innovation broadly, as a discontinuously occurring implementation of new combinations of means of production (Kubeczko and Rametsteiner, 2002). In its various forms, innovation has long been recognized as critical to a firm's competitive advantage (Brown and Eisenhardt 1995; Stock *et al.,* 1996; Motwani *et al.* 1999; Cooper 1996; Damanpour and Gopalakrishnan 2001; Scarborough and Zimmerer 2002).

A range of activities can be describe as innovation, such as new product development, product line improvements and extensions, improvements in production processes, and innovative marketing and management practices (Wagner and Hansen 2005). Innovation come in a variety of forms with the most recognize being new or improved products or manufacturing systems but innovation can also take place

in such areas as business management processes (Nybakk *et al.* 2009). According to Nybakk *et al.* (2009) truly new innovations are often referred to as *'new-to-the world innovations*' or **radical innovations** while improvements in existing products, services or management practices are referred as **incremental innovations** .

An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method inbusiness practices, workplace organisation or external relations (OECD 2005). However, according to OECD and Eurostat (2005) the minimum requirement for an innovation is that the product, process, marketing method or organizational method must be new (or significantly improved) to the firm. This includes products, processes and methods that firms are the first to develop and those that have been adopted from other firms or organizations.

Innovation is complex concept (European Commission, 2006) which can be classified into different categories:

Process Innovation - A process innovation is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software. Process innovations can be intended to decrease unit costs of production or delivery, to increase quality, or to produce or deliver new or significantly improved products. Production methods involve the techniques, equipment and software used to produce goods or services. Examples of new production methods are the implementation of new automation equipment on a production line or the implementation of computer-assisted design for product development. Delivery methods concern the logistics of the firm and encompass equipment, software and techniques to source inputs, allocate supplies within the firm, or deliver final products.

Product Innovation - is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics. Product innovations can utilise new knowledge or technologies, or can be based on new uses or combinations of existing knowledge or technologies. The term "product" is used to cover both goods and services. Product innovations include both the introduction of new goods and services and significant improvements in the functional or user characteristics of existing goods and services. New products are goods and services that differ significantly in their characteristics or intended uses from products previously produced by the firm.

Business Innovation (Marketing Innovation and Organizational Innovation) – *A marketing innovation* is the implementation of a new marketing method involving significant changes in product design or

packaging, product placement, product promotion or pricing. Marketing innovations are aimed at better addressing customer needs, opening up new markets, or newly positioning a firm's product on the market, with the objective of increasing the firm's sales. The distinguishing feature of a marketing innovation compared to other changes in a firm's marketing instruments is the implementation of a marketing method not previously used by the firm. It must be part of a new marketing concept or strategy that represents a significant departure from the firm's existing marketing methods. The new marketing method can either be developed by the innovating firm or adopted from other firms or organisations. New marketing methods can be implemented for both new and existing products. Marketing innovations include significant changes in product design that are part of a new marketing concept. *An organisational innovation* is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations. Organisational innovations can be intended to increase a firm's performance by reducing administrative costs or transaction costs, improving workplace satisfaction (and thus labour productivity), gaining access to nontradable assets (such as non-codified external knowledge) or reducing costs of supplies. The distinguishing features of an organisational innovation compared to other organisational changes in a firm is the implementation of an organisational method (in business practices, workplace organisation or external relations) that has not been used before in the firm and is the result of strategic decisions taken by management. Organisational innovations in business practices involve the implementation of new methods for organising routines and procedures for the conduct of work. These include, for example, the implementation of new practices to improve learning and knowledge sharing within the firm.However, according to OECD and Eurostat (2005) the minimum requirement for an innovation is that the product, process, marketing method or organizational method must be new (or significantly improved) to the firm. This includes products, processes and methods that firms are the first to develop and those that have been adopted from other firms or organizations. A common feature of an innovation is that it must have been implemented. A new or improved product is implemented when it is introduced on the market. New processes, marketing methods or organizational methods are implemented when they are brought into actual use in the firm's operations. Innovation activities vary greatly in their nature from firm to firm. Some firms engage in well-defined innovation projects, such as the development and introduction of a new product, whereas others primarily make continuous improvements to their products, processes and operations. Both types of firms can be innovative: an innovation can consist of the implementation of a single significant change, or of a series of smaller incremental changes that together constitute a

significant change. An innovative firm is one that has implemented an innovation during the period under review. Innovation provides products and service of ever-increasing consumer value, as well as ways of producing products more efficiently, both of which contribute directly to enhancing productivity, there by making broader innovation driven by competition (Porter 2002.) Crespel *et al.* (2006) also noted that innovation is an important for maintaining firm competitiveness and is an important driver of firm growth and being innovative through development of new or improved products, processes or business systems that can help a company better identify and satisfy customer needs, stay ahead of the competition and explore new markets. According to Neira *et al.* (2009) innovation performance heterogeneity is related to factors of the business environment in which companies operate and actions such as planning for the future considering new potential markets, investing in new products, improvement of internal operations and capacities to be competitive in chosen markets are involved in innovative strategies.Innovation can also be seen as the result of carrying out ideas while innovativeness is a characteristic of an organization or a person that carries out ideas (Nybakk *et al.* 2009). Innovativeness is enhanced by market orientation, firms benefit from examining the competition, and listening to customers, sales force members, vendors and employees (Crespell *et al.* 2006). Constant innovation allows a company to better meet consumer needs (Cooper, 1996), stay ahead of the competition, capitalize on strategic market opportunities, and align organizational strengths with market opportunities (Thomas, 1995).

1.4 SOURCES OF INNOVATION

1.4.1 Market orientation, customers, suppliers and innovation

It is almost impossible to find an industry that is not engaged in continues or periodic innovation and reorientation due to the dynamic nature of most markets (Hurley and Hult, 1998). Researchers Kohli and Jaworski (1990) suggested that market orientation is a set of specific behaviors and activities. According to Bennett and Cooper (1981) market orientation has a negative consequence for product innovation and organizational performance because it leads to the development of uncompetitive ‘mee-too’ products rather than real innovations. On the contrary Deshpandé *et al*. (1994) suggest that market orientation leads to successful innovation and higher organizational performance. According to Webster and Deshpande cited by Gima (1996) the marketing concept defines distinct organizational structure, a fundamental set of shared beliefs and values that puts customer in the

center of firm's thinking. Market orientation affects the firm's innovation and Laforet and Tann (2006) show that customer focus in one of the drivers of manufacturing in firm's innovativeness. Hartman et al. (1994) reported that customers are very important as sources of information. According to Gima (1996) benefits, that customers get from the commercial entity is the outcome of the innovation process. Gima (1996) also defined that market orientation helps to reduce the chances of the firm producing innovation and the firm's degree of market orientation is significantly and positively associated with innovation-marketing fit, product advantage and interfunctional teamwork.

Suppliers are an important source of innovation and improvement and competitiveness of the company depends on them as much as on the company itself (Helmsing, 1999). Suppliers innovation could be classified into three groups – the first group focuses on innovation in the context of manufacture-supplier strategic alliances; a second group focuses on innovation in the context of joint manufacturer-supplier new product development; while a third is focused on sourcing strategy of outsourcing of innovation (Azadegan et al., 2008). Today, in the process of innovation, a professionalization of the supplier's selection becomes a necessary and supplier innovativeness can enhance manufacturer capabilities (Schiele, 2006). In other words, incremental improvement of the supplier is a possible indicator for innovation (Goffre *et al.* 2005).

1.4.2 Market share, exports and innovation

A number of empirical studies (Becker and Dietz, 2004; Kamien and Schwartz, 1975; Horowitz,1962 cyted by Zemplinerova, 2009) have found out that dominate firms tend to have higher rates of research and development (R&D) and innovative more. According to Blundell et al. (1999), high market share and innovation are in correlation - firms who innovative will grow and therefore have higher marker shares. A relatively high proportion of engineers, scientists and skilled employees in the labor force characterize the industries, which increase their export at high rates (Hirsch and Bijaoui, 1985). Export has long been considered as the cornerstone of economic growth and compared to non-exporters exporters appear to be more productive (Lee, 2006). Lee again defined that, exporting characteristics may influence the decision to undertake R&D and innovating firms will tend to export a higher proportion of their output in comparison to conservative firms. Hirsch and Bijoui (1985) also defined that innovative firms, especially located in small countries tend to export a higher share of their output than innovative firms located in larger countries. Firms, which are more involved to R&D, tend to be higher in export than that of the entire branch to which they belong, concluded also by Hirsch and Bijoui (1985). Non-

exporters and heavy exporters tend to be less innovative than moderate exporters (Cao and Hansen, 2006) and exporting has a strong link to investment in innovation and firms that export some of their output are more likely to expand the range of products and improve the production process (Alvarez and Robertson, 2004). Alvarez and Robertson (2004) also find out that export destination matters. In other worlds, if firms export to developing countries thy will invest more in product design (quality) and upgrade process technologies.

1.4.3 Employees and innovation

As individuals, employees have similar potential for being innovative, but have different approaches to the process of innovation. By recognizing individual's potential, developing his ability and combining it with adequate motivation or support to reinforce the innovation attitudes, the individual to bring the best innovativeness to the organization can be expected (Tan and Kaufmann, 2008).

Innovation is difficult to achieve in organizations that do not tolerate risk-taking or failure or mistakes and some organizations assume that motivating for innovation is as simple as offering a reward for every idea submitted (Tan and Kaufmann, 2008).

A creative climate characterized by high levels of supervisor encouragement, team cohesion, autonomy and openness to innovation and the degree of innovativeness shown by a company is related to the dominant climate in the workplace (Crespell *et al.* 2006). Each of us has the potential to be innovative but has a different innovation style and leaders play a vital role in providing adequate innovation climate such as, to encourage individuals to bring the best innovativeness to the organizations (Tan and Kaufmann, 2008). According to Verworn and Hipp (2009), companies need creative and skilled human resources to advance innovativeness, a high share of highly skilled employees had a positive effect on innovation input and output, and companies that experienced skills shortages were more likely to invest in future training. Verworn and Hipp (2009) did not find support for a negative effect of a high share of older employees in a company on innovation output. However, they found out that companies with high share of older employees tend to invest less in further training - considered as innovation input. The ability of organization to use its knowledge depends on many aspects and the way of organization uses, it predetermines success or failure of its activities. Knowledge is a changing system with interactions among experience, skills, facts, relations, values, thinking processes and meaning (Mládková, 2008). Hartman et al. (1994) indicated that employees in an organization can be categorized into three broad categories, which are the top (or

strategic) management level, the middle (or administrative) management level and the lower (or operational) management level. According to Burgelman and Sayles (1986) an organizational characteristics influence an individual's innovativeness, so any organization that aims to be successful should involve every individual in the organization's innovation process A number of authors (Kanter 1983; Lovelence 1986; and Sebora *et al.* 1994) cited by Ong et al. (2003) revealed that innovation decreases among employees as one moves down the hierarchy and successful innovation activities in an organization require employee participation at all levels. Top managers usually take a higher degree of responsibility for innovation activities in their organizations (Sebora et al. 1994). Ong et al. (2003) noticed that employees in the middle management level are more involved with the coordination of innovative ideas within the organization among employees from different levels. At the end, lower (or operational) level individuals play an important role in the generation and implementation of innovation in an organization, as noted by Dumaine (1990). Quality of relationship between supervisor and subordinates is also found to be related to individual innovativeness (Scott and Bruce, 1997) and giving employees a certain degree of autonomy and decision making power can effectively influence an individual's innovativeness (Cotgrove and Box 1970).

1.4.4 Company Size, Location and Innovation

Sometimes large companies are better equipped to accomplish because of their ability to allocate fixed costs over larger outputs (Acs and Audretsch 1987). Following the same argument from Schumpeter, larger firms may also be better placed to innovative with respect to products and business systems (Crespell *et al.* 2006). New small firms are continually entering the market with new ideas, products and processes (Jong and Marsili 2006.) and factors such as closeness to customers and flexibility are advantages of Small Medium (SME) companies (Salavou *et al.* 2004). Innovation is fundamental to those companies in order to survive and maintain their competitiveness in the marketplace (Laforet and Tann 2006.) According to Schumpeter citied by Laforet (2008) large firms have an advantage over small companies as their financial capabilities might allow them to be the most capable inventors. A Gelleman Research Associates study in 1982 citied by Ettlie and Rubenstein (1987) found out that small firms produce 2.5 times as many innovations as large firms, relative to the number of people employed and according to Jelačić *et al.* (2008) small firms attach greater attention to innovation. Jong and Marsili (2006) defined that small firms are more sensitive in their fast changingenvironment and

that their successful adoption of innovative technologies will depend on their capacity to plan ahead, to have a clear strategy and to manage strategically.

Location and geographic space have become key factor in explaining the determinants of innovation and technological change (Audretsch and Feldman, 2003). According to Audretsch and Fritsch (1999) geographic factors that influence firm location are human capital, labor skills, unemployment rate, population density, low manufacturing wage and local taxes. This observation is supported by Glaser et al. (1992) as cited by Audretsch and Feldman (2003) that geographic proximity matters in transmitting knowledge and 'intellectual breakthroughs must cross hallways and streets more easily than oceans and continents'. Feldman (1994) developed a theory that location mitigates the inherent uncertainty of innovative activity – proximity enhances the ability of firms to exchange ideas and be cognizant of important incipient knowledge, hence reducing uncertainty for firms that work in new fields. Audretsch and Feldman (2003) defined that the location of production is geographically concentrated in the relative importance of new economic knowledge in the industry but according to Krugman (1991) production is concentrated where demand for its products is higher. Devereux and Griffith (1998)) defined that firms will make the same location decision as previous firms with similar attributes which is also supported by Brülhart (1998) statement that firms settle in locations with a matching competitive advantage. Locations in importance of globalization allows companies to source capital, good and technology and locate operations wherever it is most cost effective (Clark *et al.* 2000).

1.4.5 Research and development (R&D) activities

The term 'research' is conventionally associated with the creation of new knowledge, while 'development' is achieved through applying knowledge; these two elements of research and development (R&D) use usually intended to lead to the improvement of existing or the development of new products and/or process (Bečić and Dabić 2008). Chesbrough (2003) suggests that many companies desire innovation but invest very little in internal research and development. Cohen and Levinthal (1990) reported that companies often focus on external sources for R&D, hoping that such a focus will lead to internal innovation. According to Bečić and Dabić (2008), industries with minimal technology often have lower levels of investment in R&D, and development is often based on the application of internal imbedded knowledge. Regardless of the level of R&D investment, it is important to maintain these investments over time in order to have a better chance

of leading to innovation (Mansfield 1984; Berginc *et al.* 2011). Parisi *et al.* (2006) found that companies that developed product innovation, invested more in R&D than companies that directed their activities towards the development of process innovation.

1.4.6 Company Flexibility and Innovation

Flexibility can be defined as the ability to change or adapt to a changing environment (Georgsdottir and Getz 2004). Flexibility is an important and necessary precursor for innovation to occur (Bolwijn and Kumpe 1990; Jaušovec 1994; Chi 1997; Thurston and Runco 1999). Oke (2005, 2013) discusses a mix of company areas where flexibility can have a positive influence on innovation in manufacturing companies, which include product modularity, labour skills, process technology, supply chains, information technology, and labour flexibility. Georgsdottir and Getz (2004) noted that flexibility is an important dimension for organizations because it allows a higher level of innovation, thus reducing vulnerability and increasing opportunities for growth. Georgsdottir and Getz (2004) noted that when company managers favour conservative thinking, regarding flexibility issues within the organization, they stifle creative thinking and restrict idea generation. A positive effect of creative thinking leads to more flexible activities, enhancing innovation (Isen 2002). Malhotra et al. (1996) and Tatikonda and Rosenthal (2000) also support the notion that company flexibility can positively influence innovative processes.

1.4.7. Internet Usage and Innovation

A significant number of processes and product innovations have been developed by the practical application of information and communication technologies (Bassellier and Benbasat 2004). The role of the Internet in the development of innovation, particularly in the development of product innovation, is manifold. For example, Internet applications can provide powerful tools to conduct market research, better understand competitor positioning (Teo and Choo 2001), aid in the design and manufacturing process of products (Waurzyniak 2001), and raise awareness among potential customers about a new product (Bickart and Schindler 2001). Sawhney et al. (2005) led a debate about the role of the Internet in the development of innovation, stating that within individual businesses, the systematic use of the Internet and its possibilities is a basis for cooperation, interaction, and communication with customers, which can ultimately result in an improvement of the existing and/or the development of new company products. Ozer (2004)

believes that the role of the Internet is positive in relation to successful product innovation.

1.5 INNOVATION AND COMPETITIVENESS

The intensity of competition in an industry, neither is a matter of coincidence nor bad luck – competition in an industry is rooted in its underlying economic structure and goes well beyond the behavior of current competitions (Porter 1998). Competitive position is predicated on proprietary product and/or market knowledge, which can be translated into market power (Hirsch and Bijaoui 1985). The power of customers and the intensity of rivalry among existing competitors had significant impacts on firm performance and its competitiveness (Wan and Bullard 2009). According to Özcelik and Taymaz (2002), Sumpeter may be regarded as a case connecting competitiveness and innovation. Competitor activities influence of innovations and many firms seek new ways of conducing their business through some kind of innovation to make a profit and stay ahead of the competition (Laforet 2008). A links between firm's innovative performance and their competitiveness are extremely complex because the intensity of innovation performance strongly depends on factors such as, involvement in exporting activity, the level of management training and skills, networking by firms, level of R&D capability, firm size, *etc.* (Dobrinsky 2008). An organizations competitiveness and ultimate survival depends on its ability to develop and bring out new or innovative product and service (Drew, 1997). According to Freeman and Soete (1997) technological innovation in manufacturing companies is one of the main engines for industrial competitiveness. In many business sectors today, innovation has become very important tool for firm competitiveness and long-term firm success will depend on firms' abilities to be innovative (Leavengood 2009).

1.6 SUMMARY

Innovation is not a new phenomenon! Arguably, it is old as mankind itself. Without it, the world in which we live would look very, very different … (Fagerberg *et al.* 2006).

Due to the very dynamic and changing nature of the market, it is almost impossible to find an industrial branch that does not include innovation or innovations (as a result of innovation) in its development, whether continuous or intermittent.

A trustworthy 'recipe' for business success does not exist and success and failure in business are relevant - it is possible to

dramatically improve your company's business and become unsuccessful, if the competition did a better job. On the other hand, it is possible to make a mistake in every business decision and remain successful because others have had a less luck ...

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2. INVESTMENT MANAGEMENT INNOVATIONS AND BUSINESS PERFORMANCE IN SLOVAK WOOD-PROCESSING

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2.1 INTRODUCTION

One of the main competitive advantages is the maximization of the business performance what leads the companies to increase their efficiency and overall effectiveness. Companies have to know their real as well as potential and planned performance and how to exploit effectively the business opportunities that the market environment creates. Investors prioritize innovative methodology which allows them to characterize the performance of the company, possible problems and opportunities. However, when they provide long-term capital, they must respect the time value of money and thus use appropriate indicators for valuating of investment. The research work presents the modern approach for the evaluation of business performance using selected traditional and non-traditional methods for measuring the performance in wood-processing company, demonstrates increasing value of the company through the Economic Value Added (EVA) indicator and planned investment with positive net present value. Innovative approach to investment management and measurement is a contribution to the growth of business performance and its competitiveness, and we present it in our work.

2.2 THEORETICAL BACKGROUND

2.2.1 Performance of wood-processing industry in Slovakia

Insufficient development focused on competitiveness of wood-processing production and efficiency increasing, no solutions of the availability of financial resources for implementing of innovative plans could cause decreasing of competitiveness and long-term recession. The main reason for the negative status of the Wood Processing Industry (WPI) is long-lasting unsolved problems.

Hajdúchová *et al.* (2016) suggest that wood-processing industry should strive to increase its competitiveness by implementing modern management methods, using new technologies, or concentrating production in a larger scale. There is also a need for optimal solutions that reflect the principles of sustainable development.

Sujová, Hlaváčková and Marcineková (2015) highlighted the fact that comparative advantage and competitive advantage based on lower prices the wood processing industry in Slovakia and Czech Republic over the past decade gradually loses. However, previous qualitative studies confirmed the competitive ability of the industry and potential to be successful on the international market, thus increase their performance and contribute to the sustainable growth.

Wood processing sector has comparative advantages, which make it possible to define potential effects of investments in analyzed industries. Performance improvement due to investment could be shown in a variety of benefits. Powerful company from a management perspective is considered if it has a stable market share, loyal customers, low cost, balanced cash flow and at a certain liquidity can achieves required profitability (Potkány et al., 2013). Thanks to competitive advantages the sectors of wood, furniture, pulp and paper could be interesting for foreign investors. Industrial distribution of FDI in 2014 (UNCTAD) presents the services sector accounted for almost two thirds of global FDI stock (64 %), followed by manufacturing (27 %) and the primary sector (7 %), with 2 % unspecified. At the global level in cross-border mergers and acquisitions, increases were particularly significant in pharmaceuticals, non-metallic mineral products, furniture and chemicals and chemical products. Differences exist between the developed and developing economies in manufacturing. Increase, driven by large acquisitions in a limited number of industries, such as furniture, food and beverages, and non-metallic mineral products, was in developing economies. Investment promotion agencies (IPAs) identified the most promising industries for attracting FDI to their country in 2016, for developing and transition regions, industries most commonly chosen are agriculture, food and beverages, and utilities. Developing-country multinational enterprises still lag farther behind in industries that are more traditional, mature or less internationalized – such as wood and wood products (WIR, 2016). FDI may become the basis for the modernization of production facilities, the transfer of new technologies, know-how, creating healthy competition and more efficient to integrate our economy into the international division of labour, decreasing unemployment, growth of GDP (Merková and Drábek, 2010).

2.2.2 Investment management and business performance

Innovations in investment measurement and management has been thoroughly edited by Girrord Fong (2008). Innovations belong to strategic and specific goals of enterprise such as enterprise position on the market, production program, production quality, growth of work

productivity, enterprise effectiveness, growth of own capital ratio, financial stability, organisation and management development, enterprise status in society (Drábek, Jelačić, Merková, 2014). For example, banks capture a larger share of underwritings with innovations than with imitative products. One interpretation of price and quantity evidence is that innovators become inframarginal rivals who enjoy lower costs of trading, underwriting, and marketing (Mullins and Mikesell, 2011).

At the time of economic globalisation it is possible to carry out different analyses which enable comparsions among enterprises from the geopolitical, economical and commercial point of view (Závadský, Hitka, Potkány, 2015). Long-lasting business success requires knowing the key factors which influence the enterprise's future development. Business performance indicators provide an overall picture of the enterprise's competitive position in the market, and of its opportunities for improvement and shortcomings to be eliminated. Looking at the past history, a fundamental shift can be observed in the approaches to measuring business performance away from the traditional ones, including the rate of profit or return. The focus of ***traditional business performance indicators*** is the past history and central to their assessment approach are mainly ***financial indicators.*** Though still used by many enterprises, traditional business performance indicators are considered to be insufficient and ineffective. The sustainability and advancement of enterprises necessitate the implementation of new, more modern methods. Systems are coming to the fore presently that are oriented on ***measuring the strategic performance of an enterprise*** and are not based on ***economic criteria*** alone but rely also on the consideration of the ***factors of quality and time associated with business risk***. Experience stemming from business practice reveals the necessity of looking at the economy of a business also through ***non-financial indicators***.

Many more or less successful attempts to adopt new managerial approaches have been made since the 1990s whose aim was clear: to make business operations more effective and improve business performance. Those most significant include quality management, continuous process improvement, lean organisation structures, reengineering, etc. However, the above methods often failed to meet the enterprise's expectations. The reason behind their failure was in that the objectives defined by enterprises were not sufficiently comprehensive. Objectives were vague, and failed to interlink the factors associated with the generation of business values, or align the values with the goal set by the company as the key, top one. The structure of indicators, or systems of indicators is based on simple mathematical expressions designed to indicate the enterprise's current situation. And this is the reason why it is not logical to uphold an opinion that a single top indicator

is able to determine the position of a large international corporation having operating companies in various parts of the world. Another problem was the explanatory power of the data possessed by an enterprise on which it based its evaluations and conclusions (*Marinič, 2008*).

Exact figures are back-looking, i.e. they convey facts that cannot be influenced as they are over. Systems using exact financial indicators thus automatically take over the properties, including drawbacks, of basic financial analysis indicators. They deteriorate the efforts towards constructing a set of **key performance factors** (Value Driver Tree) that would be obtained through decomposing the indicators into lower levels. Factor analysis can then help to define the effects of the factors on the value creation thus identify the key drivers of business performance. Indicators of this type feature a number of benefits, including fast processing and a low cost thanks to the availability of inputs (balance sheets, profit and loss statements, annual reports, etc.).

Economic indicators such as the rate of return are inevitable, but they are at the same time insufficient for securing a sustainable growth of the shareholder value. The prerequisite for real profitability is a complex cycle through which an enterprise is able to survive, adapt itself, innovate, or achieve an economic growth. Drawbacks arising from the implementation of financial indicators can be avoided by the application of non-financial indicators.

Non-financial indicators can be used to both define and measure non-financial targets. There is a variety of valuable information and data that cannot be measured by means of conventional financial instruments and without which the assessment of the enterprise's financial health would not be reliable. Some of the effects influencing the final financial performance cannot be expressed by means of financial indicators. Hence an ideal financial analysis must not only consider financial indicators but also involve the processing of non-financial indicators and their application in the overall evaluation. Non-financial indicators are not based on accounting statements. They are often more appropriate than financial indicators, particularly in defining a strategy or specifying tasks. Non-financial indicators, and sub-indicators derived from them, serve as prevention against the unilateral risk of financial indicators. Another advantage is the fact that the nature of non-financial indicators allows the use of higher analyses, which makes an enterprise able to extend the existing scope of the financial management’s control instruments. Two marginal tendencies exist in defining business targets and measuring performance in business practice. The two approaches differ in the application of financial and non-financial indicators. There is also a third, minor stream that combines the two approaches. The main benefits of non-financial indicators include (*Marinič, 2008*):

- The ability to express the share of intellectual property in the aggregate income
- The ability to express the contribution of intellectual property to the creation of value added
- Alignment with the long-term strategy and objectives
- The ability to predict the factors that influence the firm's overall success
- A more sensitive response to changes in the extraneous environment, etc.

Economists, banks analysts and investment firms note the necessary economic recovery few years after the crisis and they have to identify real possibilities and opportunities of increasing the present performance of businesses. This performance is certainly conditioned to their existing competitiveness particularly in EU markets. The competitiveness of enterprises should be considered as a general condition for business success. One of the main competitive advantages is the maximization of the business performance what leads the companies to increase their efficiency and overall effectiveness. It is necessary to know businesses actual and real performance and know how to exploit effectively the business opportunities that the market environment creates. Everyone, not just a successful enterprise entity often put a fundamental question: "How to achieve the higher efficiency and economic effectiveness of business?" For the qualified and correctly answer is the first necessary to determine what is the current and real business performance, and which appropriate and objective indicators use to measure this performance. The collected information - the values of the indicators are important factors for decision making about future

Between representatives of the theory, consulting firms and businesses conducts nowadays "a lively discussion on the relevance of the application of selected indicators for measuring the businesses performance". Different opinions and views are based on the two facts as follows:

- normal, ordinary so far used performance indicators are related to the past and is highly questionable whether they sufficiently reflect the company's future competitiveness,
- used indicators do not sufficiently reflect the quality of customer relationships.

It can be concluded that the economic experience quite often realizes the financial management based on the accounting profit and common indicators such as profitability or activity ratios. These indicators are presently considered as insufficient, which is also one of the reasons for the significantly poor competitiveness of enterprises. Traditional methods of measuring business performance (for example in Knápková and Pavelková, 2010 or Kislingerová, 1999) are based primarily to maximize profits (which is also in line with the objectives of

business activity). To measuring the performance are used absolute and relative indicators (Kislingerová, 1999). However, in recent years can be seen objections to the traditional performance measurement indicators such as profitability. According to experts the biggest concerns include the insensitivity of traditional indicators to risk for owners and investors, as well as the absence of the time value of money and the fact that the profit from an accounting perspective takes into account only the value of foreign financial resources (Jakubec et al., 2005). Successful economic development require besides the application of traditional methods also the application of new modern methods based on traditional systems of financial indicators and are completed by time and qualitative indicators (Sujová and Marcineková, 2015).

Theoretical fundamentals for investment effectiveness valuation are well described (Levy and Sarnat 1986, Ward et al. 1996, Renkema and Berghout 1997, Brealey and Myers 2003, Baum and Hartzell 2012 and others). While discounted cash flow valuation is only one of the three ways of approaching valuation of investment, it is the foundation on which all other valuation approaches are built (Damodaran 2012).

At the present time of ongoing modernisation, conventional business performance indicators such as profitability, activity and liquidity have become insufficient. Their insufficiency is due primarily to the retrospective nature of the examination and the absence of some important factors. Therefore, new indicators have been developed that are more relevant to investors and have been widely applied today, in investment decision-making in particular. The indicators are applied and accepted in businesses' annual reports as well as in banks' analyses. The new, advanced indicators have been adopted in the enterprises' current system of business performance indicators. They include in particular the following:

a) Economic Value Added (EVA)
b) Market Value Added (MVA)
c) Balanced Scorecard (BSC)
d) Discounted Cash Flow (DCF)
e) Cash Flow Return on Investment (CFROI)
f) Return on Invested Capital (ROIC)
g) Future Growth Value (FGV)
h) Cash Flow Economic Value Added (CEVA)

At the end of the 20th century was at the first time used the difference between operating profit and cost of invested capital by the company Stern Stewart & Co. The estimated actual value the company called **Economic Value Added - EVA** and registered it as trademark (Žilka, 2004). EVA has been acclaimed to be the most recent and exciting innovation in company performance measures. However, according Chen and Dodd (1997), EVA is more powerful than traditional

measures of accounting profit in explaining stock return, but accounting earnings are still of significant incremental information value in addition to EVA.

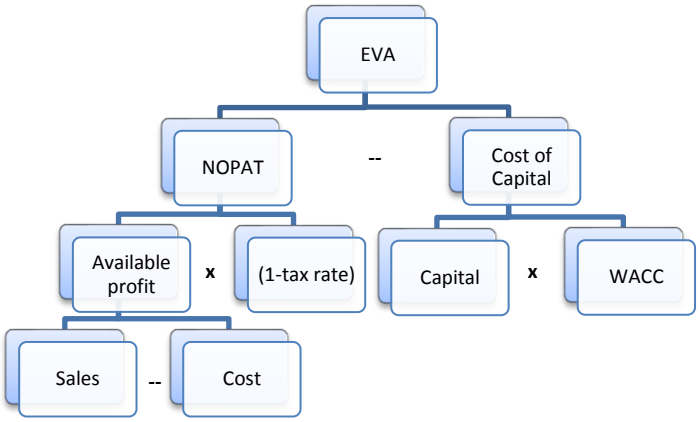

Figure 1. Structure of the EVA indicator.
Source: authors, based on Kislingerová, 1999.

The modern measuring method of the business performance EVA is the result of the efforts of investors who try to prefer those companies that would guarantee that their investment will have also required evaluation in future. The method is based on economic profit. Economic profit opposite the accounting profit accepts all the costs of capital employed, ie the cost of debt capital and also own capital (equity). **EVA indicator is based on:**

- Net operating profit minus interest
- Total invested capital
- Average cost of capital

Indicator EVA combines essentially the most important factors such as efficiency, amount of invested capital and its value.

EVA can be explained using the approach based the **INFA** model, as proposed by Neumaierová and Neumaier (*2007*). The model is based on a pyramidal decomposition of ratios. The decomposition is intended to provide a map of the firm's financial performance and create a performance indicator system. Such systems helps to maintain the performance oversight and its users are then able to monitor the effects of all decisions they make on the enterprise's performance. The main advantage of this method is its simple formulation with which it is not necessary to individually determine the significance of each group of ratios and the weight of each ratio (*Vochozka, 2011*).

Ways to increasing EVA can be defined as follows (*Fotr, 2011*):

- Generating a higher operating profit at constant costs and a constant amount of capital.
- Changing the enterprise's capital structure by employing debt capital that is cheaper than equity capital.
- Reducing the amount of invested capital.
- Implementing new projects to achieve a positive value of EVA.

If the calculated result of the EVA indicator in the company reaches a positive value - the company wealth is growing, respectively it means that the company appreciates the capital at a higher value than is capital cost. On the other hand, if the indicator EVA is negative, it means that the wealth of the company decreases, respectively capital costs are higher than real capital appreciation. Indicator EVA is therefore an absolute indicator and is consequently influenced by the size of the company. Methodological information about possibilities of performance measuring through indicator EVA describes the literature (Pavelková and Knápková, 2009 or Jakubec et al., 2005).

Market Value Added (MVA) is related to economic value added. MVA expresses the difference between the enterprise market value and the amount of invested capital. It determines how the market (until the moment when the firm is evaluated) changed the original shareholders' capital. The result is a wealth of business owners (Fotr, 1999). If the calculated values declare that the enterprise market value is greater than the capital invested into the business, it means the created shareholder value and the company's shares are traded with a premium. However, if the business profitability is lower than the cost of capital, it means the company "destroyed" the shareholder value and the shares are traded with a discount. MVA can be expressed as follows (Zalai, 2002):

$$MVA = \text{market value of the company} - \text{capital invested} \quad (1)$$

Assuming that the market and book value of debt are equal, then:

$$MVA = \text{market value of the equity} - \text{book value of the equity} \quad (2)$$

$$MVA = \text{present value of all future EVA} \quad (3)$$

Market value added can be calculated in certain circumstances as the market value of the entire company minus the capital contributed by investors. The enterprise's market value is thus the sum of equity capital and debts and priority stock. The market values of the items of the enterprise's assets can be derived from its accounting or from exchange records. MVA does not need to be calculated just annually; it can also be determined on a year-on-year basis if the enterprise's aim is to achieve a positive increase in MVA. Such positive increase in MVA means that the initial investment has been appreciated in the capital

market. The basic relations between the variables are shown in Figure 2.

An **increase in MVA** can be achieved through:

- A return on invested capital that exceeds the cost of capital;
- A decrease in the value of invested capital while the firm's market value is maintained;
- An increase in the firm's market value while the amount of invested capital is maintained.

If MVA is negative, it indicates that that the company's value has dropped. The value of its investment projects and operations in the capital market is lower than their book value. However, MVA does not include opportunity costs (*Vochozka, 2011*).

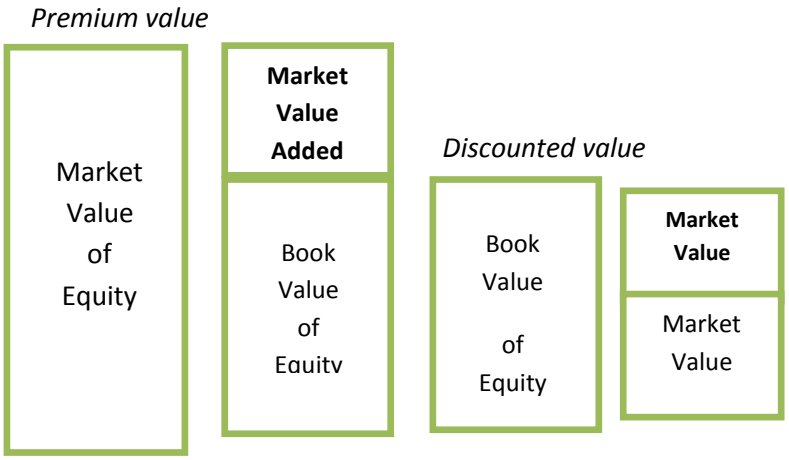

Figure 2. Relation between MVA and EVA

To evaluate business performance is also suitable by the principle of the time value of money and method **Net Present Value (NPV)**. Any acquisition of company assets should therefore considered with the rule of net present value. If this rule is respected, acquired asset should bring for the company in the future higher earnings than the cost associated with the investment. This rule is expressed with respect NPV> 0, where NPV = - Investment + PV (Present Value - the present value of future profits) (Kislingerová, 1999).

The cash flows result is an absolute value that, however, disregards the factor of the time when the cash flows were generated and the risk involved. Those drawbacks can be eliminated by discounting cash flows using the cost of capital. Discounted cash flow is a suitable method to measure the enterprise's business performance, and it is often used in appraising businesses or evaluating the advantageousness of an investment. When evaluating an investment, it is necessary to consider

its net present value. The net present value (NPV) is based on the investment's capital expenditure and discounted cash flow.

A positive value of DCF should ensure that if chosen, the investment will contribute to the growth of the enterprise's value (*Knápková, Pavelková, 2010*).

NPV method is used as an accurate and reliable in modern management, and also as a basic method of project evaluation. Calculation of NPV is based on estimation of future money income and expenses at the same period of time, which is usually the year of beginning of the project realization (Drábek, Polách, 2008). NPV is considered as the net contribution of the project to the wealth of the company. The greater value of NPV means more acceptable investment project in the company and creates the greater contribution to the market value of the enterprise.

Modern strategic system for measurement of business performance is the **Balanced Scorecard (BSC)**. The advantage of the BSC is ability to evaluate the reality comprehensively and also individually according to specific indicators. The BSC has to ensure the efficient use of financial resources aimed to long-term recovery of the shareholder´s equity. The BSC concept is interested in the key factors which have the impact into the creation of the final value, taking into account factors such as:

- Customer view
- Internal company processes, procedures and events
- Perspective of the growth
- Continuous creation of the financial value

The BSC should give particular emphasis to financial and non-financial indicators as a part of an information system that will be available to employees at all corporate levels. The BSC is used mainly by innovative companies **to the realization of critical management processes, namely**:

- To identify the business vision and strategy and to implement it into specific objectives
- The linking and communication of individual strategic business plans
- The planning, setting targets and harmonizing of strategic incentives
- To improve strategic feedback and learning processes (Kaplan, Norton, 2002).

Balanced Scorecard (BSC) as a business performance metric system is a managerial tool that interlinks the corporate strategy with the operating activities of the enterprise, with the emphasis being on the measurement of those activities. BSC came into existence as the result of an initiative towards creating a managerial tool incorporating non-financial indicators. Financial indicators are deemed to be not sufficient

as they do not fully cover the complex functionality of business processes, which gives rise to two drawbacks:

- Financial indicators are limited to observing the past history only and not always provide indications from which the present or future business performance could be deduced.
- The difference in value (surplus) between the firm's market value and the market value of its assets is treated as an intangible asset (goodwill), which is not quantifiable by means of conventional financial indicators.

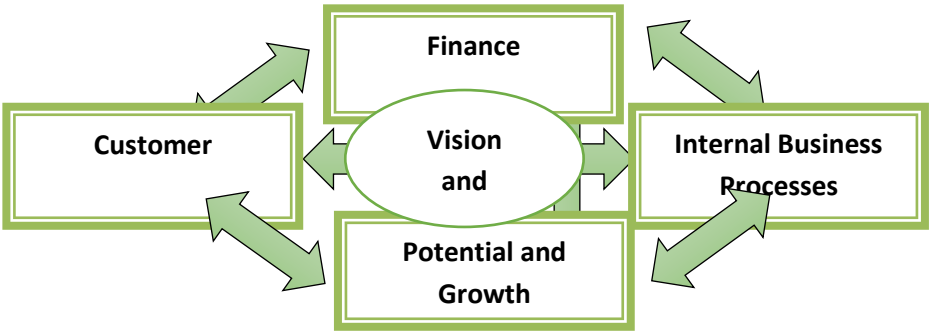

Figure 3. BSC concept

BSC as a methodological system provides a comprehensive view of the enterprise's strategic plan and eliminates the rigidity of viewing an enterprise solely through financial indicators. To that end, the BSC system looks at an enterprise from four perspectives. The enterprise's vision provides a basis for the definition of its strategic objectives. Those objectives are gradually particularised and shaped into a form that is suitable for implementation. The essence of the BSC methodology is in that it provides a detailed procedure to implement the system into the enterprise's organisation. BSC as a systematic tool to manage business performance is a system whose perspectives are mutually interlinked and integrated into a logical hierarchic model characterised by existing relations (*Fotr, 2012*).

- **The customer perspective**

The objective from the customer perspective is to ensure customer satisfaction. This perspective examines how the enterprise and its products must be perceived by customers in order for the enterprise to attain its vision. The customer's view is crucial for the enterprise. The receipt of negative signals from customers usually indicates that the enterprise's competitiveness is declining even if the other indicators do not show signs of decline. Appropriately defined customer satisfaction indicators are a key to dividing the customer portfolio and the customer

related processes into groups for which an optimum product mix can be defined.

- **The financial perspective**

The financial perspective of an enterprise is relevant to investors as well as to picturing the share appreciation dynamics. It examines what financial indicator values must be achieved in order to attain the required appreciation of shareholders' equity. One current problem in measuring business performance is the unbalanced viewing of the relevance of financial data as compared to non-financial indicators. With this in mind, it is advisable to include in the analytic system additional indicators that are linked to financial information such as risk assessment or cost-benefit analysis outcomes.

- **The perspective of internal processes**

The basis of the perspective of internal processes is the specification and identification of the business process which a firm must implement to become unique and hence gain a competitive advantage. By acquiring a competitive advantage the enterprise satisfies the most important stakeholders. The evaluation of the perspective of internal processes will help the enterprise to assess whether or not the functioning of processes is in line with customer needs. In addition to the main processes that are inevitably needed for the implementation of a strategy, it is also necessary to identify the processes aimed at the control and management of resources and the activities taking place within those processes, i.e. the management processes. It is also important to identify the processes which facilitate the running of routine activities, i.e. supporting processes that are characterised by repeatability.

- **The perspective of potential**

The perspective of potential examines how the enterprise needs to change and improve to be able to attain its vision. The focus of the perspective of potential is the

quality and refinement of human resources, approaches to the corporate culture, etc. A modern, experience and knowledge based enterprise operating in an ever changing business environment is made to further develop the principles of continuous learning and education. Kaplan and Norton (*2007*) emphasise the concept of "learning" which they consider to be superior to "training". The perspective of potential is also seen as encompassing the effective communication between employees which ensures the organisation's ability to act in situations that require action. Additionally, this perspective also includes the use of communication technology such as the Internet or communication networks where the sources of potential are intangible.

Potential of improvement in business is characterized by the dynamic and practically usable method, which is designed to solve the problem of increasing the business performance (Učeň, 2008). The

method is designed to solve the key management tasks such as updating the company's strategy, the effectiveness of the implementation of innovative projects and many more. The potential of improvement is defined in two forms, absolute potential of improvement and real potential of improvement. While the absolute potential shows the remote and yet unrealized level ever, the real potential for improvement is really achievable and desired status of performance.

Absolute improvement potential is applied to the formation of corporate strategy. This process is presented as the most appropriate manner as possible take place the process of key activities in business. The key activities are considered:

- There is realized the value added of process
- They are a tool of competitiveness
- They are critical according to the process cost and effect
- The productivity of the process is conditional
- Promote the synergy

Absolute improvement potential is determined by:

a) Best Practices that take place key activities in the present or in the near future
b) Benchmarking as comparison with top companies in the field or with the generally accepted standards in the industry.

Real improvement potential means a desired effect business processes achievable in the medium and short term. The real potential of improvement is made on the basis of specification of key elements for performance of key activities of separate realized processes. It is influenced by the constraints (Učeň, 2008):

- Business ability to undertake the change - potential of human capacity or finances
- External limits.

2.3 OBJECTIVE AND METHODOLOGY

Objective of the research was to measure the performance of the selected wood-processing company through traditional and non-traditional indicators and subsequent increasing of business performance by planning the appropriate investment based on its valuating by the dynamic and static methods. The work analyzes in a concise form the traditional performance indicators, focuses in detail on modern methods of the business performance evaluation and demonstrates investment appreciation as the factor of increasing the company's value.

The research was focused on achieving **the partial targets**:

- Theoretical background of methods for measuring and improving business performance

- Methodology of appropriate indicators of business performance and efficiency of investment
- Application of performance evaluation methods for the selected company and the investment.

In our research we analyze business performance indicators described below. Economic value added respectively true economic profit can be determined as follows (Kislingerová, 2000):

$$\boldsymbol{EVA = NOPAT - WACC * C} \quad (4)$$

Where: NOPAT – Net Operating Profit After Tax
WACC – Weighted Average Cost of Capital
C – Capital

Calculation of **NOPAT** is specific by some modifications with the task to bring the accounting concept of corporate profits as close as possible to investors' conception. The net operating income does not content profits or losses from extraordinary items, such as from sale of fixed assets or inventory and activities of non-core business.

$$\boldsymbol{NOPAT = EBIT * (1 - t)} \quad (5)$$

Where: EBIT – Earnings Before Interests and Taxes
t – income tax rate

The value of the **invested capital** may be prescribed:

- in operating aspect based on the property (assets) - the sum of operating fixed assets in residual value and working capital.
- in financial aspect (liabilities) - the sum of the residual value of equity and interest-bearing liabilities.

After calculating NOPAT and invested capital follows WACC calculation - the average cost of capital, ie the weighted average cost of the capital that is determined by the following formula:

$$\boldsymbol{WACC = rd\,(1 - t) * \frac{D}{C} + re * \frac{E}{C}} \quad (6)$$

Where: r_d – cost rate of debt
t – income tax rate
D – Debt capital
C – Capital (C=E+D)
r_e – cost rate of equity
E – Equity

In calculating the WACC should be observed the following:

r_d - the cost of debt capital means interest rate that can be determined as a weighted average of the concluded loan and debt agreements

r_e - the cost of equity is determined on the basis of the CAPM (Capital Asset Pricing Model), which is given by:

$$r_e = r_f + \beta * (r_m - r_f) \quad (7)$$

Where: r_f – risk-free premium
β – the systematic market risk (beta coefficient)
$(r_m - r_f)$ – risk premium

To determine r_e is necessary to meet the following:

1. **rf – for the risk free premium** is usually used the risk-free interest rate, which is determined for example from the US 10-year government bonds.
2. **β – beta coefficient** determination is based on the fact that the debt of the company operates in the value of β.
3. **(r_m-r_f) – risk premium** is determined for concrete country of region according the rating credit of rating agency (Standard and Poors´s or Moodys).

Damodaran (2015), Scholleová (2009) or Klieštik (2008) describe theoretical fundamentals for determining of parameters in CAPM and current values for countries and regions.

To calculate the coefficient β should be carried out following sequence of points:

1) For calculating the coefficient β takes into account the debt of the company. In the first step the rate is based on the real corporate financing by the debt capital and also by the equity in the previous period (last year).

$$\beta_n = \frac{\beta_z}{\left\{1 + (1-t)x \frac{D}{E}\right\}} \quad (8)$$

2) The second step is based on the current period. The determining the value β_z is based on values that are published by the stock exchange and scientific literature.

$$\beta_z = \beta_n \, x \left\{1 + (1-t)x \frac{D}{E}\right\} \quad (9)$$

Net Present Value (NPV) is defined as a difference between discounted money income from investment (investment income) and capital expenses. Under the term investment income we understand estimated value of the cash-flow (i.e. net profit plus amortization).

Mathematically is possible to show the NPV indicator as follows (Polách et al., 2012):

$$NPV = \sum_{i=1}^{n} CF_i * \frac{1}{(1+d)^i} - IC \qquad (10)$$

Where:

IC - invested capital

CF_i - annual investment estimated income during the economic life cycle

d - discount ratio

n - time of project life cycle

2.4 RESULTS OF THE PERFORMANCE MEASUREMENT IN THE WOOD-PROCESSING COMPANY BY THE TRADITIONAL AND NON-TRADITIONAL INDICATORS

The analysis of wood-processing company through the traditional performance indicators found that the company showed almost all the traditional performance indicators positive values moving around the optimal values, which declares table 1. Indicators of profitability for the company reported increasing in two followed years, which means the positive direction of the company. Important is the return on sales, which is relatively high at the level of 22.5% although the minimum required rate of return on sales is over 2%. Consequently have been evaluated debt ratios by the company and the results were also positive, because the total debt ratio of the company is only around 20%. Results for liquidity ratios in the company informed of the fact that in the second analyzed year the value of current liquidity was at an optimal level and in a positive trend, as in the previous year the given indicator did not reach optimal value required by the enterprise.

Table 1. Evaluation of the enterprise by traditional indicators. Source: authors

The return indicators	**Period T**	**Period T-1**
ROA (Return On Assets)	9.88%	9.59%
ROE (Return On Equity)	9.83%	9.41%
ROCE (Return On Capital Employed)	10.53%	10.13%
ROS (Return On Sales)	22.54%	20.44%
RC (Return On Cost)	30.95%	26.62%
The debt ratios	**Period T**	**Period T-1**
Total debt	20.26%	19.29%

Self-financing	25.40%	23.90%
The liquidity ratios	**Period T**	**Period T-1**
Current liquidity	1.33	1.66
Immediate liquidity	0.66	0.68
Net working capital	475.00	590.00
The activity indicators	**Period T**	**Period T-1**
Liabilities turnover period	210.78	161.32
Liabilities turnover	1.71	2.23

Verification of the business performance measurement was applied in the company and dominantly interested in calculation the EVA indicator. For the valuation is necessary to follow the methodological process to calculate the indicator correctly and thus obtain the required meaningful value. The first important calculation is the indicator NOPAT that we get through the profit before tax and interest.

Table 2. Calculation of NOPAT in the enterprise. Source: authors

NOPAT calculation	**Period T**	**Period T-1**
EBIT (Earnings Before Interest and Taxes)	784	810
t – income tax	19 %	19 %
NOPAT	**635.04**	**656.00**

Table 3. Calculation of the coefficient β in the enterprise. Source: authors

Coefficient β	**Period T**	**Period T-1**
Debt capital/Equity (D/E)	0.20257	0.19290
t – income tax	19%	19%
βn	0.32432	0.30755
βz	0.37534	0.35801

The non-risk interest rate was determined on the base of the 10-year government bonds issued by the National Bank of Slovakia and their value was in the first analyzed year at the level of 5,5%, the next year was average of 4% .

Table 4. Calculation of the Cost rate of Equity in the enterprise. Source: authors

Cost rate of Equity	**Period T**	**Period T-1**
rf – non-risk interest rate (%)	4	5.5
β – systematic market risk (coefficient β)	0.375	0.358
Risk premium (rm – rf) (%)	6.4	6.4
t – income tax (%)	19	19
re – cost rate of equity	**6.40**	**7.79**

Table 5. Calculation of the WACC in the enterprise. Source: authors

WACC calculation	**Period T**	**Period T-1**
rd – cost rate of debt (%)	4.4	4.4
t – income tax (%)	19	19
D – Debt capital	1607	1625
C – Capital	7933	8424
re – cost rate of equity	6.40	7.79
E – Equity	6326	6799
WACC	**5.826**	**6.9747**

Table 6. Calculation of EVA in the enterprise. Source: authors

EVA calculation	**Period T**	**Period T-1**
EBIT (Earnings Before Interest and Taxes)	784	810
t – income tax (%)	19	19
NOPAT	635	656
WACC	5.826	6.975
C	7933	8424
EVA	**172.8**	**68.4**

Given that the indicator EVA means an economic profit that is generated after the payment of foreign and own costs, the company generates this value at the level of 172.8 millions EUR. A positive value documents the successful business - the production of high added value. This means that EVA indicator for the enterprise is evolving in a positive direction, ie company has sufficient resources for investment, and thus it is possible to evaluate the advantage of investing - if suitable investment increases the enterprise performance.

Table 7. Calculation of NPV in the enterprise. Source: authors

Indicator	**Period T+1**	**Period T+2**	**Period T+3**	**Period T+4**
Income (mill. EUR)	51.52	53.44	61.19	63.14
Discounting for rate i = 0.05826	0.945	0.893	0.844	0.797
Discounted income (mill. EUR)	48.686	47.722	51.644	50.322
Present Value of Cash Flow (mill. EUR)	198.374			
Invested Capital (mill. EUR)	124.656			
Net Present Value (mill. EUR)	**73.718**			

To assess whether the considerate investment project is acceptable or unacceptable, we decided to evaluate the investment project by NPV method. Calculating of the Present Value of Cash Flow was based on the fact that it is possible for the discount rate to appoint the weighted average cost of capital (WACC), which was calculated with the method of EVA. In the phase of realization the company capital investment

incurred in the amount of 124.656 millions EUR and the value of the WACC was 5.826, lifetime of investment was planned for 4 years.

The calculation of NPV declares that the project contributes to the growth of business performance, ie invested capital for the company ensures to fulfill the objectives in the expansion of production capacity and the required appreciation, as well as this investment project increases the market value of the company.

2.5 DISCUSSION

From the EVA indicator for the two years is possible to analyze the development of the individual factors. Indicators EBIT and at the same rate of income tax NOPAT annually decreased, which was the negative performance development for the enterprise. However, the interest rate as the cost rate of capital decreased annually, similarly the amount of capital in the company and those two factors led to lower capital costs. But, NOPAT decreased in a lesser extent than decreasing cost of capital, what caused a positive development for the company - annual growth of the EVA indicator, thus increasing business performance.

In terms of the discussion of possible problems in the company is necessary to mention the indicator of capital market Earnings per share (EPS), which is related to lower EBT realized in the enterprise. Annual EPS decreased from 12.24 to € 11.90 per share, which is a negative development for shareholders.

A similar negative trend was also recorded in activity indicators, which has increased turnover period of liabilities (from 161.32 to 210.78 days, while turnover of liabilities decreased from 2.23 to 1.71 turn per year). The optimal value is specific to each sector. In terms of turnover period of liabilities it is a negative development for the company, the company is less able to pay its liabilities than in the previous year, this indicator increased by almost 50 days.

2.6 CONCLUSION

After calculating the EVA indicator for the enterprise was found that the observed enterprise achieves high economic value added, which has a positive trend. In the first analyzed year the company achieved EVA at 68.4 million EUR and in the next year the economic added value increased more than twice to the value of 172.8 million EUR.

In calculating the NPV the indicator is highly positive for the company, which means that investment is suitable to realize. The investment generates financial resources for business development and further growth of the business performance. Given the achieved results,

the company reported positive values in all indicators and wood-processing company should try to keep this status as long as possible.

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3. INNOVATIVE MARKETING COMMUNICATION TOOLS AND THEIR APPLICATION IN FURNITURE SECTOR

Miriam Olšiaková, Erika Loučanová

3.1 LITERATURE REVIEW

Recently marketing communication has become more significant. Using its innovative forms marketing communication enables company supporting the customer's attention, his confidence to buy, creating a good relationship, but they also help to strengthen the market position or the customer's loyalty.

Nevertheless, companies still apply traditional marketing communication tools, also called “outbound marketing”, which are primarily based on one-way companies communication with customers.

In a suitable combination of inbound and outbound marketing communication tools companies get the instant feedback from customer. The main idea of their usage is to make customer to be the inseparable part of the sales process which results in reducing the communication costs and achieving better communication and marketing objectives.

Because many companies try to appeal to a wide range of customers they have to find the right tools combination of both types of marketing in order to encourage the synergistic effect and to grab attention of different customer segments (Loučanová and Olšiaková, 2016).

If the company still uses the same old advertising practices, its business will remain invisible to many consumers who want to buy furniture. They could have problems to find the particular business or the offer. The reality shows that if internet, social media and "new media" are not the part of the marketing plan, the company will lose revenues on the market compared to the competition.

In the 80s and early 90s of the last century many traditional furniture stores used printed advertisements in commercial newspapers or advertised in yellow pages, radio and television if they could afford it. Larger shops printed circulars and sent direct mails, but most marketing

campaigns failed. They were used to address the most customers as possible, but they usually did not grab the attention of the right potential customer.

The main disadvantage of these campaigns was the problem how to determine which of applied tools brought the success. Perhaps they all were successful, maybe it was a coincidence.

Traditional communication media are designed to influence and gain the greatest number of people at once. Their probable benefit is that they are supposed to be faithful, because the customer connects the sellers' success on the market with frequency and repeatability of its advertising activity (Root, 2011).

Marketing brings a lot of opportunities to link the company with its environment and customers to meet their needs. In a persistently changing market conditions it is essential to react to changes and customer requirements as quickly as possible. That can be realized through involving customers directly into marketing when using the innovative marketing tools that fall into the open innovation system of businesses and provide two-way communication with customers. The open innovation system in this case is the ability to share information among different subjects in the network (Hrušková, 2010). Snyman et al. (2007) mention that an open innovation system represents a significant competitive advantage with respect to the limited access to information in the context of in-house innovation process, known as closed innovation system. Real-time innovation process operates on five basic principles of courage, openness, realism, influence and sustainability (Olšiaková and Loučanová, 2015). Open innovation system is connected to the phase of commercialization and communication with customers as subjects of the innovation process, so it provides innovators with information about their needs as well as needs of all stakeholders in the innovation process.

As Wu et al. (2016) mention, the aim of the open innovation process is to effectively identify valuable and profitable business innovation, as well as problems related to management decisions and practices within their innovation process. It brings knowledge about open innovation practices at the project level and provides an enlarged model of market opportunity analysis for high technology markets.

We can state that the open innovation process is a multi-disciplinary tool focusing on new products development and their marketing.

To fulfill the expected objectives the open innovation system uses inbound marketing and new innovative forms of marketing communication that are already based on two-way communication within the information distribution among stakeholders (see the Figure 1).

Inbound marketing is aimed at getting individual attention. This can be achieved by social media and content publishing that is attractive and interesting for customers. It includes blogging, educational articles publishing, publishing the troubleshooting guidebooks and contributing to forums. This aim requires producing the content that has a certain value and benefits for the target customer. Moreover, it is available free of charge, which also creates a positive brand link with the customer. The likelihood that so involved customer buys the goods increases. The whole process is cheaper and has a higher effect (Guadalupe, 2015; González-Fernández-Villavicencio, 2015; Pirnau, 2015; Simionescu, 2015).

As we have mentioned, inbound marketing is based on two-way, interactive communication with customers coming through search engines, social networks and different links. The aim and effort of inbound marketing is to entertain or to educate the customer. Within this kind of communication the customer gets a certain value.

Lower costs are also an advantage of two-way marketing.

In the future it is assumed that 61 % of marketing employees are planning to increase expenditures on inbound marketing. It is the fact that the average budget of companies allocated for blogs and social networks doubled during last two years. It has also doubled the number of marketing employees who believe that Facebook is irreplaceable in their business. In the global market 67 % of B2C (business to customer) companies and 41 % of B2B (business to business) companies have got a customer by Facebook, and 57 % of all companies have obtained a customer through a corporate blog. The answer to the question why inbound marketing is becoming so significant is that the price, respectively the costs used to address one potential customer. It is about 62 % lower compared to traditional outbound marketing (Melnyk, Korinchenko, 2015; Murín, 2011).

Regarding the e-business, it reaches a big boom due to the limitless possibilities of the electronic world, ranging in different business areas such as electronic sales, control, electronic commerce management, logistics, marketing.

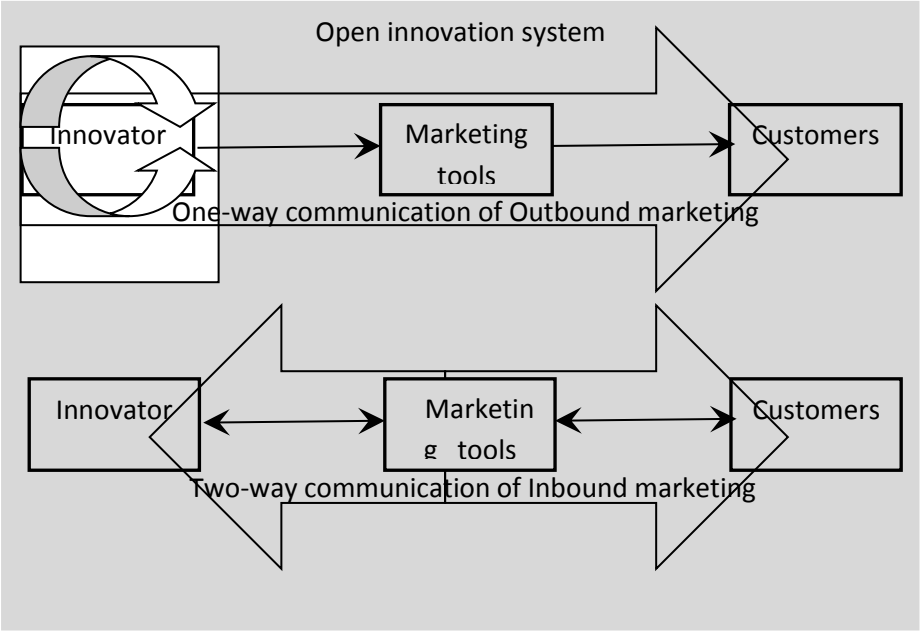

Figure 1 Information flow within the open innovation system for marketing effectiveness
Source: Loučanová – Olšiaková (2016)

Marketing and distribution logistics of information is one of the most important elements in online sales as well as e-business itself. E-business and all its components provide entrepreneurs with a variety of choices how to make an online business. It can be described by a 4-level maturity model of e-business by Madleňák (2004), see Figure 2.

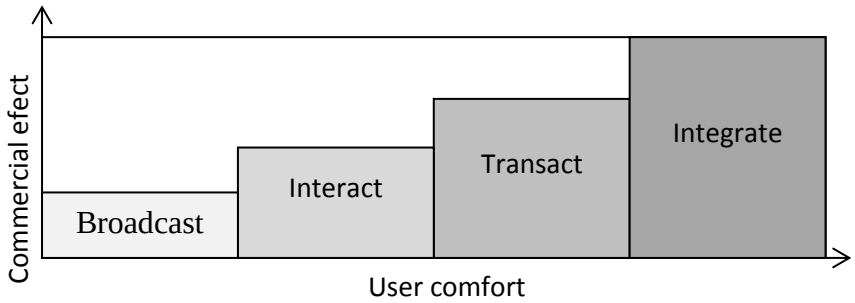

Figure 2 E-business levels
Source: Loučanová et al. (2016)

The first level of e-business is called “Broadcast”. It represents the elementary level of maturity model of e-business and it is characterized by a basic on-line access of selected information by customer.

The second level is “Interact” and it presents an extension to the first level with the possibility of interactive communication through various applications such as Public Relations, respectively on-line forms.

The third maturity level “Transact” provides customers with the opportunity of ordering, respectively products purchasing through the online shop.

The highest level from the point of e-business maturity is the fourth level ”Integrate”, which is based on the involvement of business into virtual business network, respectively electronic shopping center, also called e-mall (Madleňák, 2004; Lee, 2004).

These levels can be developed further regarding the possibilities of the Internet.

However, the ability of the entrepreneur to offer products on the internet at different levels of e-business does not insure him surety of his products sale. Therefore it is appropriate to encourage the sale by effective marketing.

E-business can use only marketing tools that can be put into electronic form. This fact does not harm electronic business; on the contrary, it provides it with new opportunities to persistently develop new innovative marketing tools that can quickly ensure feedback and effectiveness of these tools.

E-business is no longer dependent on the means of so-called outbound marketing, which is based on one-way communication (such as billboards, television commercials), but it also uses inbound marketing and its new innovative forms of marketing communication and distribution of information for marketing.

It is possible to use them at all levels of e-business. However, it should take into account that present consumers are more demanding and often use more comfortable shopping possibilities.

There is a relation between increasing the customer comfort and company´s influence on him. It is due to the fact that if the entrepreneur has his e-business at a higher level, then his actual e-mall - e-commerce center provides customer with various forms of inbound marketing. The entrepreneur is also provided with these services, so the comfort of his business is increasing and he also has a feedback from customer

Then feedback may be used to improve the products and services through their innovation in the context of the innovation process, where its first part “Invention creation” is provided according to specific customer requirements. They are evaluated by e-shop connected with e-mall or more e-malls (such as electronic business centers) through reports.

The advantage in terms of innovation process is the information gathering within the e-business.

Is has a significant importance also in terms of timing, because the time of the innovation launching is getting shorter due to accelerated invention gathering. They can be quickly included into new forms of inbound marketing, where Content Marketing, Viral Marketing, Game advertising, Guerilla Marketing, Undercover Marketing - Product Placement, Experiential Marketing, Murketing, Social Media, Astroturfing, Marketing Search Engine White Paper and E-newsletters belong to.

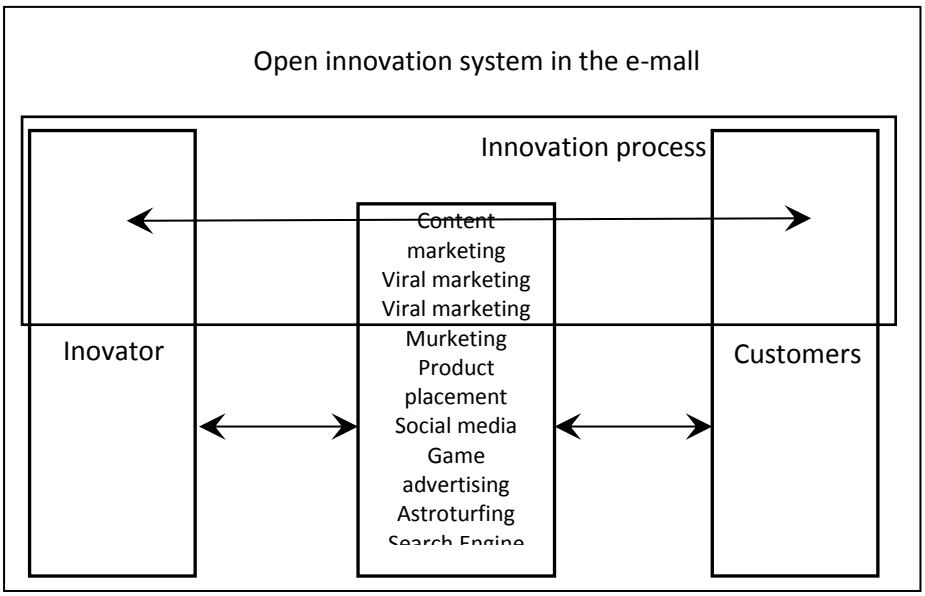

Figure 3 Information with open innovation system, e-mall and inbound marketing
Source: Loučanová et al. (2016)

The Internet marketing communication complex is a specific action plan aimed at achieving the company´s objectives by its implementation on the Internet. It contains Public Relations, Direct Marketing, Personal Selling, Sponsorship and modern possibilities associated with the

Internet (corporate site, content sites, portals, banners, virtual communities, social networks, forums, message boards, search engines, etc.). They use Internet technology (social media marketing, viral marketing, product placement, lead generation, search engine optimization, targeting, etc.). Company's Internet communication complex uses a branded SEO optimized website, analytical materials, contextual advertising, banner advertising, various thematic Internet resources (portals, forums, electronic bulletin boards, etc.). All of them help to adjust analytical and advertising subject content and personal communication (Melnyk, Korinchenko, 2015; Shurmann et al., 2014).

In the meaning of the open innovation system in e-business with inbound marketing using when innovation is created, the distribution policy carries out two tasks.

The first task is associated with the innovation value creation. The second one focuses on realization of distribution flows in e-business and innovation process by creating the balance between supply and demand. That means the flows realization between sources and consumers. Finally, innovation implementation and distribution accomplish that entrepreneur detects at the right time and on the right place what the market requires. This ability is called FIT (flexibility, innovation and implementing activities at the right time). All outputs of mentioned functions of distribution must be in required quantity and quality when managing innovation in business at different levels, whether national or global one (Straka, 2013; Cisko et al, 2013; Repková-Štofková, 2013).

Then business process consists of mutually linked activities and their output represents a value for the customer. It rules globally that the business process and its outputs can lead directly or indirectly to the creation of end value for the customer. The process itself consists of smaller sub-processes, or operation (including processes connected with marketing communication) that can be shown on a map of sub - processes. It is also possible to characterize this process as a sequence of partial activities with a mutual objective. The beginning of the whole process results from the start-up signal, and an output for the customer is sequentially created by the defined partial processes with the usage of allocated resources (Štofko et al., 2016; Kováčiková and Repková-Štofková, 2016).

As Krajňák and Meier (2016) state, globalization nowadays affects practically the whole economy, which is influenced by innovations and

their marketing support. The role of innovation and marketing is important not only at the national level but also plays an important role in the global context (Loučanová et al., 2015). The globalization tendency consequence is an expanding market space where a business entity can be active, see Figure 4.

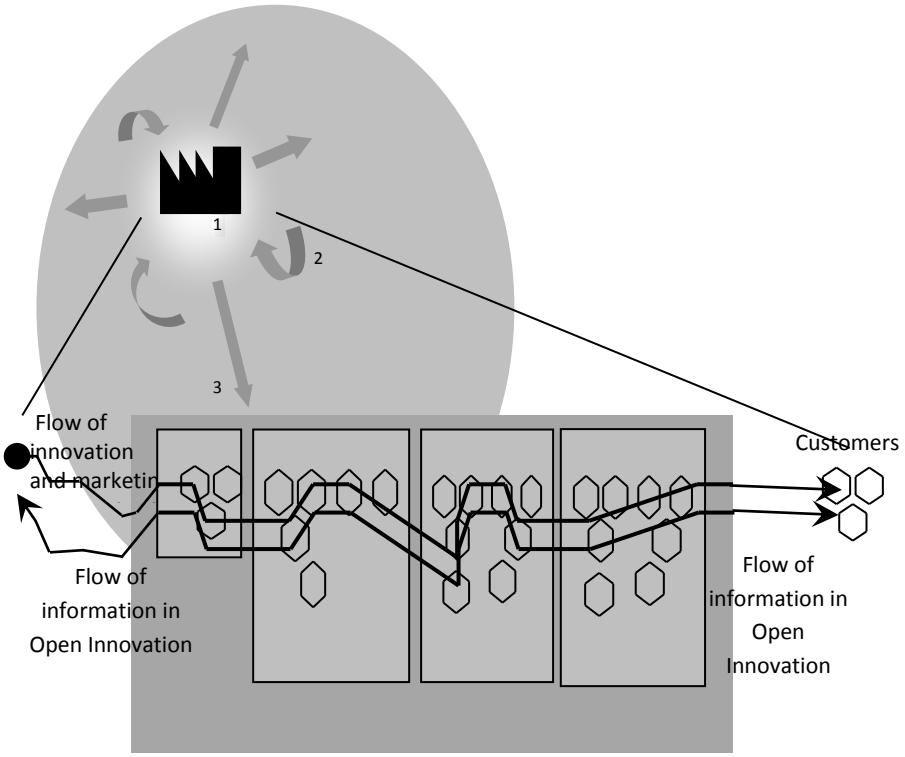

Figure 4 Information flow in the open innovation system in the global market
Source: Loučanová - Olšiaková, 2017

The furniture industry is also the part of the global market and it also needs to be active in this market. Therefore, it is necessary to monitor which innovative communication tools are effective for the active participation of the enterprises of the furniture industry on the market.

3.2 METHODOLOGY

Through the analytical - synthetic method we have studied the conditions of innovative forms of marketing communication within an

open innovation system and global market, where the authors present the effect of these forms from different point of view. The main method to detect the efficiency of individual innovative forms of marketing in the furniture industry was the questionnaire through interviews with 33 specialists in the given field. The monitored objects have selected innovative marketing forms, namely Content Marketing, Viral Marketing, Game advertising, White Papers, Guerilla Marketing, Undercover Marketing - Product Placement, Experiential Marketing, Murketing, Classic Marketing forms. In the interview, the experts had to sort the monitored objects in the form of the necessary decision (Figure 5) according to the effect of chosen monitored marketing forms in the furniture industry.

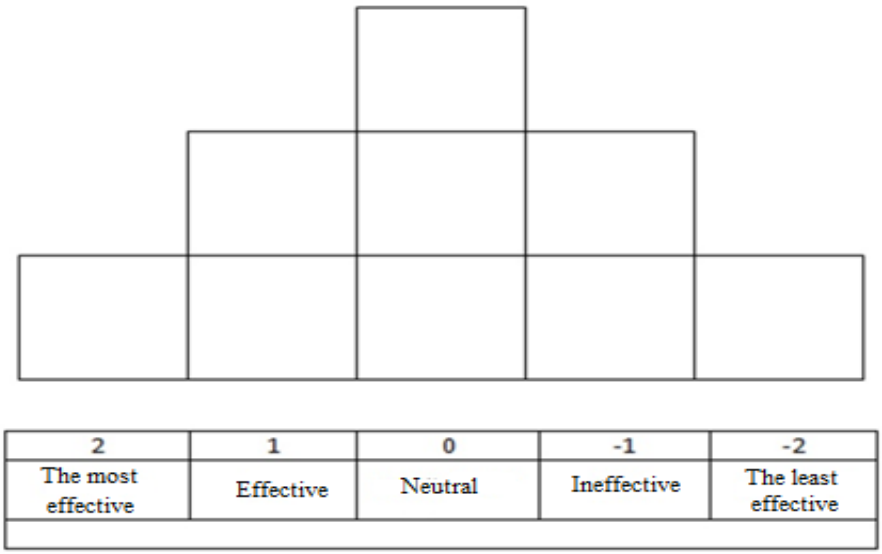

Figure 5 The form of decision making

Subsequently from the obtained data we have created a database that was calculated by the basic statistical data. Through the further analysis it was evaluated the effectiveness of individual marketing tools in the furniture sector.

Within the discussion to the solved issue of effectiveness of innovative forms of marketing in the open innovation system, we have

tried to evaluate the results of our survey by inductive-deductive method using.

Another used method is based on analysis. It rests in analysis of a range of items that have different levels of significance and should be handled or controlled differently. In this type of analysis the items are grouped into three categories (A, B, and C) in order of their estimated importance. „A“ items are very important, „B“ items are important, „C“ items are marginally important.

For example, the best items who receive the highest value are given the 'A' rating, are usually serviced by the sales manager, and receive the most attention. 'B' and 'C' Items warrant progressively less attention and are serviced accordingly (Businessdictionary.com, 2017).

3.3 RESULTS AND DISCUSSION

Based on the obtained data, we have elaborated the basic statistical indicators (Table 6), which point to the fact that according to the average value from the form of the decision making in the interview results that the most effective tool is viral marketing, at a standard deviation of 0.581843 and dispersion 0.338541. They point to the fact that there is a close relationship in respondents' responses from our research. Other effective marketing communication tools are Guerilla Marketing (mean 0.51) and Experiential Marketing (average 0.3336). Generally used marketing tools are traditional forms of marketing communication (mean 0.3476, median 0, mode 0), Product Placement (mean 0.0.215117, median 0, mode 0) and Murketing (mean -0.33964, median -1; mode -1). The less applied forms of marketing communication in the furniture industry are Content Marketing and the White papers. However, they are an important element of the technical description of the furniture industry, but their effectiveness is evident only after the product purchases of the furniture industry and therefore they do not represent a significant element of marketing communication mix for the customer's purchasing decision making. From the results of the survey follows that Game Advertising seems to be the least effective.

Table 1 Basic statistical indicators

	Content Marketing	Viral Marketing	Game Advertising	White Paper	Guerilla Marketing	Product placement	Experiential Marketing	Murketing	Traditional forms of Marketing Communication
Mean	-0,46	1,22	-1,12	-0,41	0,51	0,22	0,33	-0,34	0,35
Standard deviation	0,89	0,58	1,09	0,72	0,94	1,09	0,99	0,88	1,28
Median	0	1	-1	0	0	0	1	-1	0
Mode	0	1	-2	0	0	0	1	-1	0
Dispersion	0,80	0,34	1,19	0,52	0,88	1,18	0,98	0,78	1,63

On the basis of found data we have elaborated a final form of individual kinds of marketing communication usage by professionals from the furniture industry. It is illustrated in the Figure 2.

For a further analysis of data from the database, where the values of the Likert scale from -2 to 2 were transformed to values from 1 to 5. Then they were calculated for the individual forms of marketing communication (survey objects) the efficiency values of individual forms of marketing communication in the furniture sector according to the decisions making of the involved subjects. Subsequently we have calculated their percentages from their total post as well as the cumulative efficiency of individual forms of marketing communication in the furniture sector. Their values are shown in the Table 2.

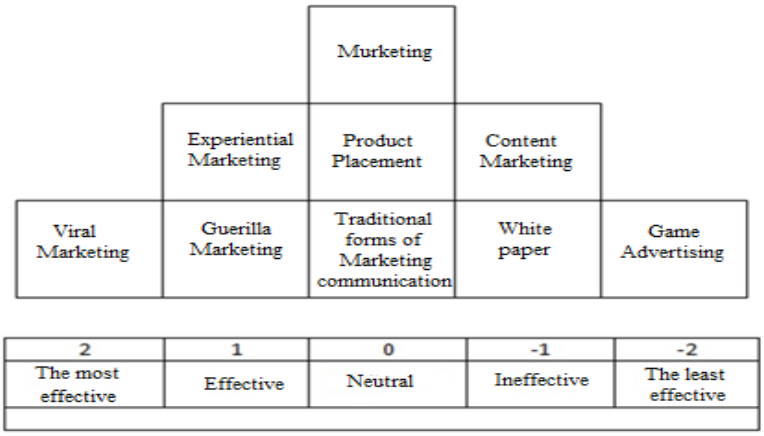

Figure 6 Form of managers decision making for effective using of individual kinds of marketing communication in the furniture industry

Table 2 Cumulative efficiency values of individual forms of marketing communication in the furniture sector

Searched forms of marketing communication	Efficiency values of individual forms of marketing communication in the furniture sector	Percentage	Cumulative efficiency values of individual forms of marketing communication in the furniture sector
Viral marketing	123	15,66879	15,66879
Guerilla marketing	105	13,3758	29,04459
Experiential marketing	97	12,35669	41,40127
Traditional forms of marketing communication	96	12,2293	53,63057
Product placement	89	11,33758	64,96815
Marketing	76	9,681529	74,64968
White paper	76	9,681529	84,33121
Content marketing	73	9,299363	93,63057
Game advertising	50	6,369427	100

On the basis of the mentioned data it was elaborated the curve which is illustrated in the Figure 7.

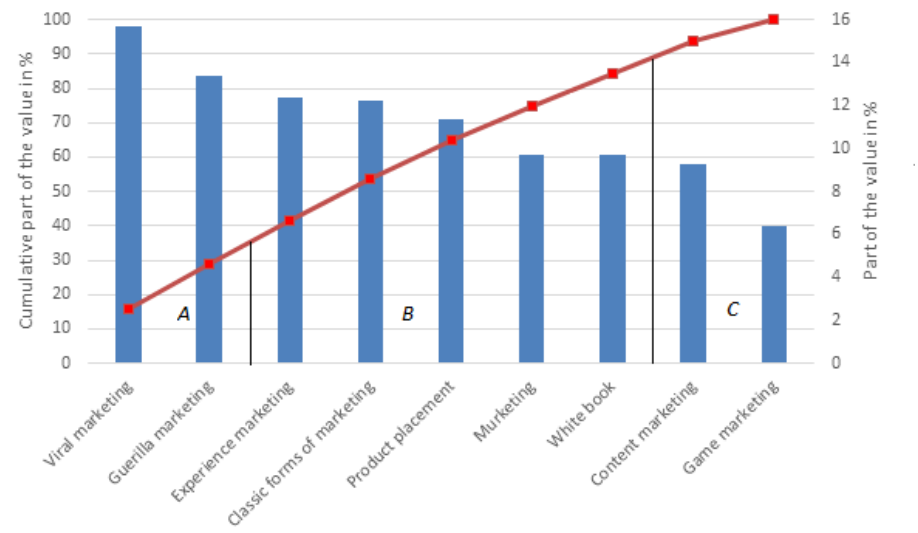

Figure 7 The curve of cumulative efficiency values of marketing communication individual forms in the furniture sector

Regarding the Pareto principle that explains that 80 % of consequences result from 20 % of total possible reasons (Sixta - Žižka, 2009) and realized analysis that is graphically shown in the figure above we can state that in the group A the most effective forms of marketing communication in the furniture sector are Viral and Guerilla Marketing. In the group B the most effective marketing communication tools there are Experiential Marketing, traditional marketing communication tools, Product Placement, Murketing and White Papers. The group C represents the group of searched objects with the lowest share on the total marketing communication effect in the furniture sector. It includes Content Marketing and Game Marketing.

The similar opinion share the studies of other authors, where for example Thoros N. (2011) states that technological developments make the marketers use viral marketing more effectively in the search of a new medium. People used to communicate in a completely different way and it has become easier for consumers to share their experiences about products, brands and services through internet. Through viral marketing marketers can reach their consumers by using their imaginations, creativity, and interactivity to purchase furniture.

Another example offers Robyn Blakemanin in the book Nontraditional Media in Marketing and Advertising (2014) presents a

concrete example of IKEA application of guerilla marketing campaign titled „A little Fabric Makes A Big Difference" to draw attention to its brand. IKEA has become a master of presenting itself and its products using guerilla marketing techniques.

The issue how to use guerilla marketing in the furniture sector is also analysed by Ďurková (2014), Lundstrom – Sjobom (2011) a many others.

The results of individual marketing communication tools using is confirmed by the mapping of innovative communication tools using in the furniture industry. The most effective and applied tools are mentioned within the following part of the paper. The following tools belong among the most successful in the furniture industry:

Guerilla marketing

Guerrilla marketing is an unconventional marketing strategy that brings maximum results using low costs. This alternative advertising style relies on unconventional marketing policies, high customer involvement and imagination. The purpose of Guerrilla Marketing is to prepare a surprise to the final consumer to gain an unforgettable impression and feeling. Guerrilla marketing is often ideal for small businesses that need to reach a wide audience, but it also has a significant application in large companies (Creativeguerrillamarketing, 2017).

Even Guerrilla marketing can be applied in the furniture industry as we present in the Figure 8 and 9. These presented examples are connected especially with the IKEA Company that is known for a great number of brilliant ideas how to be noticed by as many people as possible.

Figure 8 Another IKEA ´s idea of guerilla marketing
Source: https://patriciafarah9.wordpress.com/2010/11/14/campaign/, 2017

Figure 9 Another IKEA ´s idea of guerilla marketing
Source: https://sk.pinterest.com/julianneaerts/guerilla-marketing-genius/?lp=true, 2017

Viral marketing

Viral marketing is a marketing technique that spreads via the Internet. This "bacillus" name is based on the principle, as the advertising message circulates.

The virus as well as the viral content spreads among people who came into contact with them. Its main objective is the product promotion and advertising as well as strengthening the brand awareness.

Viral marketing is supported by the social networks where people contribute content and share information. Chain e-mails, chat and SMS are other media for forwarding various messages.

Viral marketing is based on creative, funny videos or interesting pictures that are spread naturally among users.

Although furniture industry does not belong among top users of this tool (such as automotive, fashion, cosmetics, food or clothing industry), it is recommended to use it also in the furniture sector, as the good news that are spread in a circle of trusted people can overcome any well-designed campaign and it does not require any special financial resources (Olšiaková, Loučanová, 2015).

For example, a viral marketing in the furniture industry are a campaigns VIRAL IKEA ad - simply brilliant!, Start something New - IKEA Commercial or IKEA - Dubbed Husband and other.

3.4 CONCLUSIONS

Business environment is constantly facing new challenges that require companies to react promptly as fast as they can. Innovativeness is evident in all parts of marketing, certainly in marketing communication. Companies search tools that seem to be more affective in a relation with their customers. Appropriately chosen tools effect shows in addressing more customers, getting their attention, their confidence to buy and keeping the customers´ loyalty.

Companies use more or less traditional marketing communication tools that are also called “outbound marketing” and “inbound marketing”. The new trend requires from companies to apply marketing communication tools that which involve the customer into the communication that enables the instant feedback so the customer feels to be the inseparable part of the sales process. This is also the way how

to reduce the communication costs and to achieve better communication and marketing objectives.

The reality also points to the fact that consumers tend to spend leisure time on the Internet, play online games, chat on social networks, watch videos on YouTube etc. So it is necessary to include new trends of leisure time and changes in customer preferences related to favourite forms of marketing communication into marketing plans. It is essential to create the right composition of communication mix, which will consist of an appropriate combination of the traditional and modern tools. This supports the successful appeal to target audience and allows minimizing of incorrectly spent money and failure in the market.

Acknowledgement

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4. INNOVATION IN FORESTRY BASED SUPPLY CHAINS

Rossitsa Chobanova

The forestry 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 forestry 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 data from official resources of the European Commission the paper attempts to characterise innovation in forestry based supply chains after the crisis. Generally 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. In this respect forestry based industries success factors lye 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.

In this respect the paper attempts to characterise innovation in forestry based supply chains after the crisis in two regions in Bulgaria, which are on the crossborder with FYROM.

The paper presents results of a statistical survey as well as a sociological survey among the companies from the forest sector and the companies related to the supply chain in the regions of Blagoevgrad and Kyustendil in Bulgaria.

The survey summarizes the data from the conducted on-line and field survey on face-to-face of 107 companies in 2017 as well as data from the labor market statistics and business statistics of the National Statistical Institute for the period 2008 - 2015 for the regions of Blagoevgrad and Kyustendil.

According to the methodology of the National Statistical Institute (NSI), data on the structural business statistics are collected through the annual reports of non-financial enterprises during the reference year. These reports are two types - a complete set and a shortened version

and their completion depends on the size of the enterprise and current national legislation:

- Annual Report on the Activities of Non-financial Enterprises Compiling Balance Sheets;
- Annual Activity Report of Non-Compiling-Balance-Sheets Entities.

Therefore, the statistical information presented here is based on the data that is provided by the enterprises to NSI and may not fully reflect the state of the forestry sector in the areas under consideration.

For the purposes of the supply chain analysis, the following NACE rev. 2 classes are grouped together and these classes are referred to as divisions to facilitate the perception of the information that is presented:

- Division 02 Forestry and Logging
  02.2 Logging
  02.4 Suport services to forestry
- Division 16 Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
  16.10 Sawmilling and planing of wood
  16.21 Manufacture of veneer sheets and wood-based panels
  16.22 Manufacture of assembled parquet floors
  16.23 Manufacture of other builders' carpentry and joinery
  16.24 Manufacture of wooden containers
  16.29 Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting materials
  And
  43.32 Joinery installation
- Division 17 Manufacture of paper and paper products
  17.11 Manufacture of pulp
  17.12 Manufacture of paper and paperboard
  17.21 Manufacture of corrugated paper and paperboard and of containers of paper and paperboard
  17.22 Manufacture of household and sanitary goods and of toilet requisites
  17.23 Manufacture of paper stationery
  17.24 Manufacture of wallpaper
  17.29 Manufacture of other articles of paper and paperboard
- Division 31 Manufacture of furniture
  31.01 Manufacture of office and shop furniture
  31.02 Manufacture of kitchen furniture
  31.03 Manufacture of mattresses
  31.09 Manufacture of other furniture

- Division 46 Wholesale trade, except of motor vehicles and motorcycles
  46.13 Agents involved in the sale of timber and building materials
  46.15 Agents involved in the sale of furniture, household goods, hardware and ironmongery
  46.47 Wholesale of furniture, carpets and lighting equipment
  46.65 Wholesale of office furniture
  46.73 Wholesale of wood, construction materials and sanitary equipment
  and
  47.59 Retail sale of furniture, lighting equipment and other household articles in specialised stores

The scope of the study the potential for supply chain development here for the one of the divisions - forestry and logging - the following indicators were used:

Number of enterprises

Production (BGN thousand)

Value added at factor costs (BGN thousand)

Emloyed persons

Employees

Net sales revenue (BGN thousand)

Profit (BGN thousand)

Loss (BGN thousand)

Wages and salaries (BGN thousand)

Turnover (BGN thousand)

The analysis are elaborated using the following derived metrics:

Average production of an enterprise (BNG thousand)

Average value added at factors costs of an enterprise (BGN thousand)

Average operating income of an enterprise (BGN thousand)

Average operating expenses of an enterprise (BGN thousand)

Average fixed tangible assets (BGN thousand)

Average employed persons per enterprise

Average employees per enterprise

Average net sales revenue of an enterprise (BGN thousand)

Average profit of an enterprise (BGN thousand)

Average loss of an enterprise (BGN thousand)

Average wages and salaries of an enterprise (BGN thosand)

Average turnover of an enterprise

Average wages and salaries per employed person in an enterprise (BGN thosand)

Annual growth rate of the number of enterprises (in %)

Annual growth rate of production (in %)
Annual growth rate of the value added at factor costs (in%)
Annual growth rate of operating income (in %)
Annual growth rate of operating expenses (in %)
Annual growth rate of the employed persons (in %)
Annual growth rate of emloyees(in %)
Annual growth rate of net sales revenue (in %)
Annual growth rate of profit (in %)
Annual growth rate of loss (in %)
Annual growth rate of wages and salaries(in %)
Annual growth rate of turnover (in %)

According to NSI, the indicator **'Number of enterprises'** refers to all non-financial enterprises, which were active during whole or part of the reference year and have submitted their annual reports in the National Statistical Institute or National Revenue Agency.

The turnover includes the value of all revenue from sales of own products, goods bought and sold in the same condition, services provided and row materials sold, including accrued excise duties, which are invoiced during the reference period. It does not include the revenue from sales of fixed assets, the income from financing, the financial and the extraordinary revenue. The value of turnover does not include accrued taxes on the type of value added tax (VAT) which are charged to the end user.

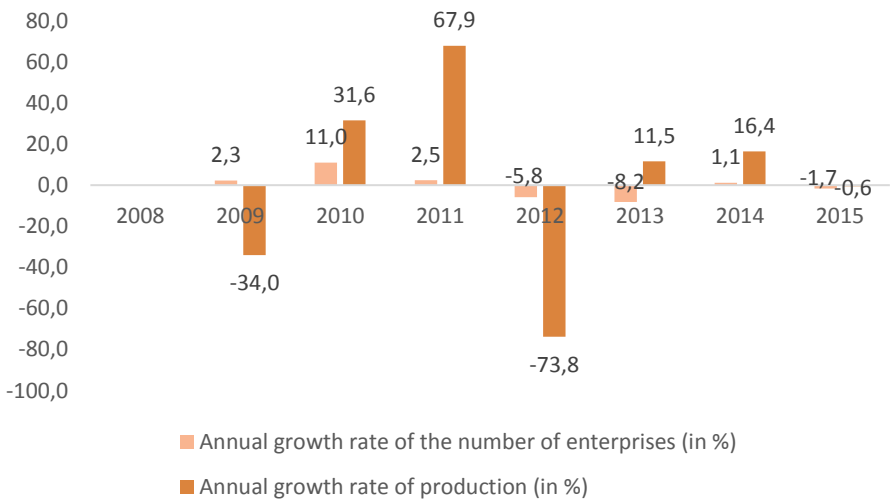
Employees are all persons who have a labour contract (fixed or permanent; full-time or part-time) with their employer by virtue of the Labour Code or the Civil Servants Act and who receive remuneration in cash or in kind for certain quality and quantity of work done.

NSI defines **the number of persons employed** as all persons employed working in a given enterprise on full or part-time, including seasonal workers, home workers, working owners, employees under contract for management and control, employees in civil contracts that do not work with another employer and unpaid family workers. It does not include those absent for an unlimited time, as well as those provided under contract by other companies.

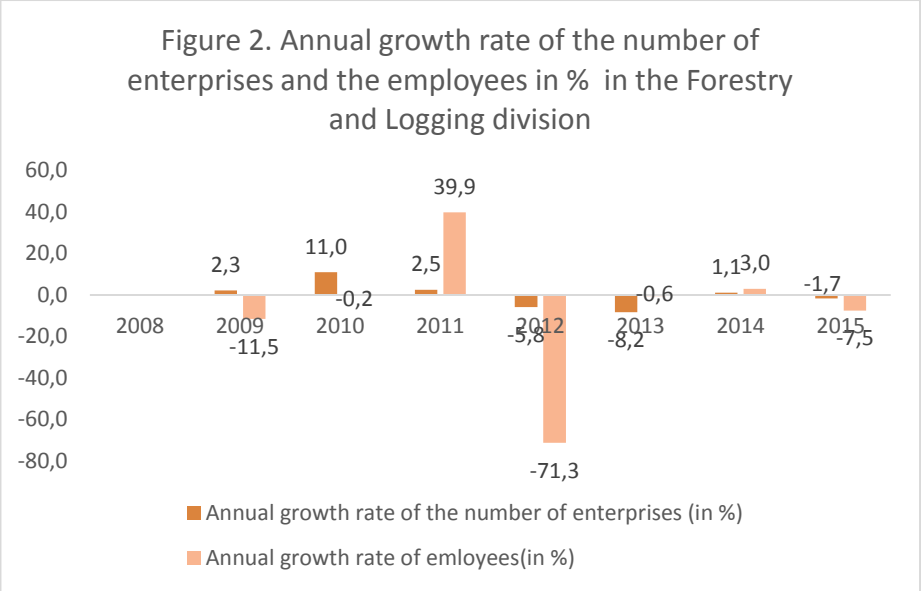
4.1 TENDENCIES IN PERFORMANCE OF LOGGING AND SUPPORT SERVICES TO FORESTRY

In the period 2008 - 2011 the number of enterprises in the division Forestry and Logging, according to NACE Rev. 2, increase. In 2008 in the Blagoevgrad and Kyustendil regions they are 177 and in 2011 - 206. The rise in the number of companies from the two divisions until 2011 is followed by a decline which goes on until 2013, when the firms are down to 178 and the total number is equal to the one from 2008. This level remains relatively constant until 2015 (177 companies). Despite the dynamics throughout the period considered, the number of enterprises in the classes at the beginning and end of the period is the same.

Figure 1. Annual growth rate of the number of enterprises and the production in % in the Forestry and Logging division

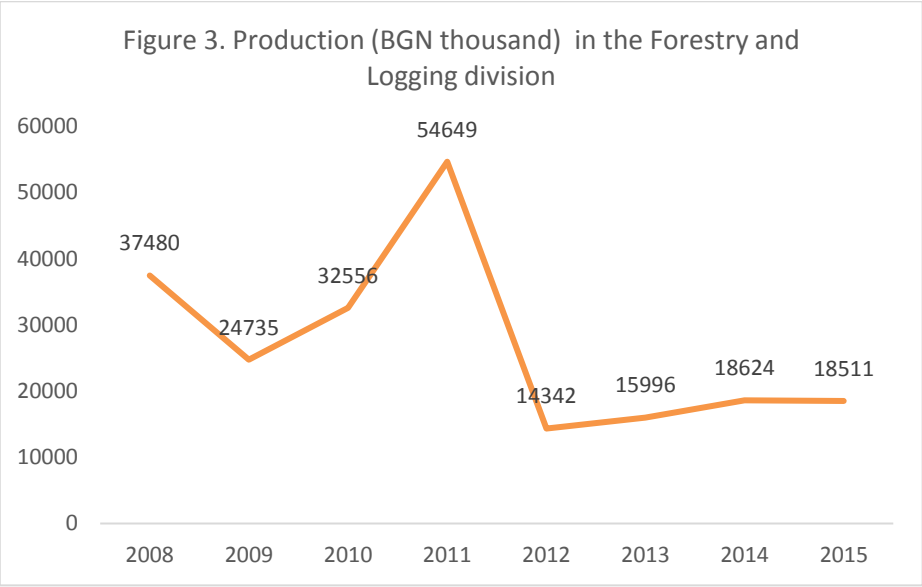


The changes in the production on an annual basis are similar to the variation of the number of enterprises in the division, but there are also differences. Due to the global financial crisis, in 2009 the number of enterprises increases by 2.3 percentage points. At the same time, production decreased by 34%. In 2011 the total number of enterprises in the division reaches its highest value, and then the growth in the production is the biggest. In 2013, the number of companies in the division change negatively (-8.2%) and the production goes up by 11.5%.



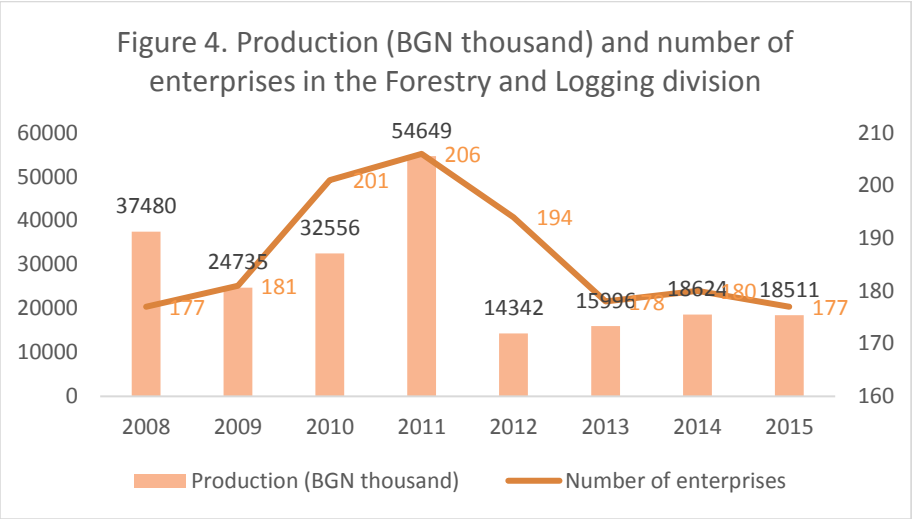
The percentage change in the number of employees in the Forestry and Logging division in the regions of Kyustendil and Blagoevgrad follows the growth of the number of enterprises. At the beginning of the period under review, the growth of both indicators is the opposite: in 2009, enterprises increased and employees decreased, and in 2010 the number of enterprises increase while the employees retained their level from the previous year. In 2011 and 2012, the change in the number of employees is greater than the change in the number of companies operating in the division.

It could be concluded that the crysis affected forestry and logging with a delay of 3-4 years in the surveyed refions. The majour consequence was fragmentation of sector.There is no evidence that this tendency has been stopped, or changed in this regin. The assumption about tendecy of fragmentation obtains additional evidence while going to analyse the tendencies in production in the forestry and logging and number of enterprisesin the both divisions.

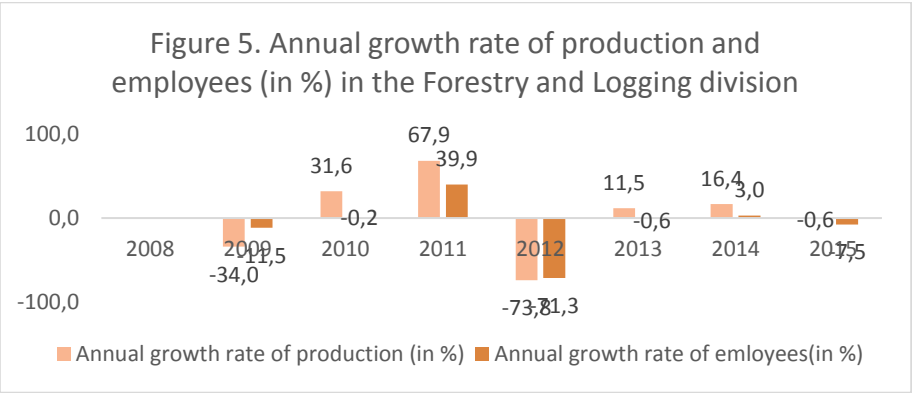


During the global financial crisis, the values of production, the value added at factor costs, the operating income and expenses, the net sales revenue, the fixed tangible assets, the employees, as well as the wages and salaries, are reduced. These indicators have positive changes in the 2009-2011 period, reaching their highest point in 2011. There is a sharp decline in 2012 when the delayed crises appeared .

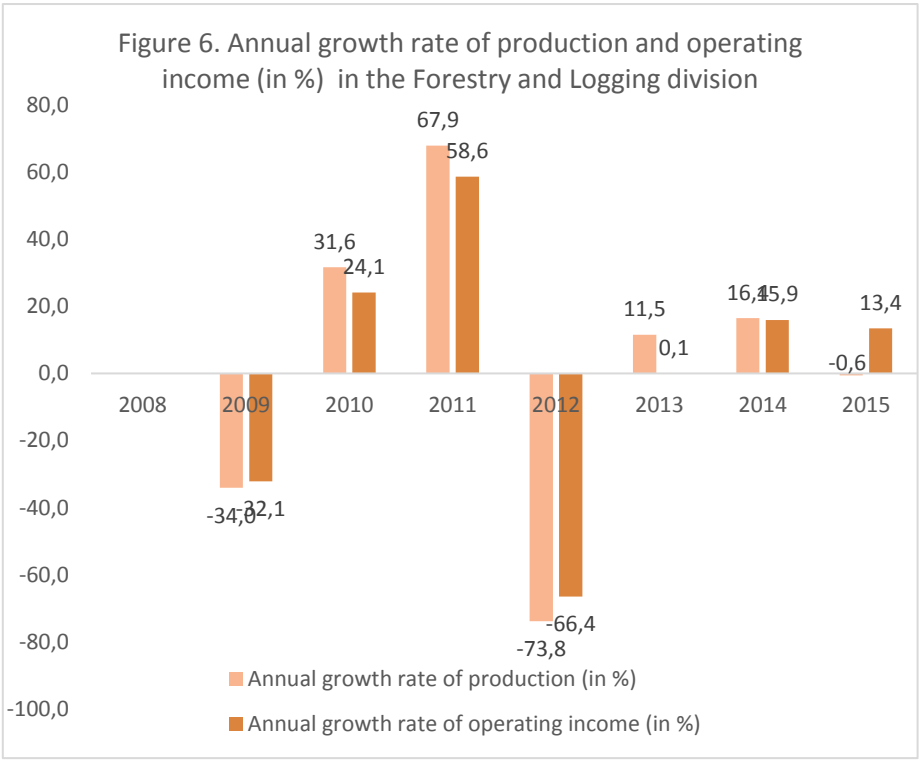
It could be assumed the effect of the global crisis of 2008 delayed its effect and has appeared in 2011 in the two Bulgarian regions in a form of fragmentation. After the diminishing production, the number of enterprises in the sector fell down from 194 in 2012 to 178 in 2013. After 2012, there is a relative retention or an increase in the value of production and the value added at factor costs, which is observed until 2015. The changes in operating income and expenditure, employeed persons and employees in the division, as well as in the wages and salaries, net sales revenue and turnover of enterprises are analogical to that of the forementioned indicators.



In the first year of the reviewed period there is high productivity in the division. The number of enterprises in 2008 is smaller than that in 2009 and 2010, and yet the value of the 2008 production is higher than in 2009 and 2010. The production value is the smallest in 2012 and the highest in 2011, when number of the enterprises in the division is the biggest.



The annual growth rate of the persons employed in the enterprises in the division correlates with the growth of the production on an annual basis. 86% of the increase in the value of production is determined by the increase in the number of employees in the sector. Typical of the period under review is that the annual increase in output is higher than the annual rise in the number of employees.



During the monitored period, the annual growth of production is higher than the change in operating income. Only in 2015 the production decreases and the operating income in the logging sector increases.

For the 2008-2015 period, the annual changes in the production are both positive and negative and they are greater than the changes in turnover in the logging division during most of the time. In 2015, the production decreases and the turnover increases - the sold production, goods and services are more than the production during the current period.

Figure 7. Annual growth rate of production and turnover (in %) in the Forestry and Logging division

Figure 8. Value added at factor costs (BGN thousand) in the Forestry and Logging division

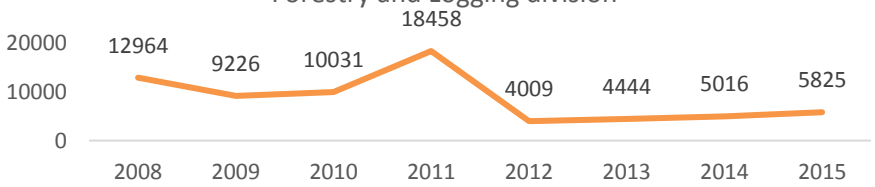


Figure 9. Operating income and expenses (BGN thousand) in the Forestry and Logging division

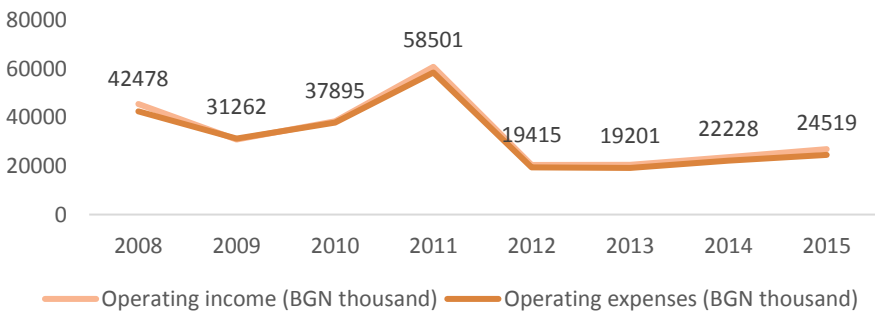


Figure 10. Fixed tangible assets (BGN thousand) in the Forestry and Logging division

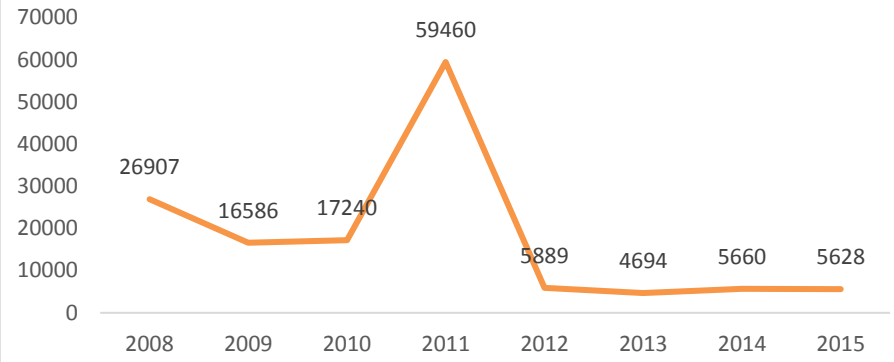
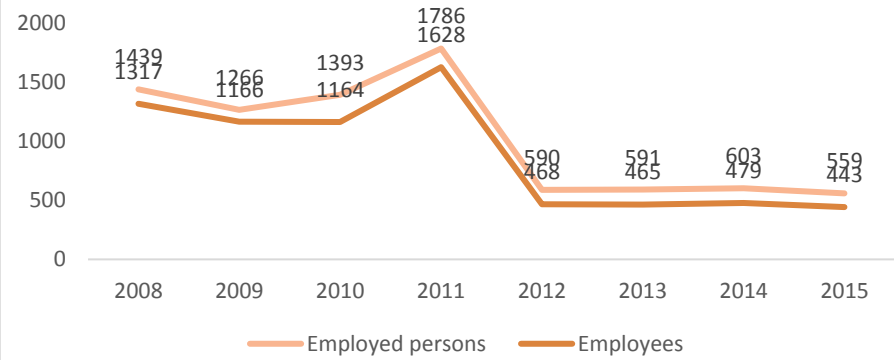
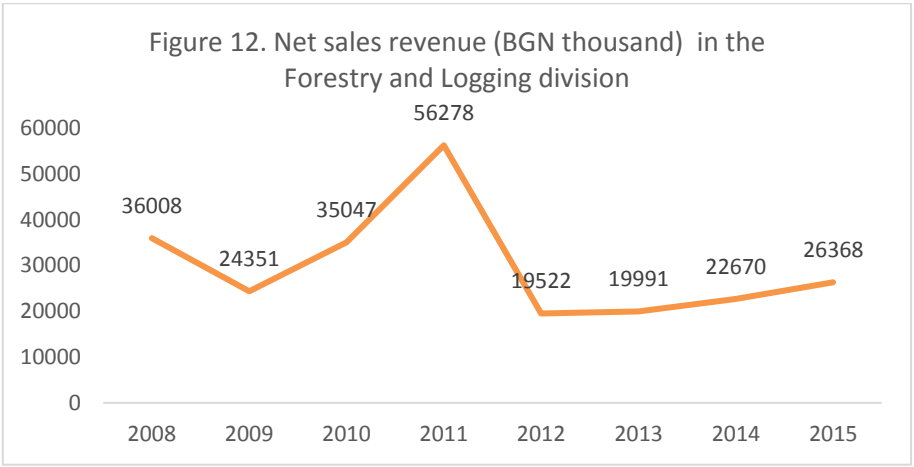
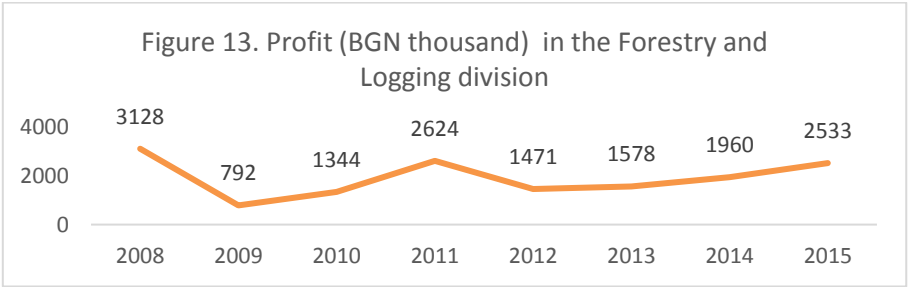


Figure 11. Employed persons and employees in the Forestry and Logging division







Following the dynamics of the other economic indicators, the profits in the division decreased sharply at the beginning of the period, reaching BGN 792,000 in 2009 from a total of BGN 3.1 million for all enterprises. There is a rise in the value of the indicator until 2011 and a decline in 2012, again followed by an increase observed until the end of the period under review. The loss in the division in 2008 was BGN and in 2009 it rose to BGN 1.3 mln. In 2009-2013, the loss in the sector decreased, in 2014 it increased and in 2015 its growth was negative.

Figure 14. Loss (BGN thousand) in the Forestry and Logging division

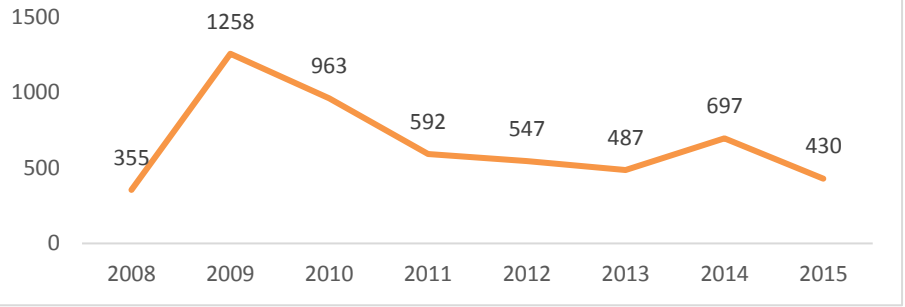


Figure 15. Loss (BGN thousand) in the Forestry and Logging division

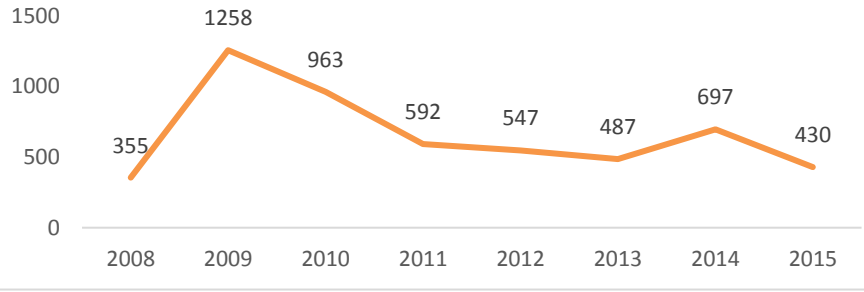
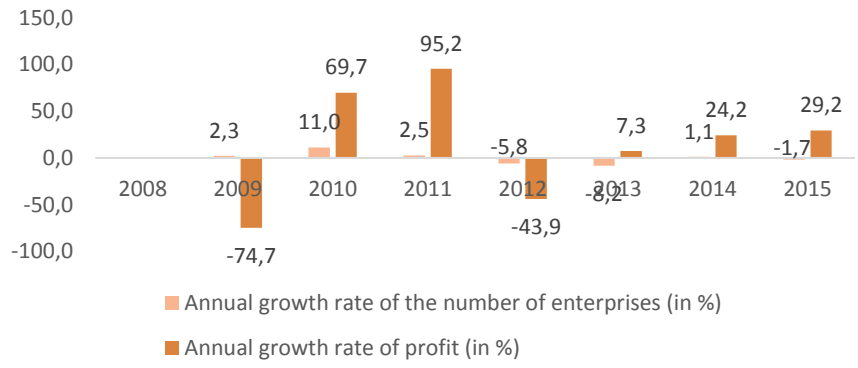
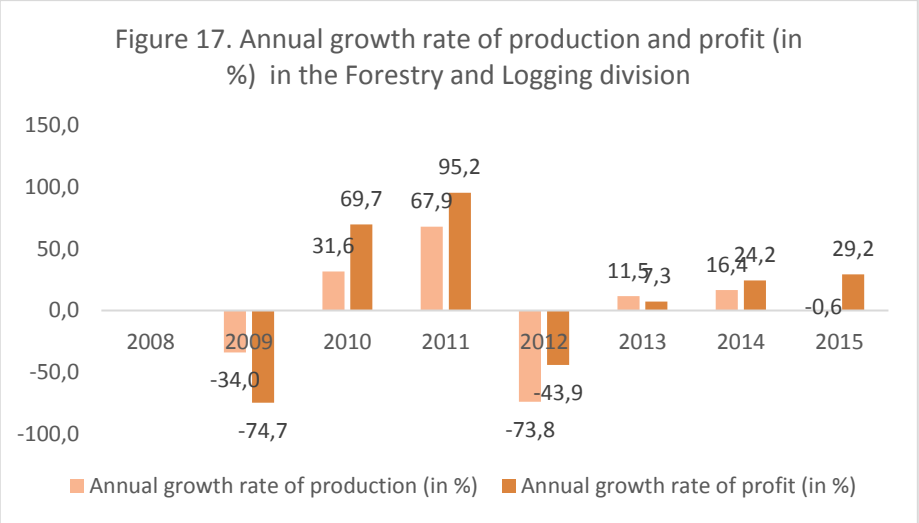


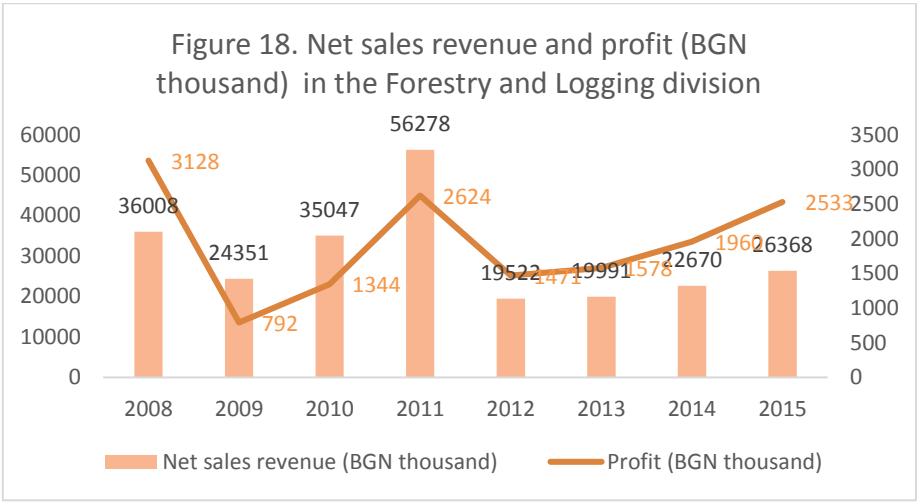
Figure 16. Annual growth rate of the number of enterprises and profit (in %) in the Forestry and Logging division

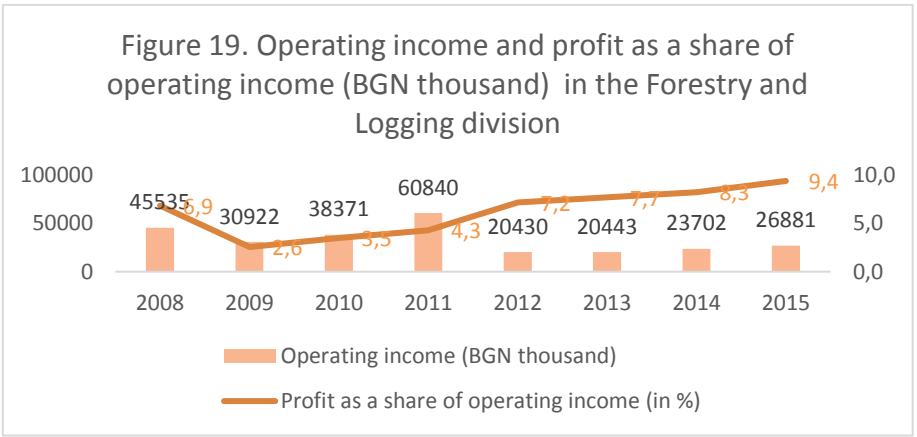


It is interesting to observe the change in the profit in the division and the link with the number of enterprises or production. For example, the reason for the increase in profit may be either the greater productivity of companies or an increasing number of firms in the division. For most of the years from the period under review, changes in the number of enterprises and profits are in the same direction: the more the companies in the division are, the bigger increase in profit. There are opposite changes in the annual growth rate of the number of companies and the profit. A possible reason for that is the increased or decreased productivity of the companies in the logging division.

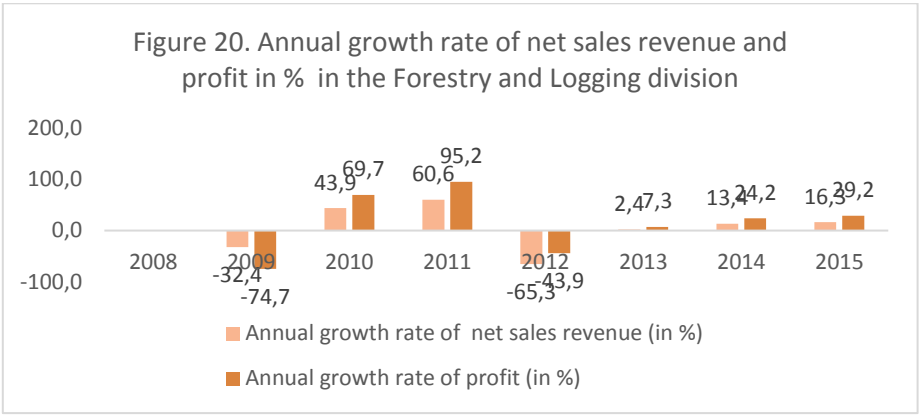


The relationship between the annual growth rate of production and annual growth of profit is strong. 75.9% of annual profit changes are due to the annual variation in production. For example, in 2009, production declined by 34% and the profit was down by 74.7%. In 2010, the positive change in production could be linked to more than double growth in profits in the logging division. Increased production, respectively, productivity and efficiency of production processes can significantly improve profits in the division.





Profit in the logging division follows the movement of the values in net sales revenue. Profit as a share of operating income in the division declined in 2009 in the context of the ongoing financial crisis and then increased from 2.6% of operating revenue in 2009 to 9.4% of sales revenue in 2015.



Net sales revenue and profit change in the same direction throughout the period that is considered. With the increase in net sales revenue, profits also increase and, in the case of a decline in net sales revenue, profit in the division is decreasing. The annual growth of net sales revenue and turnover in the logging division is almost identical. The nominal values of net sales revenue and turnover are almost the same.

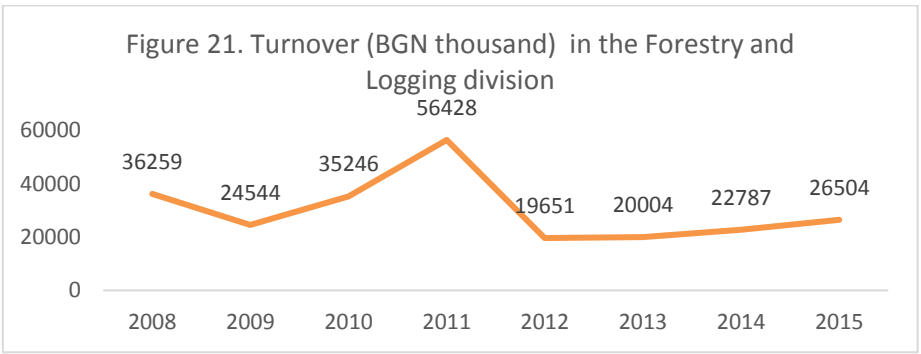


Figure 22. Annual growth rate of net sales revenue and turnover in % in the Forestry and Logging division

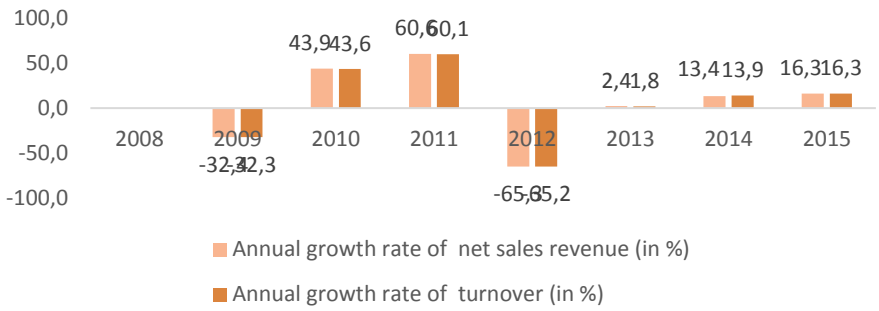
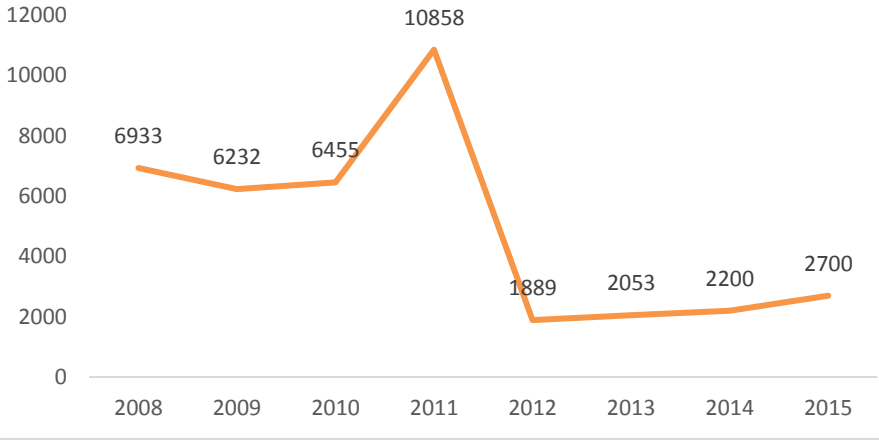
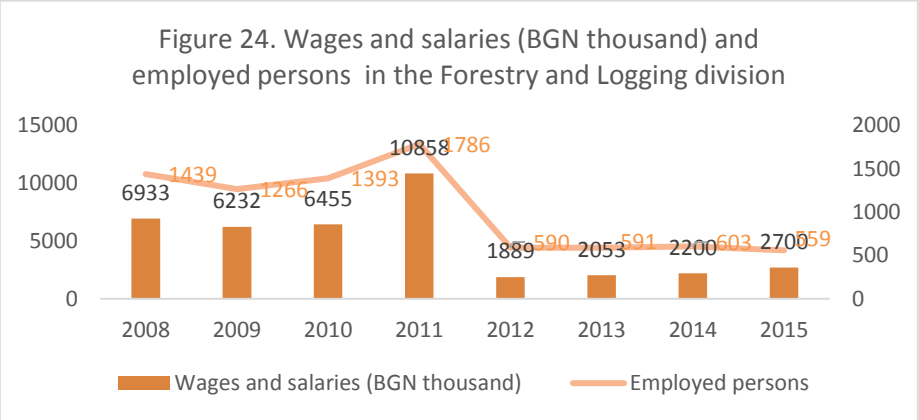
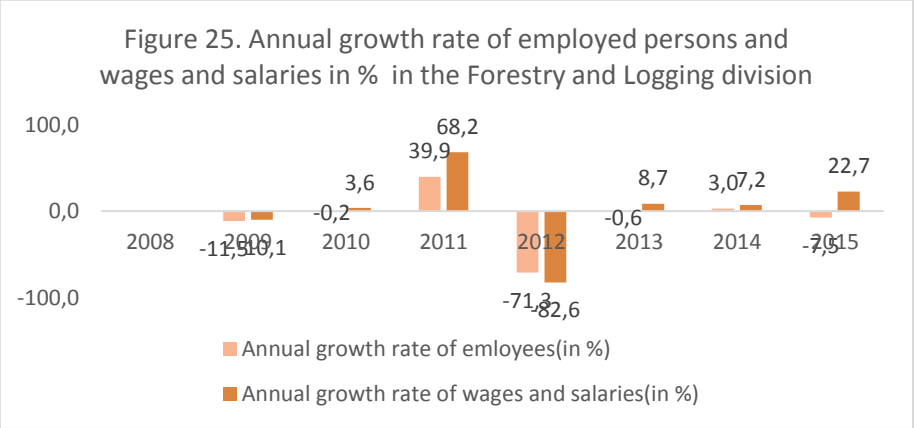


Figure 23. Wages and salaries (BGN thousand) in the Forestry and Logging division

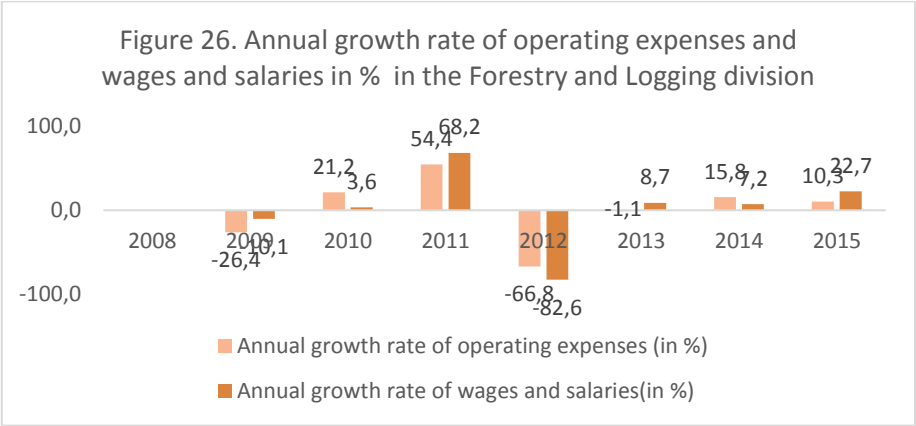




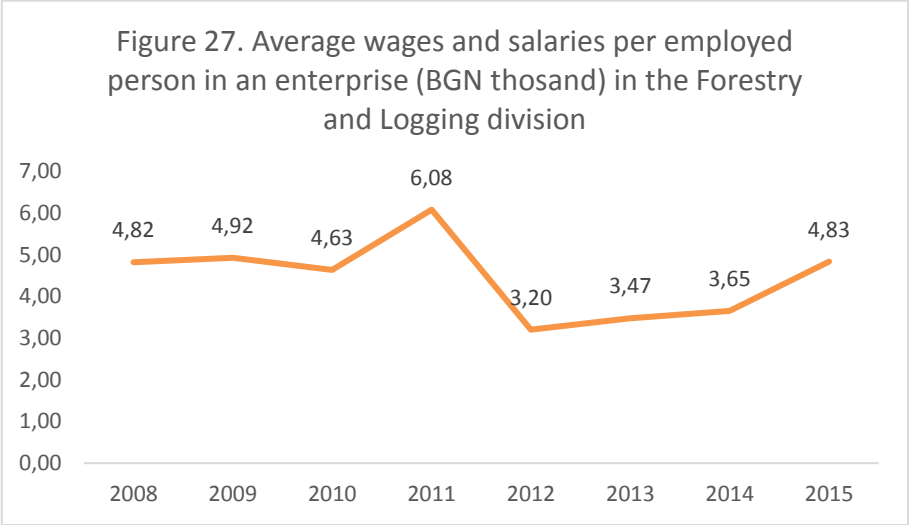
Wages and salaries and employees change in a similar way, the higher wages and salaries of companies happen when the number of employees in the division increases.



Changes in the employed persons and wages and salaries in the division follow a similar rate of change. In 2011, wages and salaries increase by 68.2%, and employees - by 39.9%. The change in the wages and salaries raises by almost double the positive change in the number of employed persons in the reviewed classes. The difference between the two indicators is the largest in 2015 - then the wages and salaries increase by 22.7% and the annual change in the number of employed persons is -7.5%.



In the logging division, the operating expenses and the wages and salaries follow the same dynamics. Changes in operating expenses may be observed, and they are higher than the one in the annual growth rate of the wages and salaries. In addition, over the years, the annual growth of rate of wages and salaries over the period under review exceeds the annual changes in operating expenses.



The indicator average annual wages and salaries per employee in an enterprise is calculated as the average annual wages and salaries of an enterprise in the logging sector divided by the average number of employees in a company. The average annual wages and salaries per

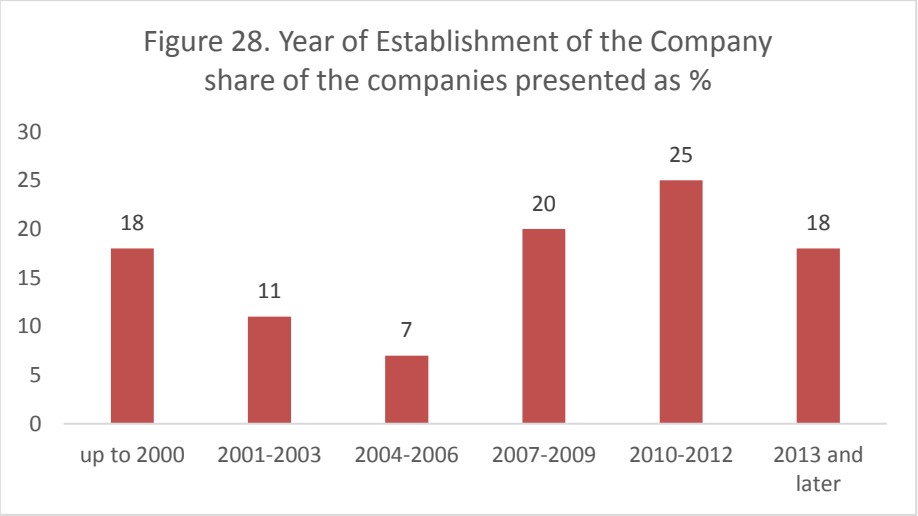
employee in an enterprise follows the change in the number of enterprises in the sector. The figures for 2008 and 2015 are almost identical, despite the changes during the period that is considered. The growth in the number of enterprises as well as in the production of the sector since 2011 is also followed by an increase in the average annual wages and salaries per employee in an enterprise. The subsequent decline led to a reduction in the average wage by half.

4.2 RESULTS OF THE SURVEY IN FORESTRY SECTOR AND SUPPLY CHAINS

The study is aimed at fostering the competitiveness and the cross-border cooperation through

- examining and defining initiatives for innovational cooperation between the forestry enterprises of Blagoevgrad and Kyustendil regions in Bulgaria and the Northeastern, Eastern and Southeastern planning regions of Macedonia
- Studying the obstacles and the ways to overcome them
- Defining ideas to increase the productivity, economic growth and investment in the region

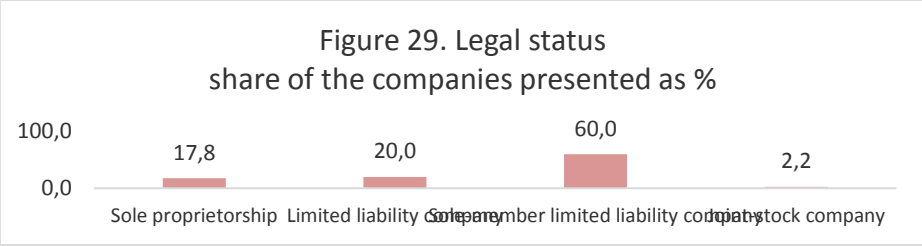
Profile of the companies



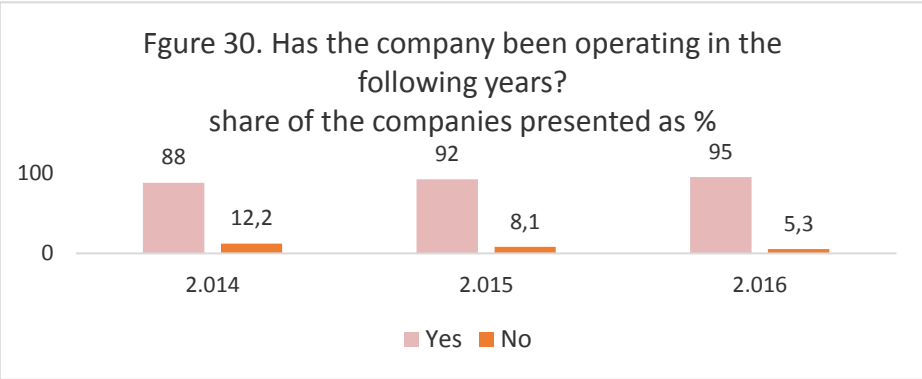
Our research has shown that 63% of the companies that were surveyed were established in 2007 or later. Despite the financial crisis, there was a sharp increase in the number of newly set up businesses during the years 2007-2009 in the observed sectors. In the period 2004-

2006, 7 enterprises were started in the regions of Blagoevgrad and Kyustendil. That number almost tripled in the period 2007-2009, reaching 20 companies which then started operations. 18% of the businesses which completed the questionnaire were set before the year 2000 and another 18% started their operations in 2013 or later.

The majority of the companies are privately-owned by Bulgarians. They are typically independent enterprises, not part of other business entities**.**



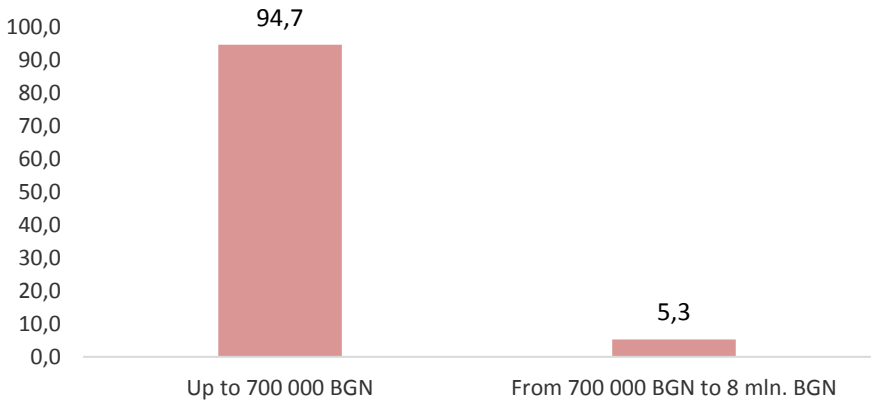
The most common type of business entity in the sector and the region is the sole-member limited liability company (EOOD) with 60% of the businesses that participated in the survey operating under this legal status. Sole proprietorships or ET (17,8%) and limited liability companies or OOD (20%) are also widespread. 2.2% of the respondent companies are joint-stock (AD).



88% of the companies which took part in the survey were operating in 2014. The percentage of the businesses that were operating in 2015 and 2016 was on the rise. 92% and 95% respectively of the respondent enterprises were producing in those years. This shows not so stable

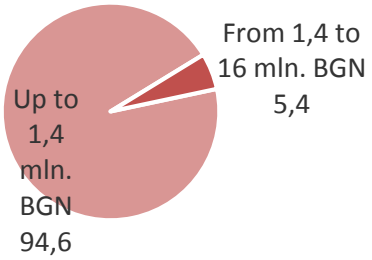
business environment as some of the companies do not operate sustainably and miss some of the years. Evidence for this is given by the fact that some of the companies send their financial report but are not operating on the ground. The share of this companies are around 1-2% of the total sector.

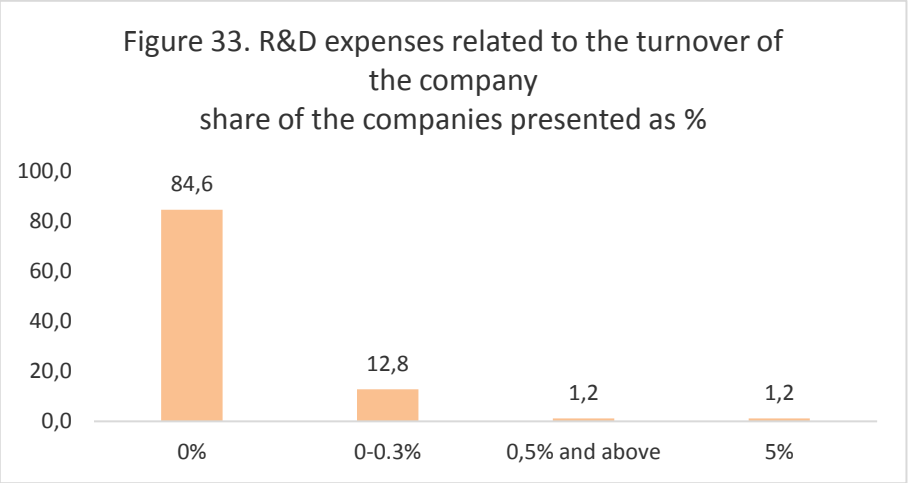
Figure 31. Book value of the assets share of the companies presented as %



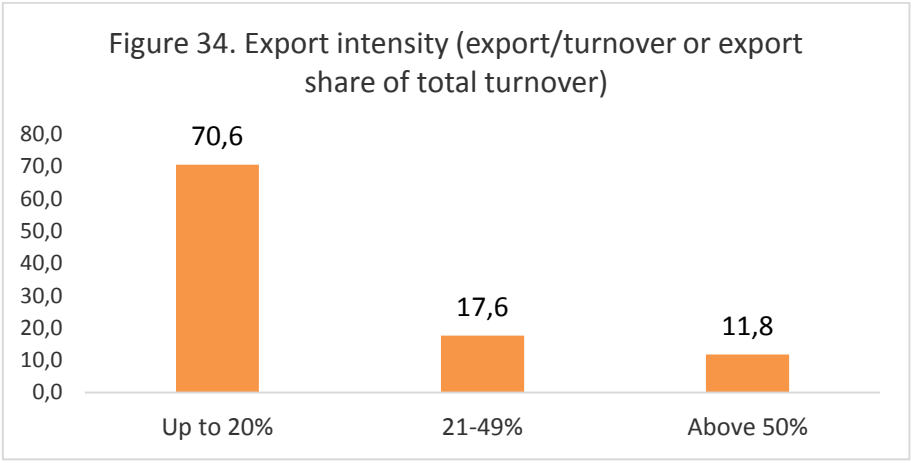
The book value of the assets of 94.7% of the companies in the regions of Blagoevgrad and Kyustendil is either below or equal to 700 000 BGN. This fact is an indication of the small scale of the operations of the enterprises. Under that criteria, the businesses could be classified as microcompanies (according to the Law on Small and Medium-Sized Enterprises). 94.6% of the business entities have a net sales revenue of 1.4 mln. BGN or less. This further suggests that the enterprises could fall into the category of microcompanies.

Figure 32. Net sales revenue share of the companies presented as %

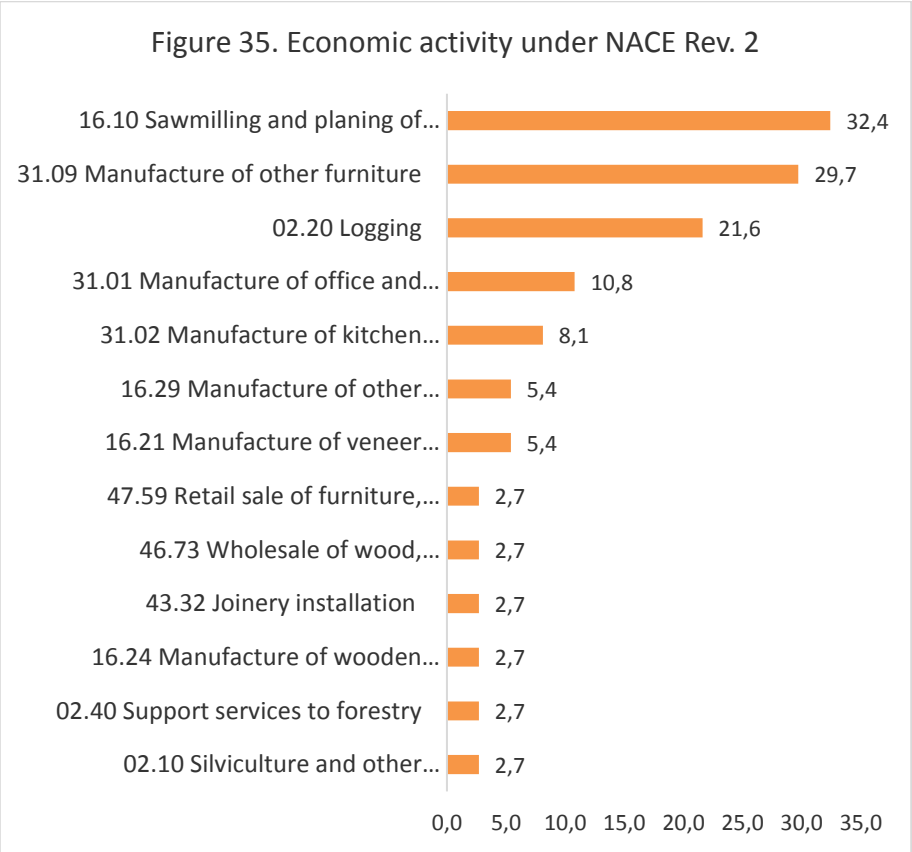




The expenses on research and development activities of the companies in the region of Blagoevgrad and Kyustendil are relatively low. Among the enterprises participating in the survey, 84.6% spend 0% of their turnover on R&D and 12.8% of the businesses spend between 0% and 0.3% on such activities. 1.2% of the companies spend 0,5% or more of their turnover on research and development and another 1.2% dedicate 5% of their turnover to researching and developing new products. The R&D expenses are directly related to the introduction of innovations to the market. Innovations could help companies be more competitive not only locally, but abroad as well. Additionally, a greater level of innovations contributes to more value added to the production. The low levels of investment in R&D are a prerequisite for a modest market performance of the companies in the observed sectors. That might also hinder the enterprises from being competitive on the Bulgarian and the European market.



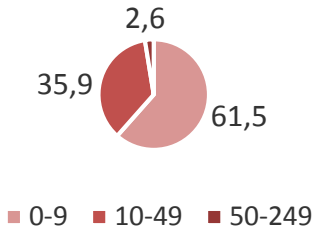
The export intensity (or the exports as a share of the total turnover of the companies) is typically below 20%. 70.6% of the companies which participated in the questionnaire indicated that they export 20% or less of their total turnover. Thus, the majority of the companies of the observed industries are more domestically oriented and a small percentage of their production is exported. 17.6% of the businesses in the sector point out that between 21% and 49% of their produce is sold abroad. 11.8% of the enterprises export more than a half of their production. Competing on foreign markets validates the businesses (their production is of sufficient quality so as to compete internally and abroad) and might increase the revenue of the companies.



The operations of 32.4% of the companies that participated in the survey fall into the economic activity 16.10 Sawmilling and planing of wood. 29.7% of the businesses are part of the economic activity 31.09 Manufacturing of other furniture under NACE Rev.2 and 21.6% belong to the 02.20 Logging. The activities of the companies in the observed sectors, among others, are also 31.01 Manufacture of office and shop furniture, 31.02 Manufacture of kitchen furniture, 16.29 Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting materials and 16.21 Manufacture of veneer sheets and wood-based panels.

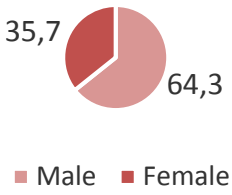
Profile of the employees

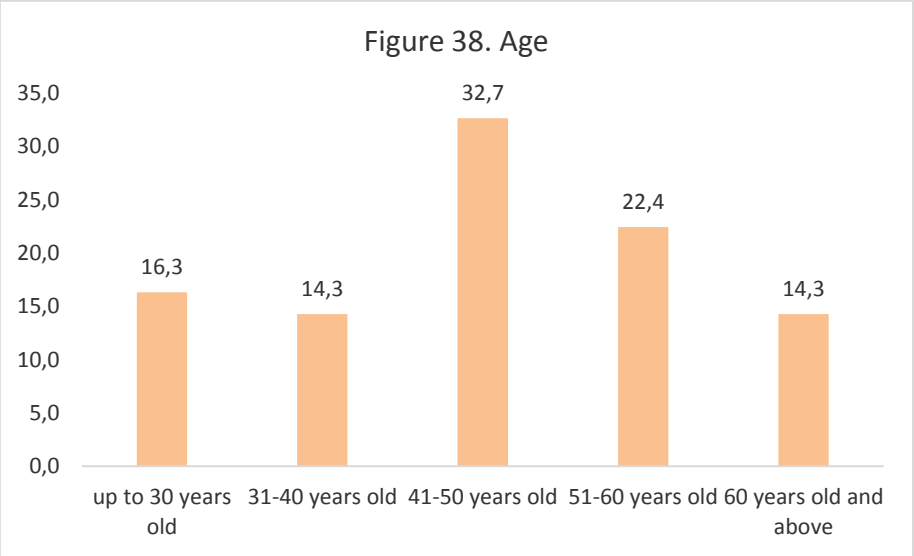
Figure 36. Average number of employees for the reporting period



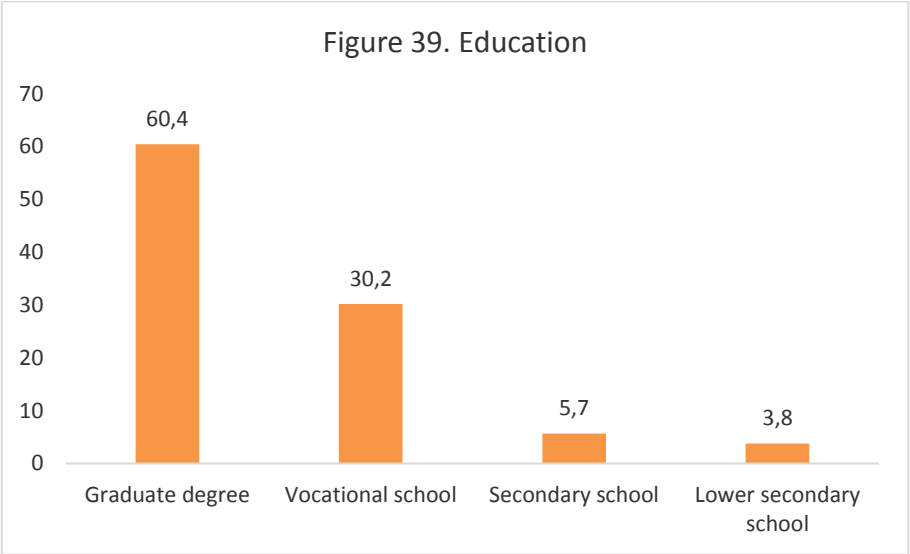
The majority of the enterprises could fall into the category of microcompanies, according the criteria related to the numbers of people employed of the Law on Small and Medium-Sized Enterprises. 61.5% of the companies in the survey indicate that the average number of employees is between 0 and 9. 35.9% of the enterprises in the regions of Blagoevgrad and Kyustendil have between 10 and 49 employees. In 2.6% of the businesses the people employed are between 50 and 249. The predominant gender for the companies in the observed sectors is male (64.3% of the employees).

Figure 37. Gender

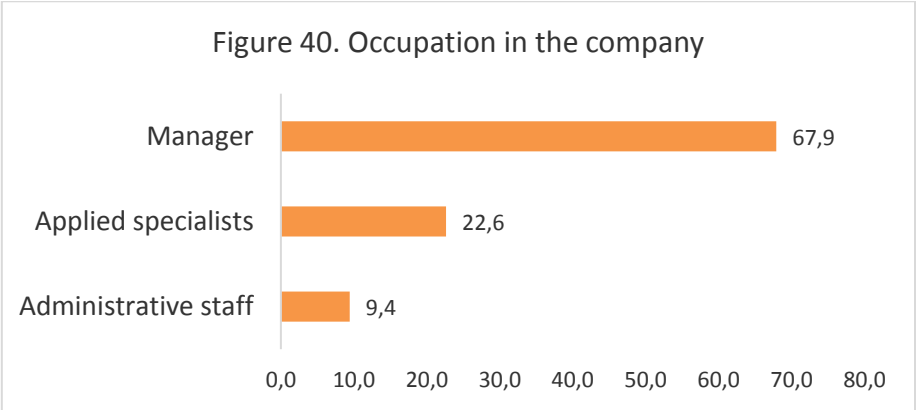




32.7% of the employees in the companies that responded to the survey are aged between 41 and 50 and 22.4% are between 51 and 60 years old. More than half of the employees which participated in the survey are between 41 and 60 years of age and approximately 70% of the respondents are 41 years old or older. 16.3% of the people in those enterprises are 30 years old or younger. 14.3% are aged between 31 and 40 and another 14.3% are 60 years old or above. The aging workforce in the enterprises in the region might be a problem in the medium to long-term perspective. That issue emphasizes the need of attracting younger workers to the sector.



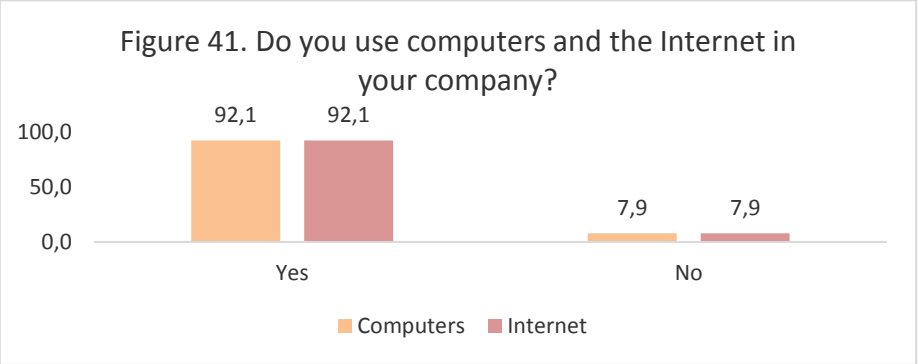
The majority of the employees (60.4%) indicate that they have graduate degree. 30.2% of the respondents have completed their education in vocational schools. 5.7% and 3.8% have graduated secondary or lower secondary school respectively.



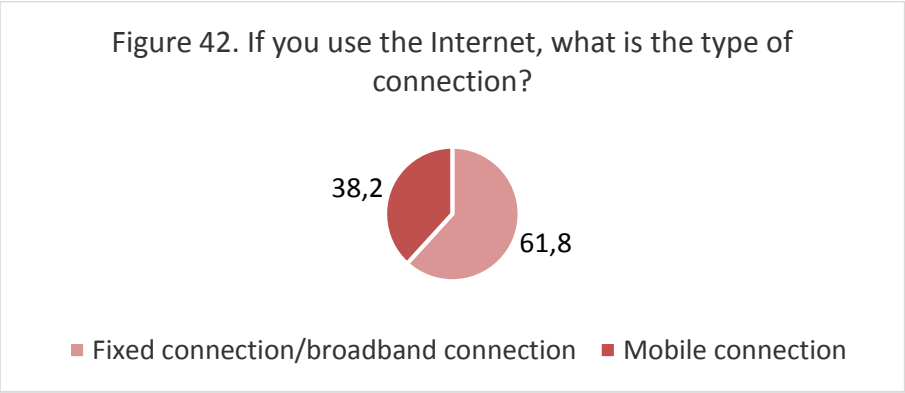
Since one of the requirements of the conducted survey was that it had to be completed by the manager of the enterprise, most of the answers collected (67.9%) were those of the chief executives of the companies. 22.6% of the questionnaires were filled by applied specialists and 9.4% of them - by administrative staff. Consequently, the

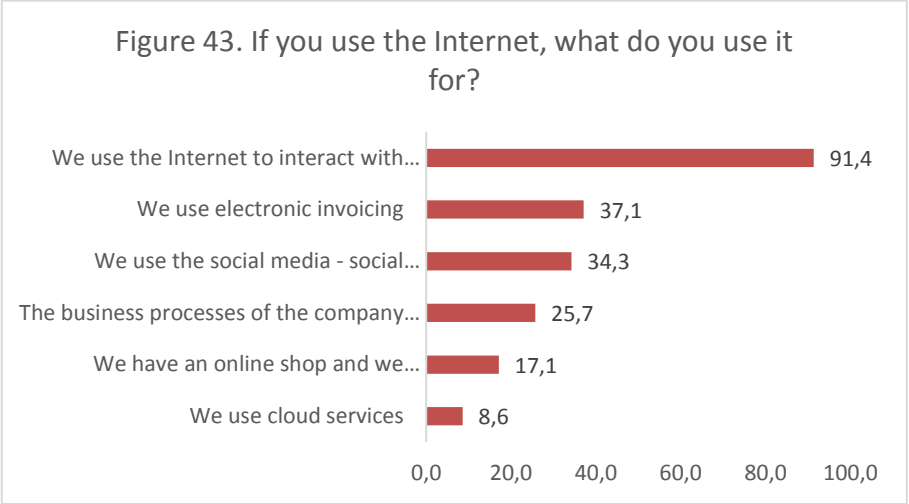
views expressed in the survey are predominantly those of the managers of the companies.

Usage of the Internet

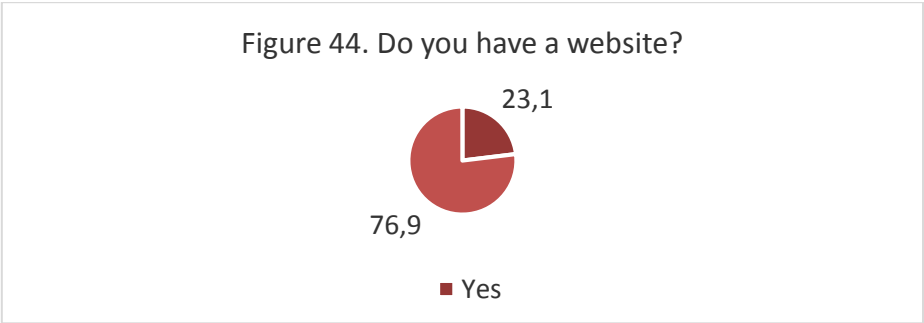


92.1% of the companies in the regions of Blagoevgrad and Kyustendil in the observed sectors use both computers and the Internet. In addition, 61.8% of the businesses that use the Internet have a fixed or broadband connection. The rest of the responding companies use mobile connection.





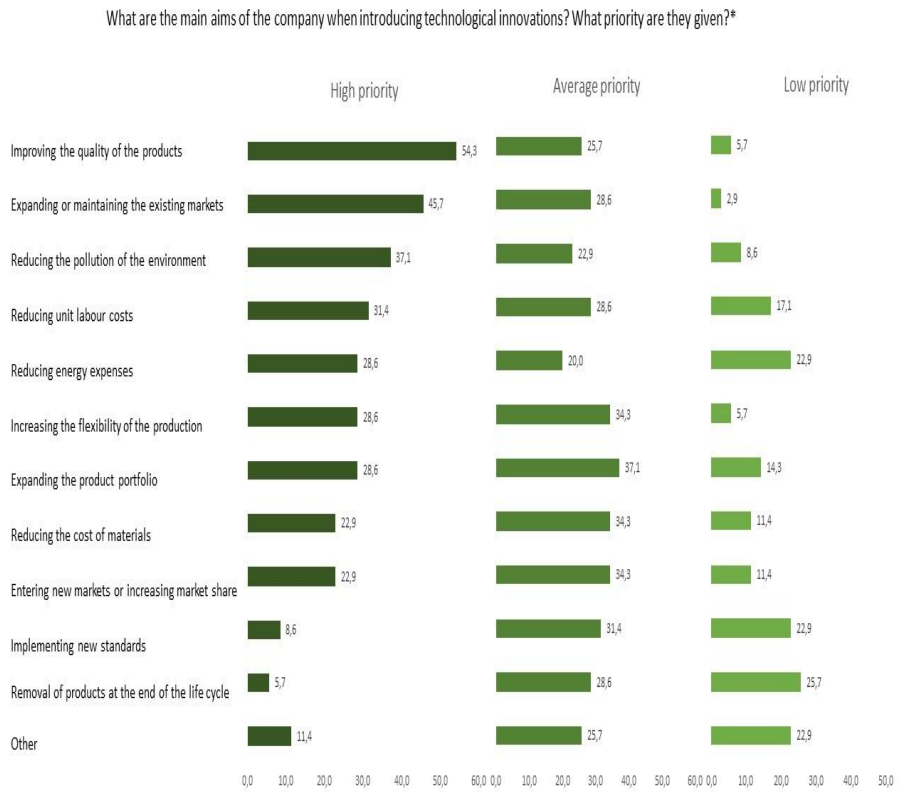
The main usage of the Internet for the companies in the observed sectors is to interact with public institutions (91.4% of the enterprises do so). 37.1% of the businesses in the survey use electronic invoicing and 34.3% use the social media (including social networks, blogs, multimedia sharing websites and others). 25.7% of the entities report that their business processes are automatically related to their suppliers or customers. Online orders through an online shop are received by 17.1% of the enterprises. 8.6% of the companies in the region use cloud services.



76.9% of the companies participating in the survey do not have their own website. The online presence of the enterprises might increase their sales and their position on the market.

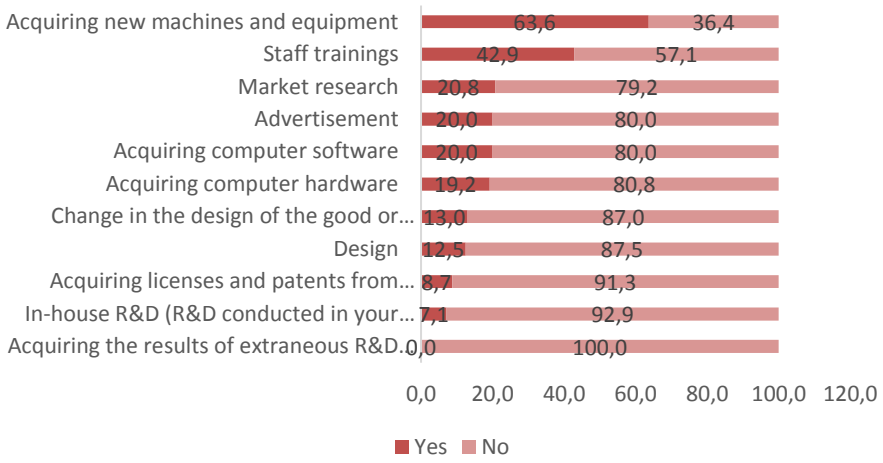
Innovation

When introducing technological innovations, companies give highest priority to the aim of improving the quality of the products (54.3%), followed by expanding or maintaining the existing markets (45.7%) and reducing the pollution of the environment (37.1%). Lowest priority is given to removing products at the end of the life cycle (25.7%), reducing energy expenses (22.9%) and implementing new standards (22.9%).



*The difference to 100% for each of the aims is completed by those who give no priority.

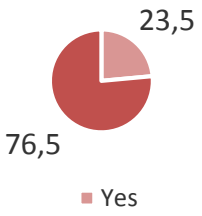
Figure 46. Has your company invested in any of the following activities in the period 2014-2016?



Companies in the observed sectors in the regions of Blagoevgrad and Kyustendil have invested in acquiring new machines and equipment (63.6%), staff trainings (42.9%), market research (20.8%), advertisement (20%) and acquiring computer software (20%) in the period 2014-2016. 91.3% of the enterprises that answered the questionnaire have not acquired licenses and patents from other companies or organisations. In-house R&D was conducted in only 7.1% of the surveyed business entities. None of the enterprises which participated in the survey have acquired the results of R&D coming from other companies, universities or educational institutions. The results from the survey show that the businesses prioritized their investments so as to ensure the efficient functioning of the machinery and equipment and the productivity of the workforce. Obtaining information on the market and advertising were also important to some of the companies, along with acquiring computer software and hardware.

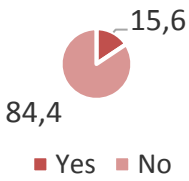
Product Innovation

Figure 47. Has your company introduced technologically new or modified products in the last three years?



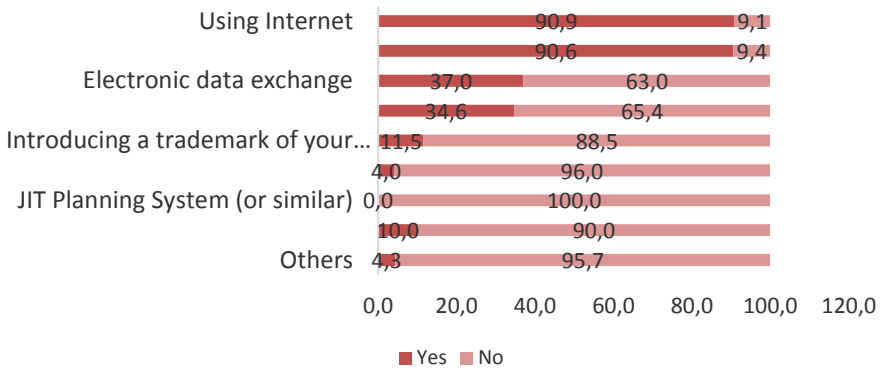
As indicated above, the innovation level in the observed sectors is relatively low. This is shown by the statistics of new product introductions. Technologically new or modified products have been introduced to the market by 23.5% of the surveyed companies in the last three years. The companies that introduced technologically new or modified products have created or modified them themselves. **(related to Q26 How was the technologically new or modified product acquired).**

Figure 48. Has your company introduced technologically new or modified products, which are also new to the market, in the last three years?



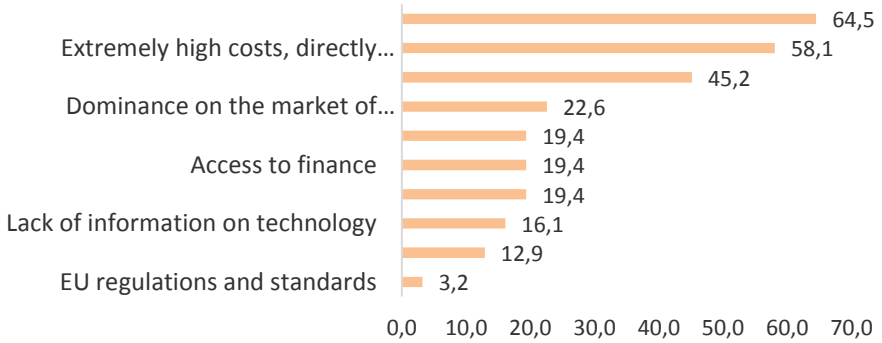
15.6% of the companies which took part in the questionnaire have introduced technologically new or modified products which are also new to the market.

Figure 49. Has your company implemented the following organisational changes or new management techniques in recent years?

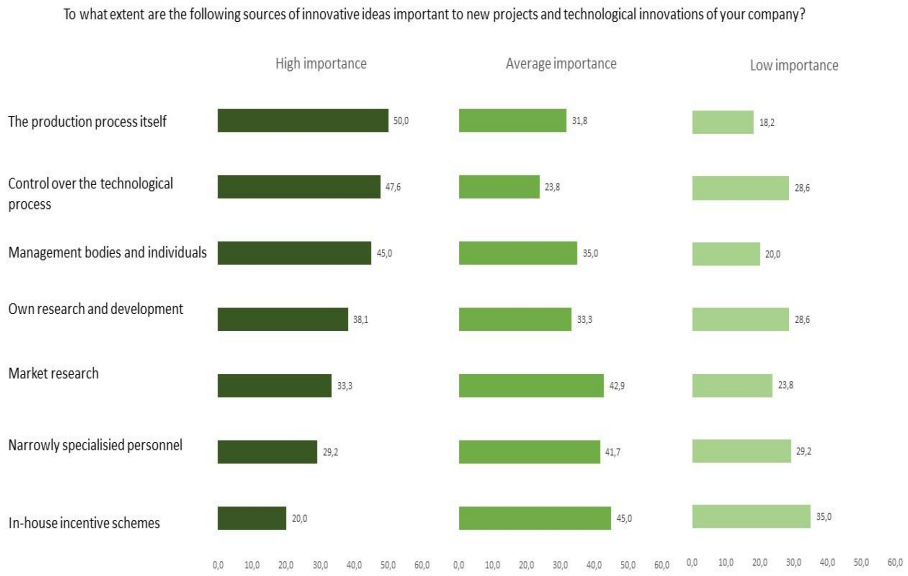


There is a tendency towards digitalizing the organizational processes in the businesses in the observed sectors. 90.9% and 90.6% of the companies that participated in the survey have introduced using the Internet and using e-mail in recent years. Electronic data exchange and investing in the development of the staff were among the other organisational changes implemented by 37% and 34.6% of the enterprises respectively.

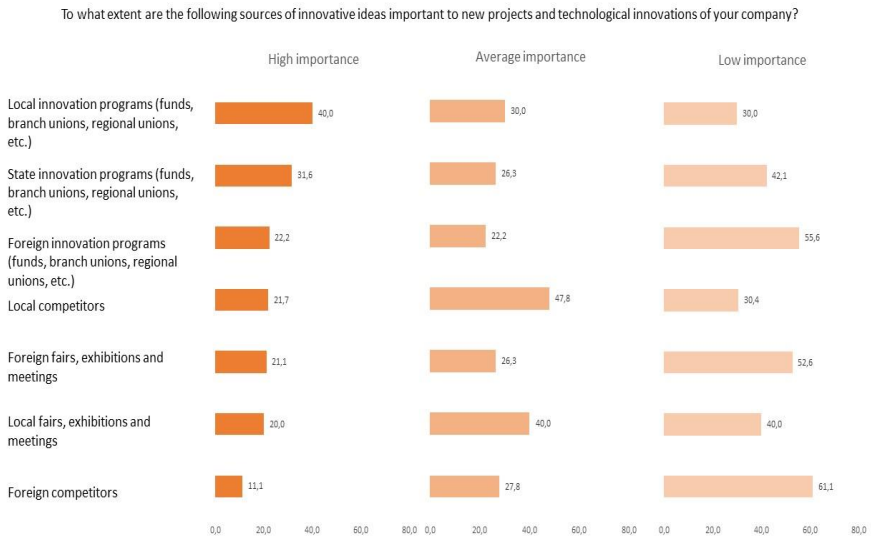
Figure 50. Which were the obstacles to innovating in your company during the period 2014-2016?



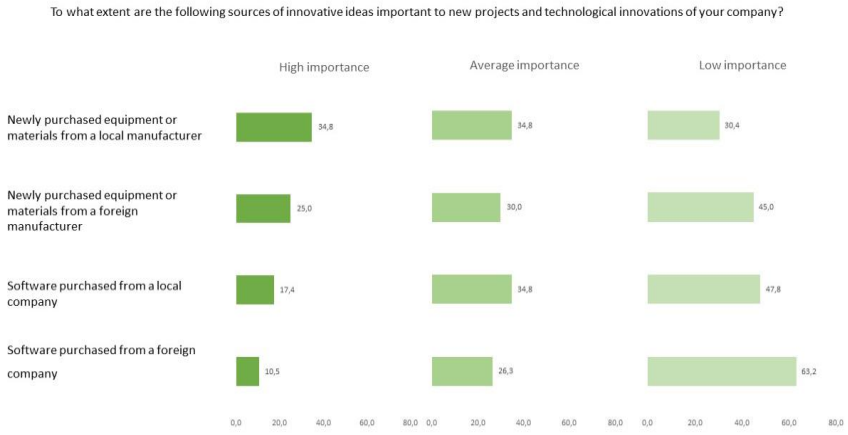
The biggest obstacles which the companies in the observed sectors in the regions of Blagoevgrad and Kyustendil are facing when it comes to innovation are the cost of financing and the extremely high costs directly related to innovations (64.5% and 58.1% of the enterprises respectively point those as the greatest obstacles to them). The lack of qualified workforce is identified as a problem in relation to innovating by 45.2% of the businesses. EU regulations and standards are not perceived as an obstacle by the majority of the surveyed companies (3.2% indicated that these are the biggest obstacles to innovation).



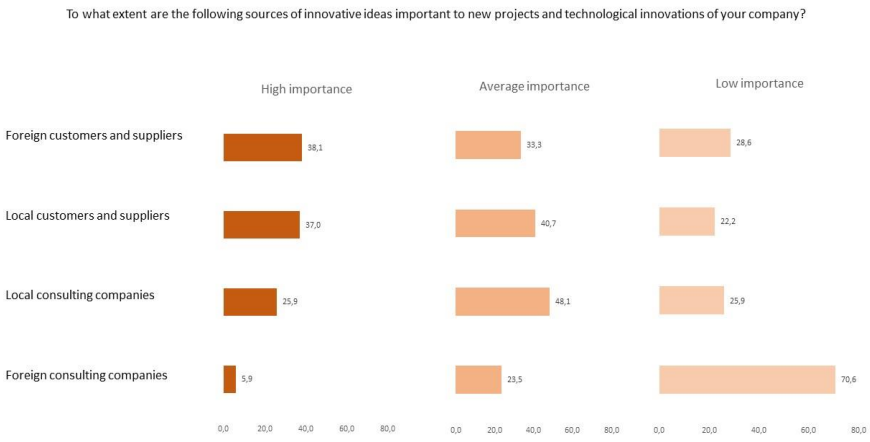
The production process itself (50%), the control over the technological process (47.6%) and the management bodies and individuals (45%) are regarded as the sources of innovative ideas with highest importance to new projects and technological innovations of the companies. Innovative ideas of low importance are in-house incentive schemes, own research and development and narrowly specialized personnel: 35%, 28.6% and 29.2% of the companies respectively pointed out those as factors of low importance.



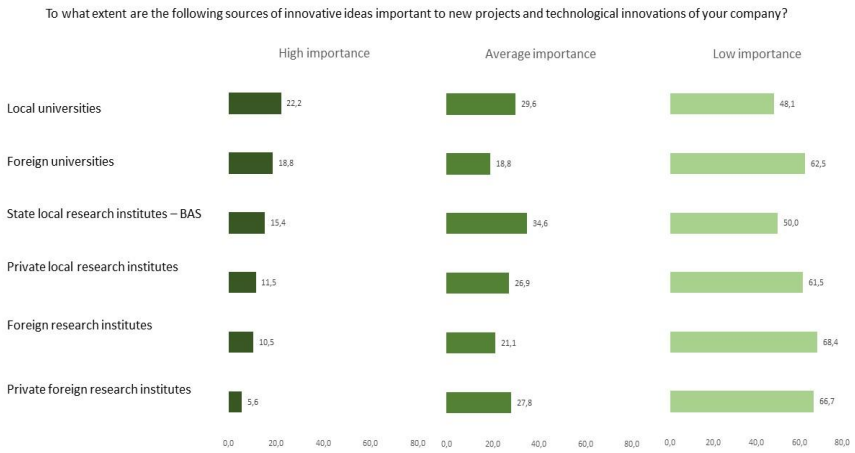
Local and state innovation programs (funds, branch unions, regional unions, etc.) are important sources of innovative ideas to businesses. 40% and 31.6% of the surveyed enterprises indicate that those sources of innovative ideas to new projects and technological innovations of the companies are of high importance. Foreign competitors, foreign innovation programs and foreign fairs, exhibitions and meetings are stated to be of low importance when it comes to innovative ideas which are essential to new projects and technological innovations in the companies.



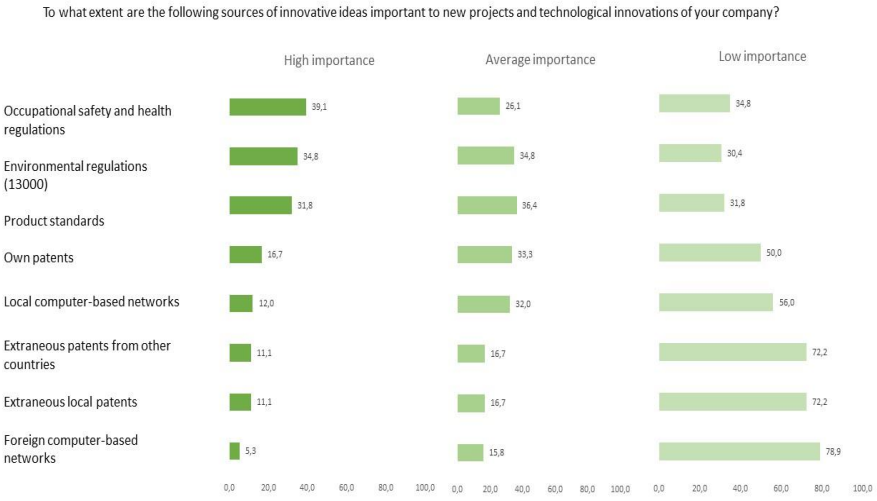
Newly purchased equipment or materials from local manufacturers are regarded as sources of innovation which are highly important when new projects or technological innovations are developed in companies (34.8% of the companies state that this factor is of high importance to them). On the contrary, newly purchased equipment or materials from foreign manufacturers are seen as factors of low importance, according to 45% of the surveyed businesses. So is software purchased from local companies (47.7% of the enterprises say it is a factor of low importance to new projects or technological innovations) or foreign companies (63.2%).



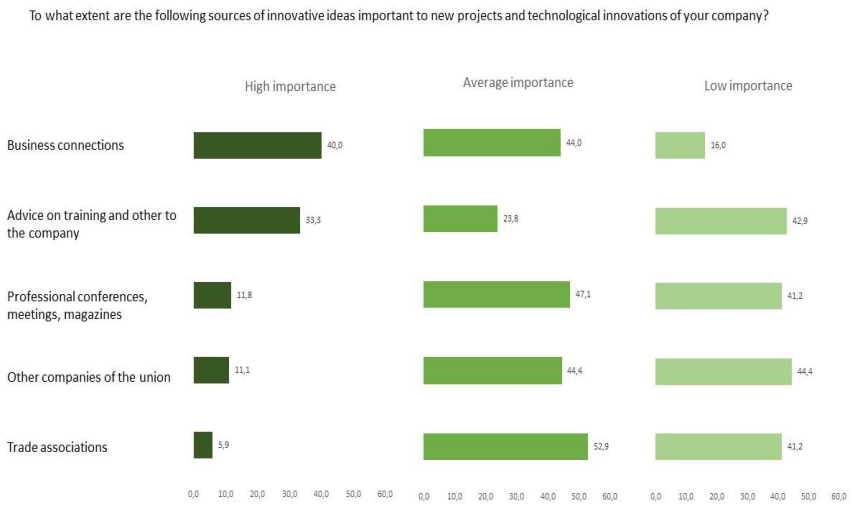
Foreign customers and suppliers as well as local ones are among the highly important sources of innovative ideas to new projects and technological innovations, as regarded by respectively 38.1% and 37% of the companies. Foreign consulting companies are considered to be of low importance to innovative ideas by 70.6% of the surveyed businesses.



Universities and research institutes are of low importance to the innovative ideas of the companies in the observed sectors in Blagoevgrad and Kyustendil, as pointed out by approximately half of the surveyed companies or more.

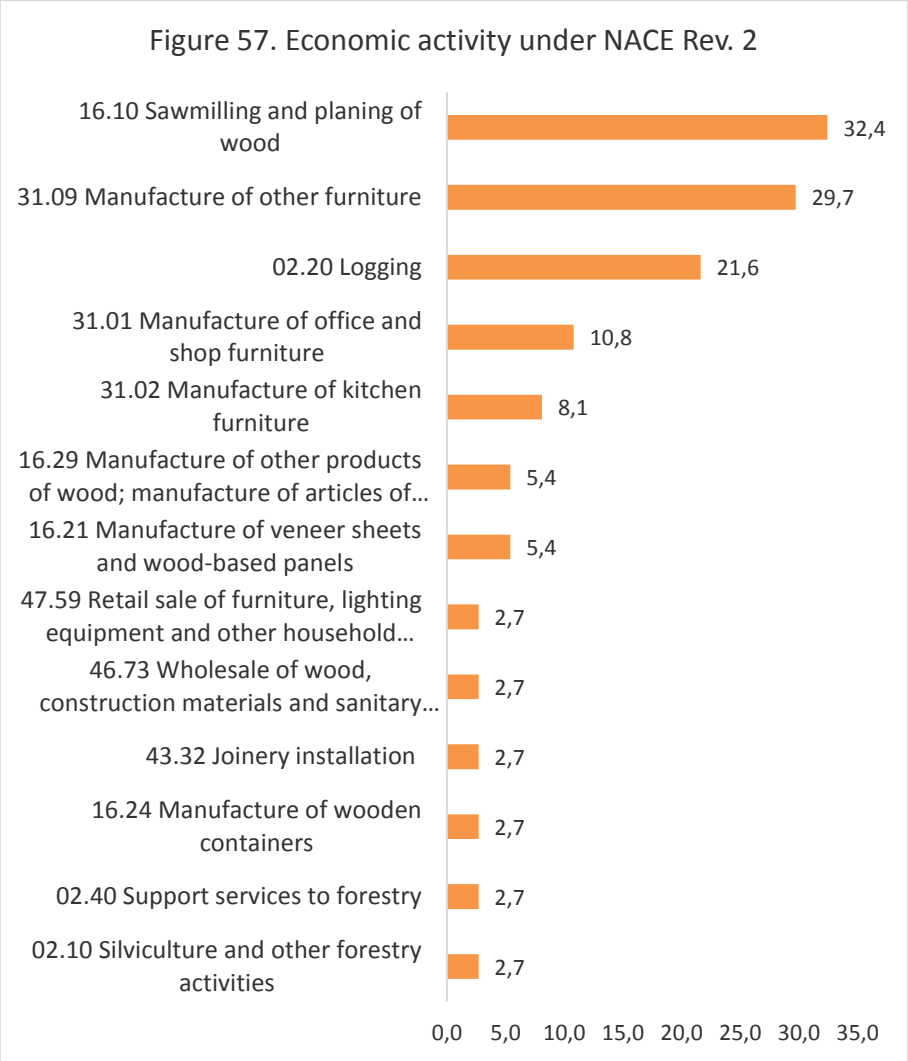


39.1% of the surveyed companies indicated that occupational safety and health regulations are of high importance to the innovative ideas to new projects and technological innovations of the companies. Environmental regulations and product standards were seen as highly important by respectively 34.8% and 31.8% of the businesses. Patents (either own, local or foreign) as well as computer-based networks were regarded as factors of low importance to innovative ideas.



40% of the enterprises state that business connections are a highly important source of innovative ideas and 33.3% share the view that advice on training and other to the company are of high importance to new projects and technological innovations. Approximately 40% of the companies regard professional conferences, meetings and magazines, other companies of the union and trade associations as factors of low importance to innovative ideas.

Presentation of the supply chain



The operations of 32.4% of the companies that participated in the survey fall into the economic activity 16.10 Sawmilling and planing of wood. 29.7% of the businesses are part of the economic activity 31.09 Manufacturing of other furniture under NACE Rev.2 and 21.6% belong to the 02.20 Logging. The activities of the companies in the observed sectors, among others, are also 31.01 Manufacture of office and shop furniture, 31.02 Manufacture of kitchen furniture, 16.29 Manufacture of other products of wood; manufacture of articles of cork, straw and

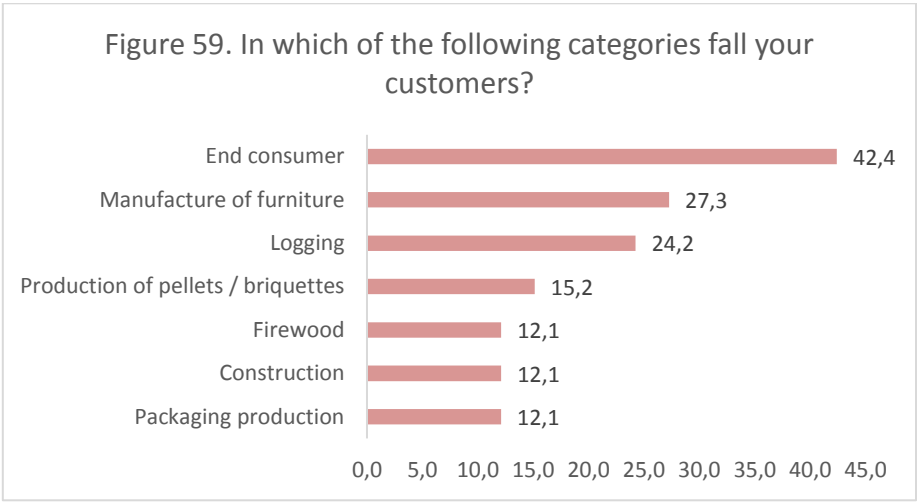
plaiting materials and 16.21 Manufacture of veneer sheets and wood-based panels.

The majority of the enterprises participating in the survey have local suppliers in the territory of Blagoevgrad and Kyustendil. These suppliers are both private companies and state-owned forest holdings. Private companies supplying forestry firms in the region under consideration range from small and medium to large enterprises, leaders in the country and the Balkans. Some companies receive supplies from the Southwest State Enterprise of the Ministry of Agriculture, Food and Forestry. Although less frequently, companies in the divisions concerned say they have suppliers from Macedonia as well. This means that cooperation in the forestry sector between the two countries is relatively weak. Promoting it could lead to greater productivity of the businesses in the monitored regions.

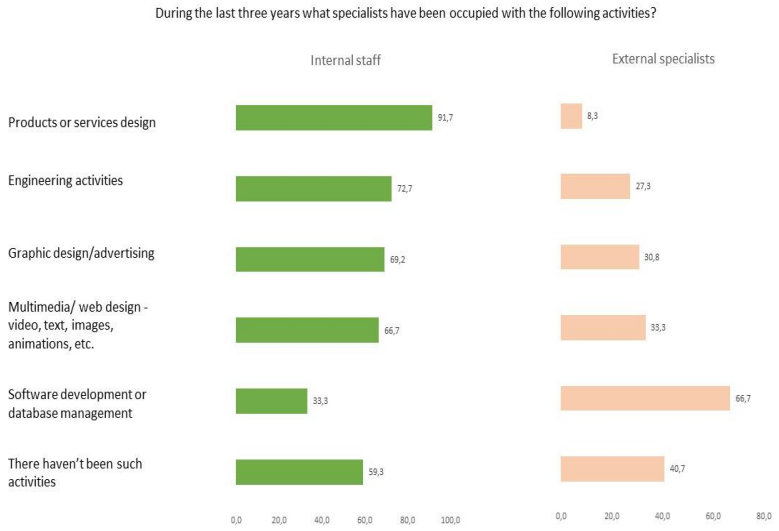
The clients of the forestry companies in Blagoevgrad and Kyustendil are mainly companies or end-users from the region as well as from the whole country. The businesses that export their products abroad are fewer. Most often, exports from the areas under consideration are to neighboring countries, with most of the respondents saying they are exporting the production to Macedonia and Greece. There are also organizations that export to other European countries (Italy) and Asia (China and South Korea).

Cooperation with customers, suppliers and others

10.8% of the companies in the observed sectors in the regions of Blagoevgrad and Kyustendil have customers in Macedonia and 2.9% of the surveyed have suppliers from Macedonia. That numbers might be increased when the cooperation between the border regions of the two countries is stimulated.

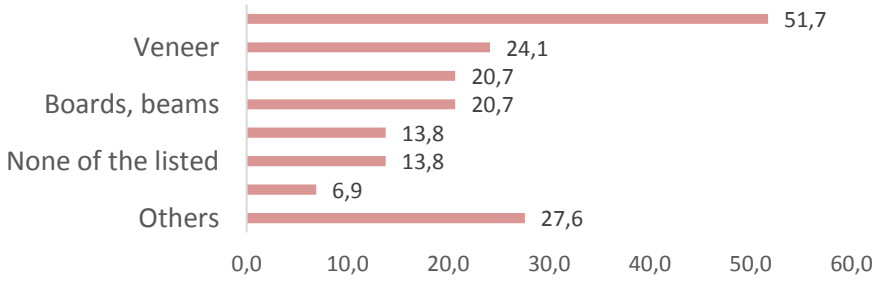


42.4% of the businesses in the observed sectors in Blagoevgrad and Kyustendil produce to satisfy the needs of end consumers. 27.3% of the enterprises supply their products to manufacturers of furniture, 24.2% - to logging companies and 15.2% - to those producing pellets or briquettes. Equal proportions (12.1%) of the surveyed business entities have customers which fall into the categories of producers of firewood, construction or packaging production.



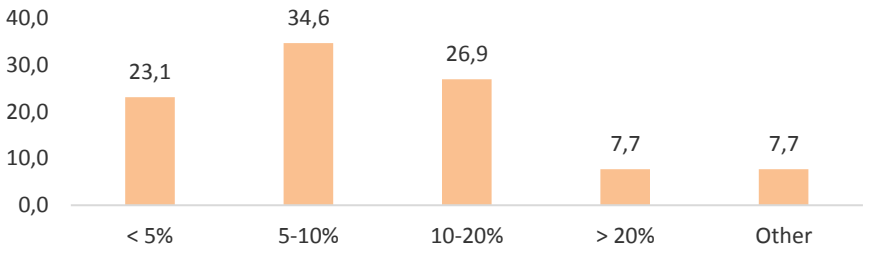
Activities which are typically performed internally in the companies of the observed sectors and regions are the design of products or services (in 91.7% of the enterprises), engineering activities (72.7%), graphic design and advertising (69.2%) and multimedia or web design (66.7%). Software development or database management activities are usually done by external specialists (according to 66.7% of the surveyed companies) 51.7% of the companies in the observed sectors buy logs from their suppliers, 24.1% buy veneer, 20.7% get supplies of wood slabs and another 20.7% - of boards and beams. 6.9% of the surveyed businesses point out that they only buy finished products.

Figure 61. What kind of materials does your company buy from suppliers?



Deliveries and transport

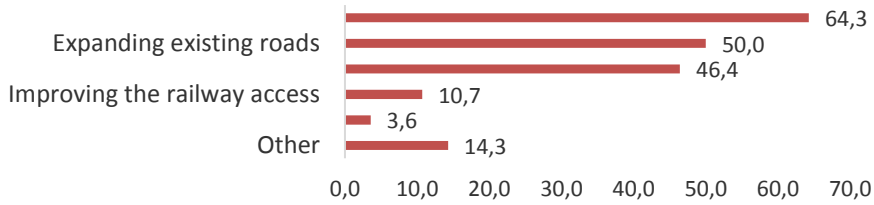
Figure 62. Delivery costs out of the total production volume



34.6% of the companies which took part in the survey responded that their delivery costs equal 5 to 10% of their total production volume. According to 26.9% of the businesses the delivery costs are about 10 to

20% of the total production volume and 23.1% of the enterprises state they are less than 5% of their production volume.

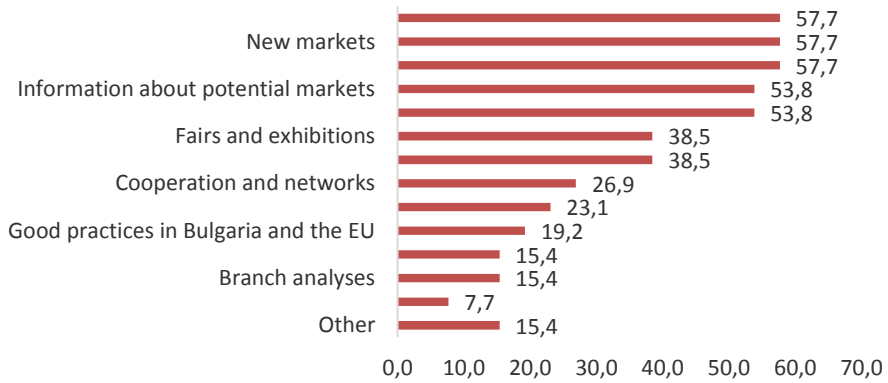
Figure 63. Which of the following infrastructural projects would support the operation of your company?



64.3% of the companies in the observed sectors state that maintaining the existing roads would support their operations. Half of the surveyed enterprises point out that the expansion of the existing roads would contribute positively to the operations of the company. Additionally, 46.4% of the businesses believe building new roads would foster their performance.

Virtual services

FIgure 64. If you had access to a virtual educational platform, what information would you search for?



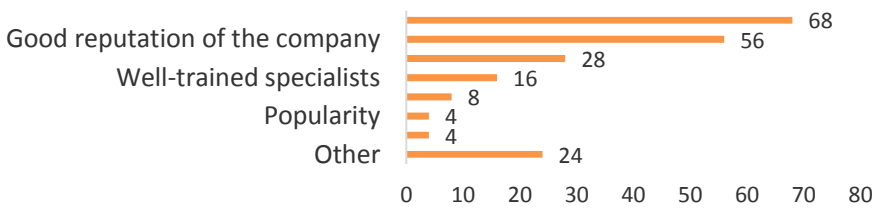
More than half of the surveyed companies indicate that if they had access to a virtual educational platform, they would search for information on new technologies, new markets, innovations in production, potential markets and suppliers. Information about fairs and exhibitions, new raw materials, cooperation and networks and new products would be searched for as well. The enterprises pointed out that they would least search for ICT innovations in such a platform.

Figure 65. If you had access to a virtual consulting office, what information would you search for?

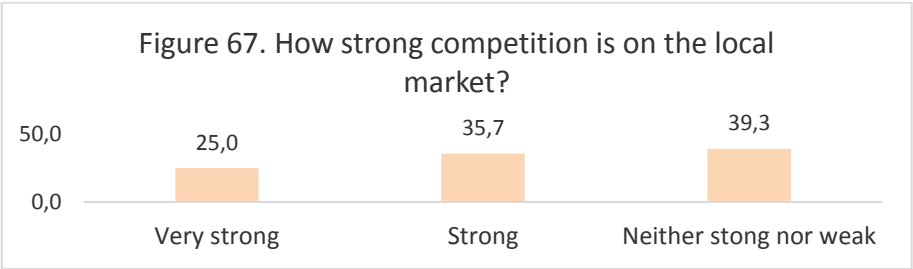
A virtual consulting office would help the majority of the companies in their search for information on business opportunities and external markets, EU projects and programmes, Bulgarian legislation and standards and certifying. Patents and the procedures of buying or registering a patent are among the topics of least interest to the companies in the observed sectors in Blagoevgrad and Kyustendil.

Competitiveness

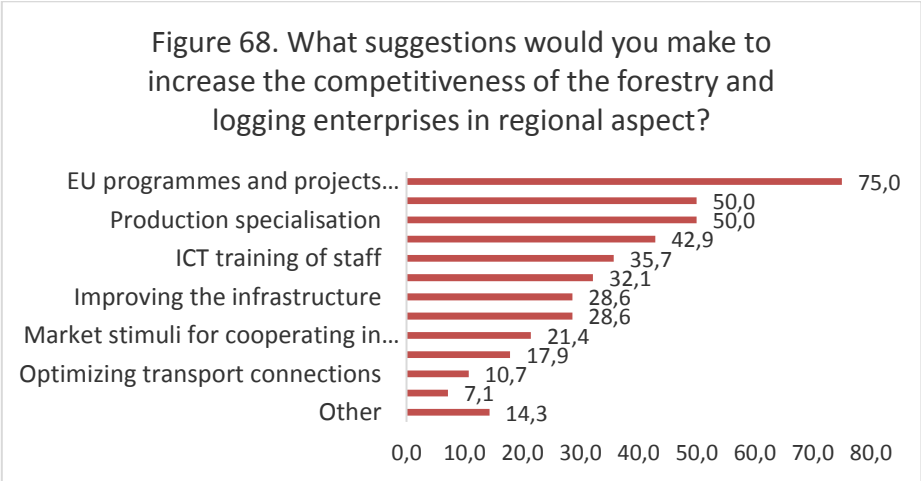
Figure 66. What do you think your competitiveness is based on?



68% of the companies that participated in the survey state that their competitiveness is based on the quality of their production and 56% of them regard the good reputation as a factor which makes them more competitive. The cheap labour is what stands behind the competitiveness of 28% of the surveyed companies, according to their staff. The well-trained specialists, the cheap natural resources, the popularity of the company and the inexpensive transport are not seen as competitive advantages by the enterprises in the observed sectors.



When it comes to competition on the local market, 39.3% of the enterprises regard it is neither strong nor weak. Thus, people in the observed sectors are inclined to believe that the power of competition of medium strength. 35.7% of the companies state that their competitors locally are strong and 25% - very strong.



In order to identify what could enhance the competitiveness of the observed sectors in the regions of Blagoevgrad and Kyustendil, the survey studied the suggestions of the respondent companies. Most important to improving the regional competitiveness of the forestry and logging enterprises is the participation in EU programmes and projects. 75% of the organisations share that view. Half of the surveyed businesses state that the quality of the production should be improved and that production should be specialized. 42.9% of the entities respond that the production processes should be improved and automated in order to increase the competitiveness of the forestry and logging sectors in the regions of Blagoevgrad and Kyustendil. ICT training of the staff and a more varying assortment of products are believed to foster the competitiveness as well. Optimizing the transport connections and the implementation of environmentally-friendly standards are seen as the factors which would contribute the least to companies becoming more competitive.

4.3 CONCLUSIONS

In contrast to Europe where after the crysis a process of consolidation of companies along the global supply chains is going on based on introduction of new technologies, the two regions surveyed are still characterised by fragmentation. This is a barrier to innovation modern developmet of the sector after the crysis the forestry based supply chains.

Developing and managing a supply chain in forestry is a solution to overcome recommended by many organizations. The Supply-Chain Council, a global trade consortium in operation with over 700 member companies, governmental, academic, and consulting groups participating in the last 10 years, manages the Supply-Chain Operations Reference (SCOR), the de facto universal reference model for Supply Chain including Planning, Procurement, Manufacturing, Order Management, Logistics, Returns, and Retail; Product and Service Design including Design Planning, Research, Prototyping, Integration, Launch and Revision, and Sales including CRM, Service Support, Sales, and Contract Management which are congruent to the Porter framework.

The conditions to meet size structure challenge include:

- improving forest management; improvement of technologies;
- improvement in management;
- improvement of policies
- improvement of scientific information database;
- sustainable consumption.

On the firm level such conditions concern application of standards for business exellence among which are the Supply Chain Operational Refenece (SCOR) the newly launched Design-Chain Operational Refenece (DCOR).

Incorporating the understanding for challenges and solutions for intensifying SMEs business networks in tools like a virtual office for forest industry support (VOSIF) and a virtual educational platform (VEP) could contribute to increasing competitiveness of the cross-border cooperation, in our case - between Bulgaria and FYROM.

Acknowledgements

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5. INNOVATIVE IDEAS FOR IMPROVING ATTRACTIVENESS OF FORESTRY SECTOR FOR WOMEN (SURVEY RESULTS)

Rossitsa Chobanova, Daniela Georgieva

Employment of women is an important source for development of each economy. The specifics of attractiveness of such employment in forestry sector are affected by many factors. Here the focus is on the impact of gross national minimum wage of women employed in forestry in Bulgaria, minimum monthly insurance income, work in forestry and maternity leave, education and training of women working in the forestry sector in Bulgaria.

5.1 EMPLOYMENT OF WOMEN IN FORESTRY SECTOR IN BULGARIA

In 2015 the employment rate among men and women especially at the age between 20 and 64 years in Bulgaria is 67.1% (Employment rate, age group 20-64, European countries [Data file]. Retrieved from http://ec.europa.eu/eurostat/web/europe-2020-indicators). A priority objective of Bulgaria is to increase the employment rate of people at the age between 20 and 64 years, up to 76% by 2020 (Europe 2020: National reform programme, 2015, p. 49). To do that for each year from 2015 to 2020 the considered ratio should mark an annual growth of approximately 1.58 percentage points. It should be noted that for the period 2000 - 2015 the highest percentages of employment rate are recorded in 2008 (70.70%) which has dropped after the economic crisis of 2008.

In 2015 the number of employed women in Bulgaria is approximately 9 percentage points higher than the number of employed men. Such kind of data could be considered as positive when it comes to the participation of females in the labor market. When it comes to forestry sector the employment of women differs from the general employment in the economy (Chobanova & Georgieva, 2017). It could be noted that although at national level there is overall improvement in employment rates, the data for the forestry sector indicates lower activity in the labor market. This could be due to:

- Different payment and minimum monthly insurance income of women employed in forestry.
- Activities that could be harmful for the health of females.
- Different working conditions and social status of females in forestry sector that have come back from maternity leave.

- Level of education.

Here we characterize some of these factors.

5.2 GROSS NATIONAL MINIMUM WAGE OF WOMEN EMPLOYED IN FORESTRY IN BULGARIA

There is a common understanding, supported by several arguments that there is a positive correlation between women's participation in the labor market and the payment they receive (Cuberes & Teignier, 2011, p. 9). Women that are employed in the forestry sector mainly relay on the gross wages that are specified in their employment contracts (Chobanova & Georgieva, 2017). A significant influence over the formation of the contracted gross wage have the minimum wage for the country per year and the minimum monthly insurance income by professions and positions per year.

There is a tendency of increasing of annual average women wages in forestry during the period 2010-2015 (See Fig.1). This is due to the fact that the gross national minimum wage regulates the minimum amount of salary, which women employed in the forestry sector must receive as remuneration. As a result of changes in economic, political and social level, the amount of the minimum wage (for all professions and positions in the country) increases annually and in 2017 it is 460 BGN (around 235 EUR). This as well is a factor that affects the increasing income of employed women in the forestry sector.

On a legal point of a view our legislator gives the right to equal payment of males and females (Labor code, 2016, art. 243).). The pointed by some authors pay gap between men and women working in the forestry sector in Bulgaria (Cuberes & Teignier, 2015, p.1; Revenga & Shetty, 2012, p. 40-43), was confirmed for the further period. The average annual wage of women for 2010 were 13% less than those of man and 17% less in 2015. It could be noted that the average annual wage of women employed in the sector in 2010 is 5196 BGN (around 2658 EUR) and in 2015 is 7608 BGN (around 3893 EUR). The average annual wage received by the men in the sector in 2010 is 5978 BGN (around 3058 EUR) and in 2015 is 9133 BGN (around 4671 EUR).

The pay gap between men and women working in the forestry sector in Bulgaria has been increased (see figure 1).

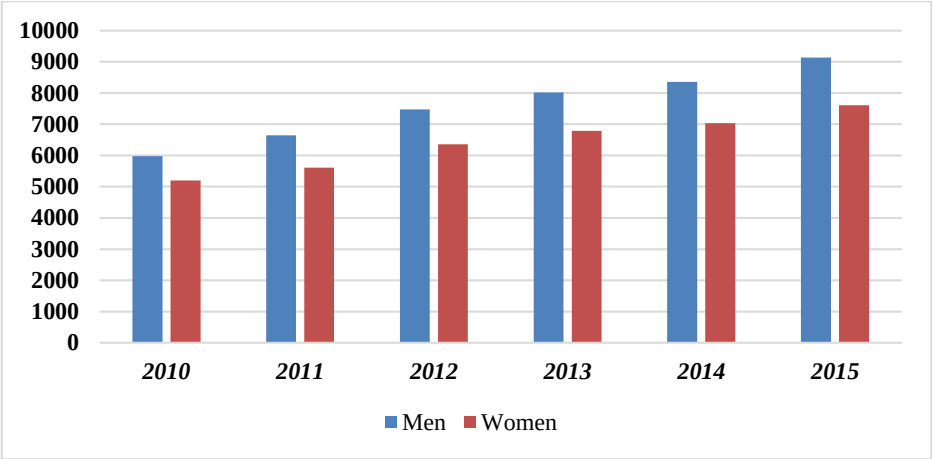

Figure 1. Average annual wages of men and women employed in sector "Agriculture, forestry and fishing", 2010-2015, in BGN
Source: calculated using data from National Statistical Institute, 2016

As main reasons for the existence of such gap the following factors were identified in EU. (Tracking the gender pay gap in the European Union, 2014, p. 5-7):

- the presence of discrimination on the workplace;
- different working tasks that are given to men and women;
- various practices that employers provide to men and women regarding their career development and skill trainings;
- underestimation of the skills women can develop or already have;
- the opportunities women to reconcile work and family responsibilities.

When it comes to remuneration in forestry sector in Bulgaria, the collected and analyzed data from the survey showed that, there is a hesitation in the satisfaction level of the wages female receives. Women do not fully agree that the remuneration corresponds to the work they do and their qualifications and skills. They expressed dissatisfaction with the way wages are formed in forestry as general. The surveyed women agreed that additional remuneration would motivate them to make more efforts in fulfilling their work duties.

It must be noted that there is no significant deviations from the way of forming the wage of employees working in the forestry sector compared to other economic sectors in Bulgaria. But employees in the forestry sector those are receiving additional remunerations for working overtime and on Sundays are almost twice less than the country's total number of people receiving additional payments (Stefanova - Bogdanska, 2014).

5.3 MINIMUM MONTHLY INSURANCE INCOME OF WOMEN EMPLOYED IN FORESTRY IN BULGARIA

Among the most important reasons/factors that influences the surveyed women to choice a position in the forestry sector, besides the need of a job, it is the minimum monthly insurance income for the position itself. It is so because the minimum monthly insurance income serves as a basis for calculating the compulsory and voluntary contributions that are made for and by the insured person. Social security contributions have an important role for the representatives of female sex in determining the amount of compensations that must be paid by the National Insurance Institute in terms of general sickness and maternity leave.

According to the surveyed women the minimum monthly insurance income is high in the forestry sector. If we analyze that statement on the basis of annually changes of the minimum insurance income it is relevant, because for the period 2010 - 2017 there is an increase among all qualifying groups of professions employed in forestry sector (Chobanova & Georgieva, 2017). This increase is largely due to changes in the minimum wage during the years. If we analyze the changes of the indicator only between the groups of professions employed in the forestry sector it could be seen that for forestry jobs that do not require special qualification from 2010 to 2013 (inclusive) the amount of minimum monthly insurance income is higher than the amount of gross national minimum monthly wages for the same period. From 2013 to 2017 (inclusive) both indicators are aligned (see table 1).

For the period 2016 - 2017 the amount of the minimum monthly insurance income for skilled workers (not including managers) in forestry is equivalent to that of the country minimum wage. In this basis, the legislature introduces equal insurance relations for the qualified and non-qualified staff (Social Security Fund Budget Act, Appendix № 1 to Art. 9, para. 1, p. 1, by years). This could be pointed as a negative factor affecting the attractiveness of the sector when it comes to women employment.

The difference of the data from the legislative analyzes and the survey results can be explained with the fact that 67.9 % of the respondents are managers. In this respect it could be pointed the minimum monthly insurance income of the managers in forestry for 2017 is approximately two times higher than the gross national minimum wage for the same period. In addition the insurance income is in a direct link to the wage of the employed person.

Table 1. Minimum monthly insurance income in forestry, 2010 – 2017, in BGN

Years	Managers	Specialists	Technicians and associate professionals	Administrative support	Employed in public services, trade and security	Skilled workers in agriculture, forestry, hunting and fishing	Qualified workers and crafts men	Machinery operators and assemblers	Professions that do not required special qualifications
2010	621	444	392	380	320	352	392	397	270
2011	655	466	412	400	336	370	411	457	283
2012	684	487	431	418	351	387	429	478	296
2013	700	500	450	430	390	400	440	490	320
2014	750	525	472	451	400	400	450	490	340
2015	780	546	491	469	416	416	468	510	360
2016	900	620	530	480	450	420	520	500	420
2017	900	620	530	480	460	460	520	500	460

Source: Collected from Social Security Fund Budget Act, Appendix № 1 to Art. 9, para. 1, p. 1, per years

The low rates of the minimum insurance income for the qualified (not including managers) and non-qualified female staff in forestry enterprises have negative effects to maternity leave and the opportunities for raising a child. In order to increase female participation in the labor market in the forestry sector, it is appropriate and helpful to increase the minimum insurance income and to bind it to the qualifications of employees. This could help women towards reconciling work, private life and motherhood.

5.4 WORK IN FORESTRY AND MATERNITY LEAVE OF WOMEN IN BULGARIA

It is believed that parenting has a significant impact over female employment (Country report Bulgaria, 2016, p.38), which is a factor that has strong impact on the productivity and competitiveness of the forestry enterprises. In Bulgaria for the period 2007-2014 the percentage of women who are not working due to maternity leave or to take care of elderly has increased by 5 percentage points (Labor force participation

of women, 2015, p.15.). However, in 2014 employed women in Bulgaria between 20 and 49 years old who have children under the age of 6 are approximately 13.5 percentage points less than employed women without children. This data is above the EU average percentage for the same period (13.2%) (Labor force participation of women, 2015, p.4). In this regard, women who participated in the survey shared concerns about reconciling job tasks and their family's duties. More concretely, women experience difficulties when taking care of their children and working at the same time. Another fear that a surveyed woman shared is the possibility of having to return to work before using the entire maternity leave. Because of the specific of the work tasks in the forestry sector, reproductive behavior of women should be taken into account as well when it comes to the factors indirectly affecting competition on the labor market (Gencheva & Marinova, p.70). This behavior is mainly connected to concerns over the negative impact of workflow and working conditions on the embryo (fetus). In this regard when it comes to risks and factors affecting the health and reproductive performance of women in the forestry sector, the following factors are very important for the females that participated in the survey (see table 2):

- wood dust;
- outdoor work;
- unfavorable microclimate (temperature, humidity, air velocity);
- biological agents (microorganisms, parasites, bacteria and viruses) and forest animals;
- prolonged walking and/or standing on forest terrain.

As factors that have little or no influence on the state of females' health the surveyed women pointed electricity; static electricity, fire hazard and radiation (ultraviolet, infrared, laser, ionizing).

In accordance to the European legal framework (Council Directive 2010/18/EU), Bulgarian legislation defines the pregnant women and mothers as a risk group, providing them specific legal protection. In this regard female employees in forestry sector have the right to leave for 410 days due to pregnancy and childbirth for each child (Labor code, article 163). It should be noted that there is a risk of loss of skills and competencies related to protracted maternity leave (European Commission 2013 Employment and Social Developments in Europe; Organisation for Economic Co-operation and Development [OECD], 2012, Closing the Gender Gap).

When it comes to the activities that females must conduct in forestry jobs it should be noted that main risks affecting the health and reproductive performance of women, according to the surveyed, are factors from the outside environment. Therefore, forestry sector in Bulgaria is a sector with a low risk in terms of safety and security for women.

Table 2: Major hazards for the employed women in forestry sector

Danger (type / category):	*Health issues due to the forestry dangers:*
Microclimatic (temperature, humidity, air velocity)	Heat strokes, fatigues and colds
Biomechanical and biological	Physical strains, nervous-mental tension, damages to the bone marrow
Noise (hearing, ultrasonic, infrasound range)	Fatigue and stress, temporary hearing loss, permanent loss of hearing
Electricity, including static electricity	Electrocution burns and unpleasant sensations due to static electricity. Acute effects for the vegetative-vascular system, chronic effects
Thermal (high or low object temperatures)	Thermal burns and frostbite due to fire and explosions
Radiation (ultraviolet, infrared, laser)	Impairment of vision, skin damages, blinding chronic effects
Lighting that does not meet the performance requirements	Visual fatigues, a prerequisite for the emergence of other hazards
Chemical	Burnings, respiratory tract damages, irritations (breathing, skin, eyes)

5.5 EDUCATION AND TRAINING OF WOMEN WORKING IN THE FORESTRY SECTOR

Generally the level of the education in forestry sector is lower than in others. Its improvement is a component of policy target on EU and national level. By 2020 40% of all women and men in Europe who are at the age between 30 and 34 years should acquire tertiary or equivalent education (Europe 2020 strategy for smart, sustainable and inclusive growth, p.13). For Bulgaria the target is 36%. It should be noted that in 2016 the percentage of women and men who are at the age between 30 and 34 years and have tertiary or equivalent education is 33.4%, which marks a positive trend. The performance of education in forestry sector differs from the national level according to Eurostat. The data shows that women who are employed in the forestry sector in Bulgaria have low level of education and skills (Chobanova & Georgieva, 2017). In this respect the impact of this factor could not be defined as positive for improving competitiveness in the forestry sector. Overcoming this state of the art could be pointed out the lack of specific programs/courses and methods for improving women's skills and their job performances. However we must note that women participated in

the survey do not believe that by increasing the number of common educational trainings will contribute to greater productivity and development of the sector. At the same time women responds that the hardships they experience when trying to combine work tasks with family obligations, another main concern of females working in the forestry sector is their job performance. More precisely they worry about a possibility of a lack of career development and at the same time they do not want to disappoint their employer by dropping down the quality of their work performance. An interesting fact is that even though the surveyed women do not believe in the positive correlation between education and job performance 60.4% of the people participated in the survey stated that they have tertiary education. Such kind of data can lead to the assumptions that the education they have is not appropriate for their job positions or they do not know how to use the knowledge they possess in real working environment. In this respect it is important the trainings and the education which women receive to correspond to the specific needs of the job position as well as the learning style of the person (Georgieva, 2016).

5.6 CONCLUSIONS AND RECOMMENDATIONS

Based on the data collected from the survey and the interviews it could be assuned that there are two main factors that influence the attractiveness of forestry sector towards women in Bulgaria.

The first one is the payment of the respective job position in forestry. In this respect women do not agree with the statement that they receive salary which is responding to the qualification and efforts they make during the implementation of the job tasks. The surveyed fully agree that additional payment would motivate them to make more efforts in carrying out their duties.

The second one is the minimum monthly insurance income. According to the data collected and analyzed from the survey, women take into account this factor when searching and applying for a job position. In this respect women who have positions as managers in forestry are satisfied with the monthly insurance income they have. According to women, working in forestry sector, who are currently on maternity leave, pending their pregnancy and birth, or parents of children up to 6 years old – they receive quite a low maternity compensation because of the low insurance income that were paid for them before the pregnancy.

The data from the survey has shown that women working in forestry sector express desire to remain on their current position and in the same sector. They do not have fears of losing their jobs but they experience a need for constantly proving themselves and showing their

skills at work. The surveyed women do not believe in traditional education as a factor which improves the productivity and development of the sector. But according to women, working in forestry sector, who are currently on maternity leave, pending their pregnancy and birth, or parents of children up to 6 years old – additional trainings are needed especially for women during their maternity leave. In this respect non-traditional long distance learning techniques and online courses could be an appropriate educational form for all workers that must be absent from work for a long period of time. Such trainings must correspond to the specifics of the job position and the learning style of the person. It would be useful a separate survey to be done of the factors that lead women to disagree about the positive correlation between education and the sectoral productivity.

Based on the conducted individual interviews with women, working in forestry sector, who are currently on maternity leave, pending their pregnancy and birth, or parents of children up to 6 years old, some measures could be suggested:

1. Employers to provide childcare facilities to their employees, which have an easy access and are not expensive. Childcare services in the country are underdeveloped and expensive, and only 11% of children under the age of 3 attend kindergartens for more than 30 hours per week (Country report Bulgaria, 2016, p.38). This is 23 percentage points below the target of the European Council in this area and could negatively affect over women participation in labor market (Chobanova & Georgieva, 2017).
2. Employers to provide flexible working hours to women when the maternity leave is over and the mother must return to work. This is a legislative right (Labor code, article 167, p. b) which aims to help mothers throughout the adaptation process from maternity leave to perform well on their jobs. However, part-time work is not a common practice in Bulgaria and less than 5% of employees do not work full-time jobs (Labor force participation of women, 2015, p.5). It should be noted that there is no data from the conducted survey that showed women to be well aware of this right.
3. Employers to transfer females that have returned from maternity leave to suitable job where there is no outdoor task to participate in. Once again this is a legislative right that the surveyed group of women stated is aware of. But the conducted survey showed no data of women who take advantage of this right.
4. Improving women job skills and qualification by providing virtual trainings during the maternity leave or just before the leave ends. As a supplement of the virtual office activity an electronic platform for distance learning (VEP) will be developed. By using the platform any person will be able to gain information about the forestry sector and capacities in the eligible area. VEP will provide information

about the recent novelties and innovations in the world, needed by target he t group of the region. The educational platform will be constructed according to the best EU and world practices and to requirements of the target group. The platform will provide respective information on the sector, the main activities, the needed skills, the possibilities for start-ups, the development of women in the forestry and so on. All needed courses will be developed according to the requirements extracted from the analysis of the data collected during the first activity, but also will take into account existing good practices. An expert will be hired to prepare specific skill development lessons for women. For the development of the platform, first, the requirements of the VEP will be concretized. After this step, follows a clarification of the technical and functional characteristics and selection of proprietary e-learning systems. Furthermore, in the next step an e-distance learning platform will be set and tested. Finally, all information included in the platform will be translated in Bulgarian and Macedonian by using a licensed translator.

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6. THE VALUE OF SAWMILL WOOD BY-PRODUCTS EXAMPLE FOR CONVERSION INTO PELLET, WOODEN BRIQUETTES AND ENERGY IN COMPARISON WITH THE PRICES OF UNPROCESSED MATERIAL – THE CASE OF POLAND

Leszek Wanat, Elżbieta Mikołajczak, Jan Chudobiecki

6.1 INTRODUCTION

The competitive position of the Polish wood industry is relatively strong. It is an effect of domestic forest resources, the quantity and quality of round timber acquired from the national resource base, as well as continually growing significance of wood-based products in global production and trade [Bergen et al. 2013, Ratajczak 2013]. Despite the imbalance in the Polish wood- and wooden products market and the deficit of the wood raw material (a permanent phenomenon being an effect of the application of the principles of sustainable forest management), there is no threat for the development of wood-based industries in Poland [Wanat and Lis 2009, Chudobiecki and Wanat 2015]. The following factors have a decisive impact on that: dynamic increase of demand for wood, fashion for wood and popularity of wood as an environmentally and human friendly raw material [Wanat 2009, Kaputa, Paluš and Vlosky 2016]. A study of intersectoral cooperations – as potential factors of development – seems justified with reference to the wood-based sector, especially owing to its territorial dispersion [Chudobiecki et al. 2016].

The Polish wood industry plays an important role for the development of the national economy. The most important sectors based on wood include: sawmill industry, furniture industry, cellulose and paper industry, market of wood-based panels. Coincidentally, it can be notices that Polish market of wood by-products has dynamically developed. This industry is highly fragmented and focuses on small and medium-size businesses (there are only a few large enterprises). A significant number of micro-enterprises (covering more than 30% of the entire sector) are not included in any official statistics. The share of the wood-based industry in the production of the entire Polish processing industry is approximately estimated 9%. The wood industry processes more than 38 million cubic metres of round timber on average per year,

purchased mainly from National Forest Holding State Forests[1] and worth more than EUR 1,6 billion [GUS Leśnictwo 2015].

The potential of the wood sector is additionally confirmed by the level of employment – more than 260 thousand employees (including 125 thousand in the furniture- and 50 thousand in the paper industry). The production value in the wood-based sectors exceeds more than 20 EUR billion (including EUR 8 billion in the paper industry and more than EUR 7 billion in the furniture industry); the upwards trend is maintained. The value of export of wood industry products in Poland totals more than EUR 15 billion with an upwards trend. Poland is the fourth largest exporter of furniture in the world (following China, Germany and Italy), while other EU countries are the main recipient of Polish furniture (more than 80% of export value) [GUS Leśnictwo 2015].

Situation on the market of sawmill by-products indicates that the demand for wooden by-products and the fuel based on them is expected to grow systematically[2]. Research and state-of-the-art-literature has developed in relation to assessing the profitability of production and the trends in the use of wood by-products [Szostak et al. 2004, Porsö 2010, de Jong 2012, Bergen et al. 2013, Ratajczak 2013, Šišák, Riedl and Dudík 2016]. The polish legal regulations on wooden biomass it constitutes deficient wooden material, as well as the remaining post-production material generated by forest and wood industries. Biomass is mainly used for the production of heat energy in randomly scattered small and medium-size plants (local boiler houses, heating stoves) as well as large capacity heat and power plants generating electricity during the process of coburning at condensed coal boiler houses. [Sobolewski et al. 2010].

The polish law's concerning RES (Renewable Energy Sources) also introduces a definition of wood of standard value[3], at the same time not anticipating any support for the energy generated from it. It also projects the increase in the accessibility of wooden biomass – not the same as for the wood of standard value – that is for energy purposes and allowing for the production of energy from the residue created by

[1] The name "National Forest Holding State Forests" means in Polish "Państwowe Gospodarstwo Leśne Lasy Państwowe".

[2] That forecast is mainly the result of the need to meet European Union commitments regarding the share of renewable energy in the final gross energy consumption. Adopted Directive 2009/28/WE [*Directive*… 2009] stipulates that all member states up to year 2020 should reach 20% share of energy from RES (Renewable Energy Sources) in the total energy consumption and 10% share of that energy in transport sector, however obligatory targets vary between member states and for Poland they are set at 15% and 10% respectively. The consequence of such arrangements was issuing the appropriate executive implementing regulations, successively increasing percentage share of electricity generated from RES and sold to final recipients.

[3] Wood that meets quality criteria determined by the norms regulating the requirements and tests for large deciduous and coniferous wood as well as medium-size deciduous wood from groups S1, S2 and S3 and wooden material created as the result of the process of deliberate milling of that wood. Classification by National Forest Holding "State Forests" (Państwowe Gospodarstwo Leśne Lasy Państwowe) in Poland [GUS Leśnictwo 2015].

the industry dealing with various types of forest products, the residue is to be used at the place where it was created excluding the need for the use of a so- called agro biomass.

In this situation efficient use of sawmill by-products, which share in the total supply of all industrial wooden by-products (including veneer sector) amounts to 60%, becomes even more significant [Szostak et al. 2004]. It should take into account, not only the sales of post-production material to the producers of wood-based panels, pulp and paper industry and energy sector, but also processing that material at the place of its creation. However, undertaking the production of briquettes, wooden pellet and energy calls for a some detailed analysis, of which an important element is determining the value of individual types of wooden by-products taking into account various factors.

The aim of this study was to show a relatively easy method of verifying research hypothesis, which has assumed that the refining conversion of sawmill by-products, based on the example of selected new products processed in Poland enhances their value.

6.2 MATERIAL AND METHODS

Comparative analysis used the data related to the prices of sawmill by-products, which was obtained via questionnaire and in-depth interview carried out at sawmills in Poland in 2015. The sawmills under the study were classified into four groups according to the volume of annual production of sawmill wood. This volume has a fundamental implication for the amount of wood by-products obtained during production [Mikołajczak 2011]. The sawmills were selected using non-random sampling technique, in accordance with the minimum size of the sampling and the verification of statistical correctness of selection. [Popek and Wanat 2014] Analysis has embraced both companies which generated their own wood by-products as well as those which have to buy those by-products.

Evaluation of the profitability of processing sawmill by-products into bio-fuels and energy, was proposed based on:

1) Determining the value of sawmill by-products in the given areas of application

a) Processing into bio-fuels [Mikołajczak 2011]:

$$W_{pi} = \frac{1}{a_{pi}}\left[c_{jp}\left(1-\frac{m_j}{1-P}\right)-k_{pi}-k_{ti}\right] \qquad [\text{EUR/m}^3] \qquad (1)$$

b) Processing into energy [Mikołajczak et al. 2012] :

$$W_{ei} = c_{je} g \frac{19{,}5 - 2{,}5 w_o}{1 + w_o} \left(1 - \frac{m_j}{1 - P}\right) - k_{pi} - k_{ti} \quad [\text{EUR/m}^3] \qquad (2)$$

where:

- W_{pi} – Value of wooden residue being processed into any wooden fuel [EUR/m^3],
- i – number of the type of by-product being converted, i ϵ <1, n>,
- p – the type of generated wooden fuel, p ϵ <1, n>,
- a_{pi} – the ratio of material intensity when processing the given by-product „*i*" into wooden fuel „*p*" [m^3/t, mp/t],
- c_{jp} – unit sales price of the fuel "*p*" generated while processing by-products [EUR/t],
- m_j – assumed net profit margin level, satisfactory for the producer, m_j: {0,01; 0,05; ... 0,15},
- P – Corporate Income Tax (CIT), in 2013 = 0,19,
- k_{pi} – cost per unit of processing wooden residue including the remaining operational cost per unit [EUR/t],
- k_{ti} – cost of transporting a unit of wooden residue to the place where it will be processed in case it takes place outside the place of its origin [EUR/t],
- W_{ei} – value of a given type of by-product of „i" number converted into energy [EUR/m^3],
- c_{je} – unit price of selling energy generated from burning by-products [EUR/GJ],
- g – bulk density of the type of by-product being burnt [t/m^3],
- w_o – absolute moisture of the by-product being burnt.

2) Comparing the determined value with the sales price of unprocessed sawmill by-products [Mikołajczak 2011, 2013].

The study aimed at determining the profitability of processing wooden by-products embraced two types of fuel: pellet and wooden briquettes as well as generating energy. In order to equalize the basis of the analysis, for the purpose of comparison the values determined for all groups of by-products were determined based on conversion using the lines of similar capacity: for pellet – 1,5 t/h, for wooden pellet 1,0 t/h. Two cases were analysed: processing the material at the place of its creation, excluding the costs of transport and processing the by-products purchased by entrepreneurs who were not involved in generating them, as well as three levels of margin: 5%, 10% and 15%. To facilitate the comparison, in cases where the product was sold in

three types of packaging: big bag, small bag and in bulk the average price was used. In individual cases (the value of the “residue” processed into pellet using 15% margin, including transport), data presented in the table takes into account only that type of packaging which allows for obtaining following processing the value which is higher than a feasible sales price of the unprocessed material. Such cases were respectively marked: bb – sales only in big bag, bulk – only bulk sales.

6.3 RESULTS AND DISCUSSION

Determined value of various types of sawmill by-products being processed into pellet, wooden briquettes and energy was presented in table 1, along with the sales prices of the post-production by-products from which they were processed.

The presented data indicates that, a significantly higher increase in the value of sawmill by-products is reached by the entrepreneurs who process them at the place of their creation, hence do not bear any transport costs. The highest here is the value of post-production by-products processed into wooden briquettes, and slightly lower, in case of those being processed into pellet. The least profitable is processing “by-products” into energy, yet not for all types of by-products. For those who generate those by-products, economically more attractive than processing them into pellet is direct combustion of defibered chips of 50% moisture, presuming 5% margin, as well as paper chips of the same moisture level in case of adopting higher levels of expected margin. The need to purchase sawmill by-products from external sources makes combustion of defibered chips of 50% moisture content the most profitable means of processing them. While using the remaining types of post-production by-products: sawdust and paper chips to generate energy becomes competitive to processing them into pellet. Also producing energy from dry sawdust does not seem economically sound. Its high price allows for obtaining 5% margin from direct sales.

To ensure comparability of the results within the same expected margin levels, designated values of individual types of sawmill by-products being processed into the fuels under analysis were presented in pairs (excluding cost of transport and including cost of transport, see: Table 1).

Table 1. Value of wood sawmill by-products converted into pellet, briquettes and energy including and excluding cost of transport in Poland[4] (2015)

Type of by-product		Sawmill by-product average price	Value of by-products in conversion divided Into								
			Pellet with margin			Briquettes with margin			Energy with margin		
			0,05	0,10	0,15	0,05	0,10	0,15	0,05	0,10	0,15
			without transport cost [EUR/ m³]								
		[EUR/m3]	including transport cost [EUR/ m³]								
Sawdust	MSTR=10%	28,10	46,48	39,89	35,68	49,52	45,54	41,56	29,21	**27,14**	**25,07**
			36,92	32,72	30,75*	42,35	38,37	34,40	**26,49**	**24,42**	**22,35**
	MSTR=50%	24,12	39,67	33,52	29,59	42,65	38,94	35,23	33,85	31,46	29,06
			30,36	26,43	24,60*	35,57	31,86	28,14	31,51	29,11	26,72
Defibered chips	MSTR=25%	28,10	44,93	39,96	34,99	52,62	47,87	43,13	33,60	31,22	28,84
			39,33	34,36	31,00**	47,02	42,27	37,52	31,75	29,37	**26,99**
	MSTR=50%	28,10	37,13	32,94	28,76	43,59	39,59	35,59	40,62	37,74	34,87
			31,51	29,59*	**23,14**	37,97	33,97	29,97	39,10	36,22	33,35
Pulp chips	MSTR=25%	35,36	50,25	44,93	39,61	57,05	52,01	46,97	**33,60**	**31,22**	**28,84**
			44,65	39,33	36,85*	51,44	46,40	41,36	**31,75**	**29,37**	**26,99**
	MSTR=50%	35,36	41,63	37,15	**32,67**	47,31	43,07	38,82	40,62	37,74	**34,87**
			36,01	**31,53**	**27,05**	41,69	37,45	**33,20**	39,10	36,22	**33,35**
Waste wood MSTR = 25%		24,59	52,68	46,75	40,82	61,88	56,22	50,55	33,60	31,22	28,84
			47,11	41,18	35,25	56,31	50,64	44,98	31,75	29,37	26,99

Source: own elaboration based on [Mikołajczak 2011]

Legend: MSTR - moisture content; - bb – sales only in big bag; ** - bulk – only bulk sales.* ***In bold*** *values of those converted by-products which came out lower than average sales price of sawmill wood by-products.*

[4] For comparison, the current average exchange rate is 1 EUR = 4,2705 PLN (Table No. 078/A/NBP/2017 of 2017-04-21, source: http://www.nbp.pl/homen.aspx?f=/kursy/ratesa.html - accessed 21.04.2017].

Comparative analysis shows that the highest over 2,5 times increase in the value of post-production by-products is achieved when wooden chips are processed into briquettes. High increase in value, almost by a 100%, is guaranteed when briquettes are processed from defibered chips and dry sawdust. Less profitable is processing sawmill by-products into pellet, especially when using by-products of high level of moisture.

6.4 CONCLUSIONS

The formula rationalizing the utilization of the stream of sawmill by-products via determining the value of their individual types facilitates the selection of the most profitable, from the sawmill perspective, way of utilizing its post-production by-products. At the same time it gives their owners the basis for choosing a versatile structure of their utilization. The above presented method may also be used when evaluating the profitability of production adopted as the main commercial activity by the entrepreneurs using the product available on the market.

The study showed that significantly higher increase in the value of further processed sawmill by-products is achieved by those entrepreneurs who process them at the place of their conversion without bearing any additional cost of transport. The highest value is characteristic for wooden by-products processed into briquettes, slightly lower for those processed into pellet. The least profitable is converting wooden by-products into energy, with the exception for defibered chips of 50% moisture. Their combustion is competitive to converting them into wooden pellet or briquettes, even when the material has to be transported for processing. Also utilization of sawdust of 50% moisture level for heating, outside of the place of its creation is economically more attractive than assigning it for pellet production.

As the result of the comparative analysis the initial hypothesis has generally been confirmed.it has been stated that refining processing of sawmill wood by-products analysed in Poland in 2015 enhances their value. Apparently, the trends for further processing of wood by-products may be determined not just by economic profitability [Jelačić et al. 2015] (which has been maintained), but also the rationality of its implementation in accordance with the paradigm of integral economy [Chudobiecki and Wanat 2015]. A research approach, applied in this paper, may constitute a starting point for a further study regarding the market for sawmill wood by-products.

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7. CRITERIA FOR EVALUATING PROFITABILITY OF PROCESSING SAWMILL WOOD BY-PRODUCTS INTO WOODEN BRIQUETTES AND PELLET – SELECTED EXAMPLES FROM THE POLISH WOOD MARKET

Elżbieta Mikołajczak, Leszek Wanat, Władysław Kusiak

7.1 INTRODUCTION

Every industry market can develop as meso-functional area in industrial economy. In this context one may indicate a specific coexistence of the market of renewable energy sources and wood market, especially the market of wood by-products [Wanat and Klus 2015]. The studies of the development of industrial sub-markets based on wood require a specific research approach relevant for forest- and-wood-based economics. Along with market development also the shape of sub-disciplines of economic sciences undergoes evolution, including the wood-market science (*Holzmarktlehre*, *Wood-Market Science*), which treats as integral economics of forestry and wood industry [Mantel 1973, Wanat 2009]. This process justifies undertaking scientific studies in search of possibilities of sustainable economic growth based both on natural resources (including forestry) and renewable energy sources (including wood by-products).

The development of renewable energy sector in the EU member states is favoured by appropriate legal regulations, among which the key role is played by the Directive 2009/28/WE [*Directive…* 2009]. The structure of possessing that type of energy in Poland is dominated by biomass. Its share in the production of electricity from RES (Renewable Energy Sources) amounts to 54,4%, and in generating heat up to 93,6% [GUS 2016]. Its popularity due to ecological aspects, as well as the urge to become independent from conventional sources of energy has been steadily increasing. Even though when converting chemical energy contained in biomass into heating carbon dioxide is extracted, it does not create greenhouse effect since the process of photosynthesis runs within a closed cycle, which length depending on the type of plant ranges from a few months to a dozen years [Lewandowski 2010]. The most accessible and especially precious for energy sector type of biomass is wood, wooden by-products from processing wood, as well as wooden fuels generated from them. Incidents of using wood of

standard for generating energy resulted in aggravating legal regulations within this area[5].

Accepted legal regulations constitute an additional argument in favour of launching the production of wooden fuels by sawmill enterprises, as they, along with the producers of veneer, generate approximately 60% of the overall volume of all wooden residue created by wooden sector [Szostak et al. 2004].

Wooden pellet and briquettes belong to a group of highly processed wooden fuels. Production of pellet – wooden fuel that is characterized by the highest level of processing – consists in exposing dried and finely grinded sawdust to high pressure and temperature. The final product due to its low content of moisture (approximately 10%) characterizes with a much higher calorific value than wooden logs and chips. 1 tonne of pellet equals energy-wise about 500 litres of fuel oil or 0, 7 tonnes of coal [Mikołajczak 2012, Lijewski et al. 2016]. In turn increasing the density of wooden material during pellet production facilitates slowing down and automatization of combustion process. Technology of briquettes production is easier. Energy expenditure used in order to produce them is lower as the consequence of the possibility of utilizing less finely grinded sawdust as it is in case of wooden pellet. Therefore, undertaking the production of wooden briquettes entails far lower investment. However 12% higher moisture content of the final product, as well as its larger dimension limit their utilization in some boilers and stoves fed with biomass. Thus briquettes are mainly used locally, while 40-50% of pellet generated domestically finds its recipients outside of Polish borders, mainly in Denmark, Sweden, Italy and Germany [Hiegl and Janssen 2009, 2009a; Steiner and Pichler 2009].

Situation on the market of sawmill by-products indicates that the demand for wooden by-products and the fuel based on them is expected to grow systematically[6]. Research and state-of-the-art-literature has developed in relation to assessing the profitability of production and the trends in the use of wood by-products [Szostak et al. 2004, Graczyk

[5] The In the last executive act, a so called Directive on RES (Renewable Energy Sources), wood of standard value has been defined, not anticipating any support for the energy generated from it. The increase of accessibility of wooden biomass other than wood has also been set up for generating energy, as well as generating it from the post-production by-products or residue from the industries processing wood at the place of their creation without the need for using the required share of a so called agricultural biomass [Mikołajczak 2012, GUS 2016].

[6] The wood-based industry in Poland plays an important role for the development of the national economy. It is an effect of domestic forest resources, the quality and quantity of round wood acquired from the national resource base, as well as continually growing significance of wood-based products in global trade [Ratajczak 2013]. The forest- and wood-based sector plays an important role for the development of the national economy in Poland. The following factors have a decisive impact on that: fashion for wood (as human friendly), popularity of wood as an environmentally raw material and dynamic increase of demand for wood, [Kaputa, Paluš and Vlosky 2016]. A study of intersectoral cooperations, as potential factors of sustainable development – seems justified with reference to the forest- and wood-based sector, especially owing to its territorial dispersion [Wanat et al. 2013, Chudobiecki et al. 2016].

2005, Hołuj 2006, Borys 2010, Porsö 2010, de Jong 2012, Bergen et al. 2013, Ratajczak 2013, Paluš et al. 2016, Šišák et al. 2016].

This article attempts to evaluate profitability criteria of converting those wooden by-products into wooden briquettes and pellet. The production of selected by-products was taken into account as complementary for the main production activities of sawmills. Selected factors have been studied: namely threshold margin, maximum price (at which the raw material can be purchased for further processing), maximum unit cost of processing (including and excluding cost of transport) and the minimum acceptable by the producer sales price of the generated wooden biofuel. Based on comperative and descriptive analysis, reccommendations for national polish forest-and-wood-based industry were formulated.

7.2 MATERIAL AND METHODS

Evaluation of profitability of processing sawmill by-products into ecological fuels and energy may be carried out determining their value using the formula (1), and then comparing it with the price of unprocessed "wooden residue". Transformation of the formula given below allows to set down the maximum possible margin, maximum costs of processing, or the price level of the "residue" up to which purchasing it is still profit-making [Mikołajczak 2011]:

$$W_{pub} = \frac{1}{a}\left[c_j \left(1 - \frac{m_j}{1-p} \right) - k_{jp} - k_{jt} \right] \text{[EUR/m}^3\text{]} \qquad (1)$$

where:

- W_{pub} – Value of wooden residue being processed into any wooden fuel [EUR/m^3],
- A – The amount of basic material (wooden residue) necessary to generate one unit of a given wooden fuel (material intensity ratio) [m^3/t, mp/t] [7].
- c_j – Sales price per unit of a given wooden fuel [EUR/t],
- m_j – Target net profit margin satisfactory for an entrepreneur , m_j: {0,01; 0,05; ... 0,15},
- P – Corporate Income Tax (CIT), in 2015 = 0,19,

[7] The symbol "mp" means spatial meter in [mp/t] and {EUR/mp].

k_{jp} – Cost per unit of processing wooden residue into a given wooden fuel including the remaining operational cost per unit [EUR/t],

k_{jt} – Cost of transporting a unit of wooden residue to the place where it will be processed in case it takes place outside the place of its origin [EUR/t],

Using the relation (1), one may determine **threshold margin m_{gr}** (4), that will enable us to evaluate the profitability of processing sawmill by-products as an alternative for their direct sales.

$$\frac{c_j m_j}{1-p} = c_j - (k_{jp} + k_{jt} + W_{pub}) \tag{2}$$

It is then assumed that the value of those by-products being processed into the fuel under analysis equals the price which may be obtained while selling them unprocessed ($W_{pub} = c_{pub}$).

$$c_j m_{gr} = (1-p)(c_j - k_{jp} - k_{jt} - ac_{pub}) \tag{3}$$

where:

c_{pub} – unit price of a particular type of unprocessed by-product which is to be converted into wooden fuel [EUR/m^3], [EUR/mp],

Thus threshold margin is understood as the maximum possible margin using specific cost of production, determined sales price of unprocessed by-product, as well as the price acceptable by the market:

$$m_{gr} = \frac{1}{c_j}(1-p)(c_j - k_{jp} - k_{jt} - ac_{pub}) \tag{4}$$

In case of determining threshold margin at $m_{gr} = 0$, one may determine **maximum price of by-products** (8), beyond which the entrepreneur who is not in the possession of those by-products is unable to purchase and process them while simultaneously making profit.

$$\frac{1}{c_j}(1-p)(c_j - k_{jp} - k_{jt} - ac_{pub}) = 0 \tag{5}$$

For the equation (5) to be true the following conditions have to be fulfilled:

cj≠0 and: 1-p = 0 or $c_j - k_{jp} - k_{jt} - ac_{pub} = 0$

Because p is constant and equals 0,19, equation (5) is true, when:

$$c_j - k_{jp} - k_{jt} - ac_{pub} = 0 \quad (6)$$

$$ac_{pub} = c_j - k_{jp} - k_{jt} \quad (7)$$

Thus the level of wooden by-products price up to which the entrepreneur is efficiently able to purchase and process them into the product sold at price *cj*, is as follow

$$c_{pub} = \frac{c_j - \left(k_{jp} + k_{jt}\right)}{a} \quad (8)$$

Equation (5) also allows for determining the threshold level of production efficiency as ***maximum unit costs of processing*** wooden by-products, ***including cost of transport***, at margin m_{gr} = 0 and the defined sales price of the product generated based on them (9):

$$k_{p\max} + k_{t\max} = c_j - ac_{pub} \quad (9)$$

and the minimum, acceptable for the producer sales price of the generated fuel (10):

$$c_{\min} = ac_{pub} + k_{jp} + k_{jt} \quad \text{[EUR/t]} \quad (10)$$

Comparative analysis used the data related to the prices of sawmill wood by-products, which was obtained via questionnaire carried out at wood processing plants (sawmills) in Poland in 2015[8]. Analysis has embraced both companies (wood processing) which generated their own wood by-products as well as those which have to buy those (wooden) by-products [Mikołajczak 2011].

[8] The sawmills (companies) under the study were classified into four groups according to the volume of annual production of sawmill wood. This volume has a fundamental implication for the amount of wood by-products obtained during production [Mikołajczak 2011]. The sawmills were selected using non-random sampling technique, in accordance with the minimum size of the sampling and the verification of statistical correctness of selection. [Popek and Wanat 2014].

7.3 RESULTS AND DISCUSSION

Based on the above presented formulas the values of individual indexes have been determined (table 1).

Table 1. Profitability of processing wood by-products into pellet and briquettes, generated as by-products (excl. cost of transport) and basic-products (incl. cost of transport) in Poland[9] (2015)

Type of Wood By-Product		Sawmill Wood By-Product Average Price	Profitability of processing wood by-products generated as by-products and basic-products						
			Break-even margin m_{gr}		Maximum unit costs of conversion including transport	Maximum cost of transport per unit	Maximum distance from which raw materials can be transported*	Maximum purchase price of raw materials for conversion	Minimum selling price of finished product
		[EUR/m3]	By-production	Basic-production	$k_{pmax} + k_{tmax}$ [EUR/t],[EUR/m3]*	k_{tmax} [EUR/t]	l [km]	c_{pub} [EUR/m3]	c_{min} [EUR/t]
			PELLET						
			BRIQUETTES						
Sawdust	MST P 10%	28,10	23,76	15,23	88,33	44,37	232,89	40,80	122,83
			31,64	22,63	80,29	55,94	293,65	45,96	103,21
	MST P 50%	24,12	22,12	13,09	94,11	41,31	204,97	34,44	126,82
			26,98	16,86	77,79	44,96	223,04	35,97	106,86
Defibered Chips	MST P 25%	28,10	21,86	16,22	91,82	38,13	254,76	44,18	112,98
			30,73	**24,82**	85,50	51,20	342,02	51,60	93,60
	MST P 50%	28,10	15,52	9,88	82,27	27,06	151,54	36,30	124,05
			26,63	20,99	82,27	46,45	260,07	45,54	104,66
Pulp Chips	MST P 25%	35,36	18,93	12,66	89,04	35,35	236,16	48,79	127,63
			26,41	19,79	81,00	46,69	311,95	55,24	108,24

[9] For comparison, the current average exchange rate is 1 EUR = 4,2705 PLN (Table No. 078/A/NBP/2017 of 2017-04-21, source: http://www.nbp.pl/homen.aspx?f=/kursy/ratesa.html - accessed 21.04.2017].

	MSTR 50%	35,36	11,68	5,41	77,02	21,81	122,13	40,17	141,17
			18,75	12,13	68,98	33,16	185,65	45,57	121,78
Waste Wood MSTR = 25%		24,59	28,69	23,99	105,14	50,05	400,30	33,60	53,06
			37,34	**32,42**	98,81	61,70	493,48	31,75	60,98

Source: own elaboration
*Legend: MSTR - moisture content; *transport 25 m^3, rate 1,06 EUR/km; **in bold** the highest values of: break-even margin level for various forms of utilizing sawmill wood by-products.*

The data necessary for the calculations was collected based on the research carried out in the selected enterprises generating the products under analysis that is wooden pellet and briquettes.

Analysis of the juxtaposed values indicates that the most profitable form of processing wooden by-products is briquettes production and the highest margin level: 37,3% in case of the entrepreneurs who are in possession of those by-products may be obtained utilizing wood chips. The least profitable material for the production of briquettes are paper chips of 50% moisture content, due to their high price in the unprocessed form. Yet even in such case those in the possession of such raw material can get the margin at 18,8%. In comparison with the entrepreneur buying wooden by-products for processing the entrepreneur who owns them and does not bear transport cost may reach margin from 4,7% higher (using wood chips) and up to 9% (when using sawdust of 50% moisture content).

The holder of “wooden by-products”, undertaking a more risky but at the same time more perspective production of wooden pellet will be able to obtain the margin comparable with the margin possible to obtain by the producer of briquettes whose production is based on the material purchased outside.

Determined for the pellet maximum net margin is on average 7,6% (including cost of transport – picture 2) up to 8% (excluding cost of transport – picture 1) lower than profitability of processing wooden by-products into briquettes and amounts to, in case of the holder of “wooden residue” from 11,7% for wet paper chips to 28,7% when processing wood chips and from 5,4% to 24,0% using the same groups of by-products yet in the situation where the entrepreneur utilizes the material purchased outside.

The subsequent ratios confirm the regularities determined when analysing threshold margin that is: the highest level of profitability in case of processing wood chips and the lowest in case of wet paper chips. Thus:

1. Maximum cost of processing including cost of transport ranges between, for processing:
   a) into wooden pellet – between 77,02 EUR/t (paper chips with moisture content of 50%) and 105,14 EUR/t (wood chips), allowing for the values higher than in case of briquettes due to the specific characteristics of their production and related costs of processing,
   b) into wooden briquettes – between 68,98 EUR/t (paper chips with moisture content of 50%) and 98,81 EUR/t (wood chips),
2. Maximum distance for transporting the material, being the direct result of the determined maximum cost of transport ranges, for processing:
   a) into wooden pellet from 122 km (paper chips with moisture content of 50%) to 400 km (wood chips),
   b) into wooden briquettes – from 186 km (paper chips with moisture content of 50%) to 493 km (wood chips),
3. Maximum price of raw material being purchased for processing should not exceed:
   a) in case of wooden pellet: for dry sawdust – 40,80 EUR/m^3, wood chips – 53,06 EUR/m^3, paper chips with moisture content of 50% – 40,17 EUR/m^3,
   b) in case of wooden briquettes: for dry sawdust – 45,96 EUR/m^3, wood chips – 60,98 EUR/m^3, paper chips with moisture content of 50% - 45,57 EUR/m^3,

   Taking into account the current prices of unprocessed “wooden residue”, respectively: 28,10 EUR/m^3, 24,12 EUR/m^3, 35,36 EUR/m^3.
4. The lowest acceptable for the producer price of the wooden fuels under analysis stays at a visibly lower level than current average market prices of those products,
5. The producers of wooden pellet and briquettes should not be afraid of even a significant increase in the price of raw material used for the production of those fuels because maximum prices used when purchasing wooden by-products indicate broad possibilities for accepting changes within that field. The break-even point is:
   a) for pellet – increase in prices from 14 % (paper chips, moisture = 50%) to 116 % (wood chips),
   b) for wooden briquettes– increase in prices from 29 % (paper chips, moisture = 50%) to 148 % (wood chips),

   Keeping the rest of the parameters constant.

7.4 CONCLUSIONS

The following conclusions were formulated:

1) The highest level of threshold margin: 37,3% is reached by the holder of wooden residue, who produces wooden briquettes utilizing wood chips. The least profitable material for their production are paper chips with moisture content of 50%. Compared with the entrepreneur who purchases wooden by-products for processing, the producer who does not incur transport cost may reach a higher margin, from 4,7% (wood chips) up to 9% (sawdust with 50% moisture content).

2) Maximum margin of net profit determined for wooden pellet is on average from 7,6% (including cost of transport) to 8% (excluding cost of transport) lower than in case of processing wooden by-products into briquettes.

3) The most recommended for processing into pellet are: dry sawdust and paper chips due to a small differences in maximum possible margin level and the high quality of product required (lack of contamination with bark) for which the average sales price may be higher.

4) For briquettes production the most profitable material constitutes defibered chips with moisture content of 25% and wood chips of the same moisture content, due to lower quality requirements concerning final product.

The descriptive analysis showed that significantly higher increase in the value of further processed sawmill by-products is achieved by those entrepreneurs who process them at the place of their conversion without bearing any additional cost of transport. Investigating the further processed sawmill by-products (i.e. the wooden by-products into ecological fuels), is of essential importance for the economic development of regions, especially for industries characterised by high territorial fragmentation, e.g. the forest and wood-based sector in Poland. Institutional conditions of intermunicipal and intersectoral cooperation in Poland are concurrently an opportunity and a barrier for the establishment of partnerships with the participation of the wood industry. The functioning of a secondary wood market, dispersed and territorially diversified, is subject to market mechanisms. It creates a new market for sawmill wood by-products, which is an opportunity for the development of small- and microenterprises in the forest- and wood-based sector in Poland.

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8. MEASUREMENT OF WORKSHOP WOOD DUSTINESS IN ORDER TO CONTROL AND MAINTAIN PROCESSES TO MEET INTEGRATED MANAGEMENT SYSTEMS REQUIREMENTS

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8.1 INTRODUCTION

Working environment in the woodworking workshop is influenced by the physical, chemical and biological factors. These factors can be considered as a source of risk, an effect of uncertainty for the organization in which production processes are operated, (ISO 14001:2015). The most serious effect of uncertainty seems to be the combination of these factors with their synergetic impacts (Železník, 2012). The most relevant physical factors are: the acoustic parameters, the light parameters, the micro-climatic parameters, the energy parameters, etc. (Vyhláška 542/2007). The important chemical parameters are the olfactory parameters relating to the used chemical materials (paint substances, solvents, paint thinners, acetones, mordants, glues, etc.), the indoor air composition, etc. (Nariadenie 471/2011). The biological parameters are determined by the applied woody species and by a presence of the ligniperdous, i.e. by the biological wood-destroying agents, such as the Horntail (Urocerus gigas), the Old-house borer (Hylotrupes bajulus), the Furni-ture Beetle (Anobium punctatum), the Bookworm (Anobium pertinax L.), the Death Watch Beetle (Xestobium rufovillosum), the Wood Borer Beetle (Ptilinus pectinicornis), bacteria and viruses or fungi: Serpula lacrymans, moulds, mites and other), (Nariadenie 83/2013, Atlas of Wood-Destroying Agents, 2016). Several kind of jobs in woodworking workshops can cause very serious diseases. Hardwood dust, special oak and beech dust, is carcinogenic what imposes the serious risk in the occupational setting. This fact and the circumstance that softwood species may lack the carcinogen property, bring up the question as the whether the carcinogenic factor could be identified and quantitated in workroom air. The circumstances may make them suitable indicator compounds for revealing the origin of the dust, (Mämmelä, 2002). The strongest association of exposure to wood dust and development of nasal cancer is observed in those occupations where workers are exposed to hard wood dust and chemical additives are not used. The time between first occupational exposure to wood dust and the development of

adenocarcinoma of the nasal cavity averages 40 years, range 7÷70 years, (Nylander, 1993). Exposure to wood dust also results in numerous other respiratory health effects, including allergic rhinitis, asthma and irritation (Demers, 1997). Lungs are most vulnerable to air-borne hazards which are caused due to exposure to wood dust which is produced in sawmills, furniture industries, cabinet making, and carpentry, (MeoSA, 2004).

The above-mentioned factors and parameters are implicating working comfort or discomfort of the employees and they are influencing working performance of the workers. The working environment quality can be increased by elimination or reduction of the negative impacts, together with supporting of the positive influences. The outputs obtained from the special measuring equipment, which is determined for objectification of the working environment factors, are helpful for a positive adaptation of the working environment parameters. There are described two important physical factors in this contribution – namely it is dustiness in the real woodworking workshop, which is investigated with regard to decreasing of dustiness in order to improve micro-climatic comfort as well as visual comfort in the working environment (Zákon 154/2013). As well as the organization shall decrease risks in operational plant and to plan the preventive and corrective actions to continually improve the occupational health and safety, (OHSA 18001:2007) in in accordance with prepared (ISO 45001:2017).

Another aspect which should be considered the defined scope of the environmental management system in the organizations. The organization shall determine the environmental aspects of its activities, products and services that it can control and those that it can influence, and their associated environmental impacts, considering a life cycle perspective, (ISO 14001:2015).

The main aim of this chapter is to determine the requirements for decreasing of dust-fall rate in the wood-working workshop, to perform the related measurement during several seasons, to find the most loading working place and to suggest the prevention and correction actions according to environmental and occupational health and safety management systems which the organization plans to apply at an early date. When planning how to achieve its objectives, the organization shall determine what will be done; what resources will be required; who will be responsible; when it will be completed; how the results will be evaluated, including indicators for monitoring progress toward achievement of its measurable objectives.

8.2 ANALYSIS OF THE PRESENT SITUATION IN THE WOODWORKING WORKSHOP

The analyzed woodworking workshop is specified for processing of wood material either in the basic form or in the form of prepared semi-products. There are installed all the most important woodworking machines in the woodworking workshop, i.e. the circular saws, band saws, milling machines, mortisers, sanders, etc. The woodworking machine equipment, which is really used in the woodworking workshop, depends on the actual production activities. All these machines are very helpful in the wood processing and production, however every working operation, which is performed using the above-mentioned machines, is also connected with a risk of injury provided that the working safety rules are neglected.

The working comfort or well-being of the workers is determined by the requirements concerning the workplace. That is why a purposeful arrangement of the workplace in the woodworking workshop is essential and necessary. The area of workplace, illumination, noisiness and the microclimatic conditions (including dustiness, temperature, air humidity, content of CO2, etc.) are the most relevant factors influencing working performance and safety of work, (Pauliková, 2009).

Wood sawing and sand abrading operations, besides forming the main products also generate saw dust and wood dust; the shape, dimension, and amount dust produced is dependent on both the physical and chemical characteristics of the sawed and abraded wood as well as on shape, dimension, sharpness of cutting tools, and the technological conditions of sawing and sand abrading operation, (Očkajová et al. 2014).

8.3 WORKING AREA

A proper arrangement of the machine equipment, together with a sufficient free area dedicated for passing, input, output and storing of the material or products, as well as for various manipulations performed around the individual machines, are the basic assumptions for a safe working operation in the workshop. Therefore, every workplace has to be equipped with a suitable device specified for handling material, products and waste, as well. A working position of the machine operator should be arranged so that he must not be disturbed during his working activities. The minimal width, which is required for a safe passing between two machines, as well as the minimal distance between the machine and the building wall, is 60 cm. The length of the worked material should be taken into the consideration, too. The floor has to be

flat, non-slip, without wood shavings, saw-dust and without other waste in order to keep the machine operator position safe, (STN 49 61 01, 1989).

8.4 CLASSIFICATION OF PLANTS ACCORDING TO TYPE

The individual production plants can be classified with regard to the various criteria, for example according to the kind of worked material, amount of the material worked per year, production technology, etc. This chapter describes a smaller plant or workshop, which is working the solid timber, hardwoods, chipboard materials and the wood-fibre materials. Such kind of a small production plant (workshop) does not disposes of sufficient financial sources that are necessary for purchasing of expensive, high quality and fully automated machines equipped with the modern cleaning and separating facilities. The smaller workshops consist of 1÷10 employees. The machine equipment of such workshops is very similar each other, i.e. there are usually installed almost the same basic woodworking machines specified according to the technology required for the given production activities, (Chovancová, 2014).

8.5 PRODUCTION MACHINES AND MACHINERY IN THE WOODWORKING WORKSHOP

The main machine, which has to be installed in the woodworking workshop, is the sizing saw designed in various modifications, but it always consists of two cutting discs (saw discs) rotating in an opposite direction mutually. The first saw disc is smaller and it rotates in a material feed direction in order to cut the bottom plastic foil without a splitting of it. The second saw disc is the main saw, which is used for the final cutting of material.

It is necessary to cover the cutting edges after the material cutting operation by means of a special tape using the edge-banding machine. There are available various types of the edge-banding machines (handy, table or mechanical edge-banding machines). This special machine is able not only to cover the cutting edges, but also to cut off and to grind the overhanging parts of the covering tape (Daneshjo, 2011).

The final connection of the prepared parts is made by the milling machine or by plug contact.

8.6 MATERIALS WORKED IN THE WOODWORKING WORKSHOP

The analyzed woodworking workshop is processing the next kinds of material: solid timber; hardwoods (various kinds); wood-fiber boards (soft insulating boards, middle-hard boards, hard boards); semi-hard wood-fiber boards; chipboards; oriented strand boards; covering materials.

8.7 EXPERIMENTAL

8.7.1 Chosen Aspects of Dustiness Evaluation in Working Environment

Amount of dust in the air, i.e. concentration of solid polluting substances in the air, is one of the monitored working environment parameters that are able to cause negative impacts on human health. According to the hygienic aspect the dust consists of small particles originating in solid materials, which are dispersed in the air or they are deposited as sediment on the individual objects.

These particles are generated during various technological processes as well as by means of transfer from a surrounding. Transfer of the dust particles is caused due to a fact that the working or living interior areas with a short- or long-term staying of people must be ventilated. Ventilation can be performed using a natural or forced ventilation process. Requirement of ventilation in the given area is determined according to the air pollution level, number of participating persons, running activities and heat loading, (Kapalo, 2009).

Mechanical sanders and portable sanders are made from coarse particulate grinding material, while manual sanding paper is made from fine particulate grinding material. The abrasion rate of a grinding material is relevant to its quality, the hardness and roughness of an object, and the pressure applied. To increase the sanding efficiency, a sanding medium with large particulate materials is commonly used with a large amount of applied pressure, which results in a large quantity of dust , and a certain amount of free silica in the dust, (Yuan, 2014).

The dust is dangerous in the case of insufficient ventilation in the areas with occurrence of dust sources where the dust is accumulated and its concentration in the air is increased. High level of dust concentration is harmful to human health and there is also arising a possibility of explosion in the case of a certain concentration of the dust in the air.

8.7.2 Biological impacts of dust

Taking into consideration the biological impacts of the dust it is possible to categorize the dust as follows: the first category is the inert dust with negligible impacts and the second category is the dust with harmful impacts. The harmful dust can be divided into the following groups, (Serbousek, 1992):

- dust without the fibergenic effects: effect of this dust consists in mechanical irritation of the air passages, bulbar conjunctiva and skin; namely it is the dust from wood, hemp, animal's hair, cement, glass fibre, slaked lime etc.;
- dust with the fibergenic effect: it causes the exuberance of fibrous tissue in lungs, i.e. the so-called pneumoconiosis; it is the dust originated in asbestos, graphite, ceramic clays, chamotte, foundry sands, silicon oxide etc.;
- toxic dust: is harmful not only to the air passages, but it affects the whole organism toxically; it is such dust, which contains lead, manganese, mercury, etc.;
- radioactive dust: this dust is able to cause changes, damage or failure of biological structures due to own radiation; it is the dust with particles of uranium, thorium, radium, zircon, etc.;
- allergenic dust: is able to cause bronchial asthma and eczematous dermatitis;
- carcinogenic dust: is able to initiate exuberance of tissue; into this group belongs dust from nickel, chrome, asbestos, etc.;
- dust from mineral fibres (glass fibres and basalt fibres): this dust is dangerous also in the case of low level concentration, namely in the form of mechanical irritation of skin and mucosa.

In general, all kinds of the dust are harmful and they are able to cause serious health complications.

There are acting different physical influences in the case of various dimensions of the dust particles (gravitation, aerodynamic resistance, air flow, electrostatic forces). If the dust particles are larger than 10 μm they are deposited as sediment. Several minutes after creation of them and close to the place of their origin. Therefore, in the air, which is contaminated by the dust, there are dominant particles smaller than 10 μm. The particles with dimension 1 μm are depositing as sediment only very slowly and the particles smaller than 0.1 μm are almost never depositing as sediment. The particles smaller than 10 μm are extremely dangerous to human health because they are penetrating deep into the air passages, up to sac alveoli.

It is useful to categorize the dust in two different dimensional fractions (or components) with regard to real measuring process performed in practice. The first fraction is respirable and the second

fraction is non-respirable. This categorization is similar to sorting of dust in organism during respiration. The respirable fraction is penetrating into the sac alveoli and it remains inside. There are defined standardized curves of fractional penetrability according to the international convention in order to compare mutually results obtained from measuring of respirable fraction using various dust meters and to meet the given requirements.

In order to quantify the amount of dust in the given area there is applied the value of mass concentration, which is defined as a weight of the dust particles in the unit volume of gas (i.e. the corresponding physical unit is mg/m^3 or $\mu g/m^3$) or sometimes there is used the numerical concentration value.

The drifting dust represents a sum of particles with different dimensions, whereas these particles are dispersed freely in the air. They are originating in various technological processes, for example they are released during combustion of solid materials mainly, but they are included in the exhaust gases of motor-cars, as well. However, there is also possible the secondary dustiness, which is caused by whirling of the deposited particles.

The health significance of dust depends on the dimension of particles. While the larger particles (over 10 μm) are able to cause only irritation of the upper air passages, which is connected with coughing and sneezing or with irritation of bulbar conjunctiva, the smaller particles are passing to the lower air passages and the dust particles with the dimensions less than 2.5 μm are able to penetrate to the sac alveoli with a possibility either to sediment in the lungs or to infuse into blood circulation. With regard to the above-mentioned aspect the indicator of dustiness is classified as follows:

- total dustiness (Total Suspended Particle – TSP),
- particles with dimension less than 10 μm (Particle Matter – PM10),
- particles smaller than 2.5 μm (PM2.5).

8.7.3 Exposure limits in working area air

The highest level of the permissible exposure limit (PEL) is defined as the highest concentration of chemical factor (gas, steam or mass particles) in the working area air. This concentration is not harmful in general with regard to health of employees and it does not mean loading by an uncomfortable odor during a repeating and long-term daily exposure, i.e. in 8-hour work shift of a 40-hour workweek.

The highest values of the permissible exposure limit (PEL) defined for the chemical factors are determined by the average value and the short-term value.

The average value of the highest permissible exposure limit is a time-weighted average, which is calculated from the concentration values measured in the employee's respiration area in 8-hour work shift of a 40-hour work week, i.e. the 8-hour time-weighted average (TWA) permissible exposure limit (PEL).

The short-term value of the highest permissible exposure limit allows a short-time exceeding of the highest PEL values during 15 minutes within the working shift. This permissible short-time exceeding over the PEL (i.e. the so-called peak concentration) is limited with regard to the local irritating effects or the systemic effects of the chemical factors and it is determined by the concentration value or by the category I and II in the case of some chemical factors, as well, (VYHLÁŠKA 448/2007).

The 8-hour time-weighted average of the highest permissible exposure limit (8-hour TWA PEL) must be kept for all given chemical factors. In the case of chemical factors with the strong local irritating effects there is determined only the short-term value of the highest PEL. If the highest values of the PEL for gases and steams are determined independently of the temperature and pressure thus they are given in the physical units ml/m^3 or ppm (parts per million) and if the PEL are determined in dependence on the temperature and pressure so they are given using the units mg/m^3 at the temperature value 20°C and the atmospheric pressure value 101.3 kPa. The Eq. 1 describes conversion of concentration from mg/m^3 to ppm.

$$concentration\left[\frac{mg}{m^3}\right] = \frac{molecular\ \ weight\ [g]}{24.1}\ [ppm], \qquad (1)$$

where 24.1 = molecular volume in liters at the temperature value 20°C and the pressure value 101.3 kPa

The highest PEL of the solid aerosols are given in the physical units mg/m3 and in the case of a fibred aerosol they are given by means of the number of fibers in a unit volume of 1 cm^3 (fb/cm^3) or mg/m^3. The highest values of the short-term PEL are presented in Table1, (CFR 1910.1000 - 2016).

The actual trend of intensive industrial development influences the quality of air very unfavorably. Dust concentration measuring is only one of useful tools, which enables to perform monitoring of this situation and it serves as a certain technical support for legislation in order to reduce of air pollutants.

Table 1. The short-term highest PEL

Category		Maximal duration of peak	Maximal frequency during one work shift	Minimal interval between peaks
I[1]	Local irritating factors or factors that are sensitizing the air passages	15 minutes average value	4	1 hour
II[2]	Factors with systemic effects	15 minutes average value	4	1 hour

[1] – the highest value of the PEL must not be exceeded in general, or it can be exceptionally exceeded only
[2] - times in the case of some chemical factors; [2] - the highest PEL can be exceeded for a short term from 2- to 8-times per work shift maximally. Maximal duration of the peak concentration must not exceed 15 minutes, 4-times per work shift, with 1-hour interval between two peaks, whereas the value of the 8-hour TWA PEL must be kept;

8.7.4 Auxiliary Equipment for Suction of Dusty Particles

The wood dust is generated during operation of the woodworking machines (mainly during sawing, grinding, etc.). Most of the dusty particles are smaller than 0.01 mm, whereas 40÷90% of all particles are smaller than 0.002 mm. The wood dust is seriously harmful to the human health and therefore it is necessary to eliminate it by means of filtering equipment or by a periodical exchange of indoor air, namely 4÷6 times per hour, (Šiška, 1981).

Another negative impact of the wood dust is reduction of indoor visibility in the workshop. The wood dust is covering windows and lamps. From this reason the measurement of illumination intensity is often integrated with the measurement of dustiness.

Measurement of dust sedimentation is performed in these operational plants where we need to find how much of dust amount is developed for certain time. Dust takes harmful effect on employees' health. That is why it is necessary to inspect the conditions for person's comfortable work. As well as the amount of dust which is deposited as sediment on the surfaces of machinery, can cause the damage or cover of moving parts of machines (dust brake). By means of obtained data of dust amount we can decide what kinds of precaution for elimination or minimization will be applied.

Aims of measurement:

1. Measure and evaluate amount of dust sediments in given operational plant.
2. Elaborate a proposal for increasing of quality of the examined area:
   a) Constructional
   b) Operational
   c) Positional – for additional suction devices

Applied instruments and measurement apparatus: Laser distance meter; Electronic balance; Filter samples; ELPI®+ (Electrical Low Pressure Impactor)

8.7.5 Methods - Measurement of Dustiness

The ELPI®+ operating principle can be divided into three major parts; particle charging in a unipolar corona charger, size classification in a cascade impactor and electrical detection with sensitive electrometers. The particles are first charged into a known charge level in the corona charger. After charging, the particles enter a cascade low pressure impactor with electrically insulated collection stages. The particles are collected in the different impactor stages depending on their aerodynamic diameter, and the electric charge carried by particles into each impactor stage is measured in real-time by sensitive electrometers.

This measured current signal is directly proportional to particle number concentration and size, thus the ELPI®+ gives particle concentration and size distribution in real-time. By switching the charger unit off, the ELPI®+ can be used for particle charge distribution measurements, (Keskinen, 1992; Järvinen, 2014). In Table 2 there is measurement specification of ELPI®+.

Table 2. Measurement specification

Particle size range = 0.006÷10 µm	Pump requirements = 20 m3/h at 4KPa
Number of size classes = 14	Operating temperature = 10÷35 ºC
Sample flow rate = 10 lpm	Operating humidity = 0÷90% RH Non-condensing
Collection plate diameter = 25 mm	Sampling rate = 10 Hz

The ELPI®+ operating principle can be divided into three major parts; particle charging in a unipolar corona charger, size classification in a cascade impactor and electrical detection with sensitive electrometers. The particles are first charged into a known charge level in the corona charger. After charging, the particles enter

a cascade low pressure impactor with electrically insulated collection stages. The particles are collected in the different impactor stages depending on their aerodynamic diameter, and the electric charge carried by particles into each impactor stage is measured in real-time by sensitive electrometers. This measured current signal is directly proportional to particle number concentration and size, thus the ELPI®+ gives particle concentration and size distribution in real-time. By switching the charger unit off, the ELPI®+ can be used for particle charge distribution measurements, (Keskinen, 1992; Järvinen, 2014).

All the components in the ELPI®+ are housed in a single compact unit. The instrument can be controlled and the measured data monitored in real-time on the 7" WVGA display in the ELPI®+ front panel or the ELPI®+VI™ software installed on an external laptop or PC. Data can either be saved a USB drive in the ELPI®+ unit, network drive or the external laptop and analyzed further using the ELPI®+ data processing spread sheet provided with the ELPI®+. The unit also includes 6 analogue inputs and 3 outputs as a standard. In addition, two K-type thermoselement signals can be logged into the unit. All data is saved into one data file for easy post-processing, (Virtanem, 2001; Marjamäki, 2003).

Measuring of dust concentration is one of useful tools, which enables to perform monitoring of this situation and it serves as a certain technical support for legislation in order to reduce amount of air pollutants.

Decreasing of the wood dustiness in the workplace area would take place, this the inhalation of carcinogen substances us eliminated and threats of tumor occurrence will be decreased.

To maintain long-term working performance of employees, it is necessary to fulfil several criteria. From an organizational standpoints, this constitutes the maintenance of the supply of sufficient working material, quality technology, and machinery operation without malfunction. From management standpoint, it is necessary to secure equitable evaluation of work and sufficient motivation aimed at maintaining performance. However, last but not least, it is necessary to promote the well-being of workers in the workplace, which health status of employees depends of the quality of care devoted to the working environment, (Mračková, 2016).

The legislative tools concerning health and safety at the wood operational workplaces can be indeed implemented if the technical requirements are kept, i.e. application of high-performance exhausting equipment, safety wood-work-techniques as well as the daily regular break for rest.

The organization shall continually improve the adequacy and effectiveness of the environmental management system to enhance environmental performance. When determining environmental

aspects, the organization shall take into account abnormal conditions and reasonably foreseeable emergency situations to prevent and reduce undesired effects, (ISO 14001:2015).

8.8 RESULTS AND DISCUSSION

8.8.1 Measurement in the Real Workshop

The analyzed woodworking workshop was situated in the East Slovak region, in a small working yard Bežovce, county Sobrance. Business area of this workshop was production of furniture, Figure 1. and Figure 2.

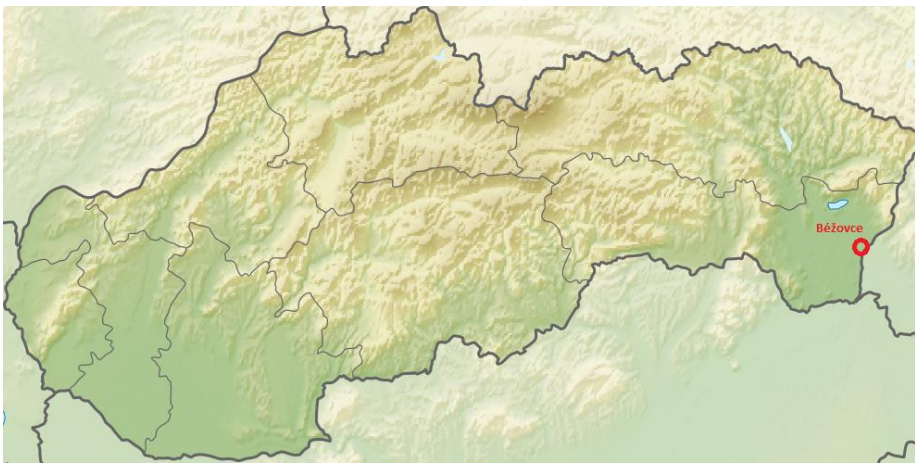

Figure 1. Location municipality Béžovce in the Slovak Republic (Source https://sk.wikipedia.org/wiki/Bezovce)

There are the ground plant (Fig 3) of the selected plant – woodworking workshop with dust measurement points (numbered circles) in workshop area (Fig 4).

The measurement points were given according to the machinery settlement, i.e. working places. It is difficult to determine the correct measurement points because there are the passive influence, e.g. settlement as well as the active influence, e.g. air circulation in consequence ventilation, humidity, the frequencies of door (or windows) opening and closing, human and machinery movements, etc. In this measurement sets there are considered only the passive influence.

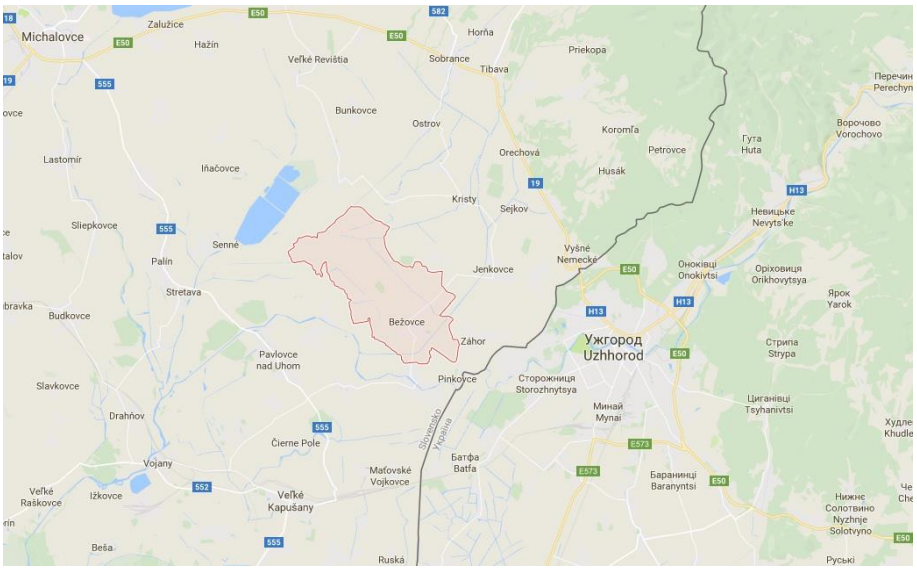

Figure 2. Closer location municipality Béžovce (https://www.google.sk/maps/place/072+53+Bežovce)

In Table 3 there are stated the measurement dates when the dust measurements were performed. The starting day was on 1st November 2016 and the ending day was on 1st June 2017. Number of measurement set was four. In the graph (Figure 5, 6, 7, 8) there are illustrated the dust measurement points in workshop area according to the ground plant (Figure 4) depending on the rate dust – fall in kilograms. In Figure 6 there is overview presentation.

In Table 4 there are stated the calculated values of dust amount for given time period. The workshop temperature was within 17÷31°C and humidity was within 46÷72% during the measurement dates.

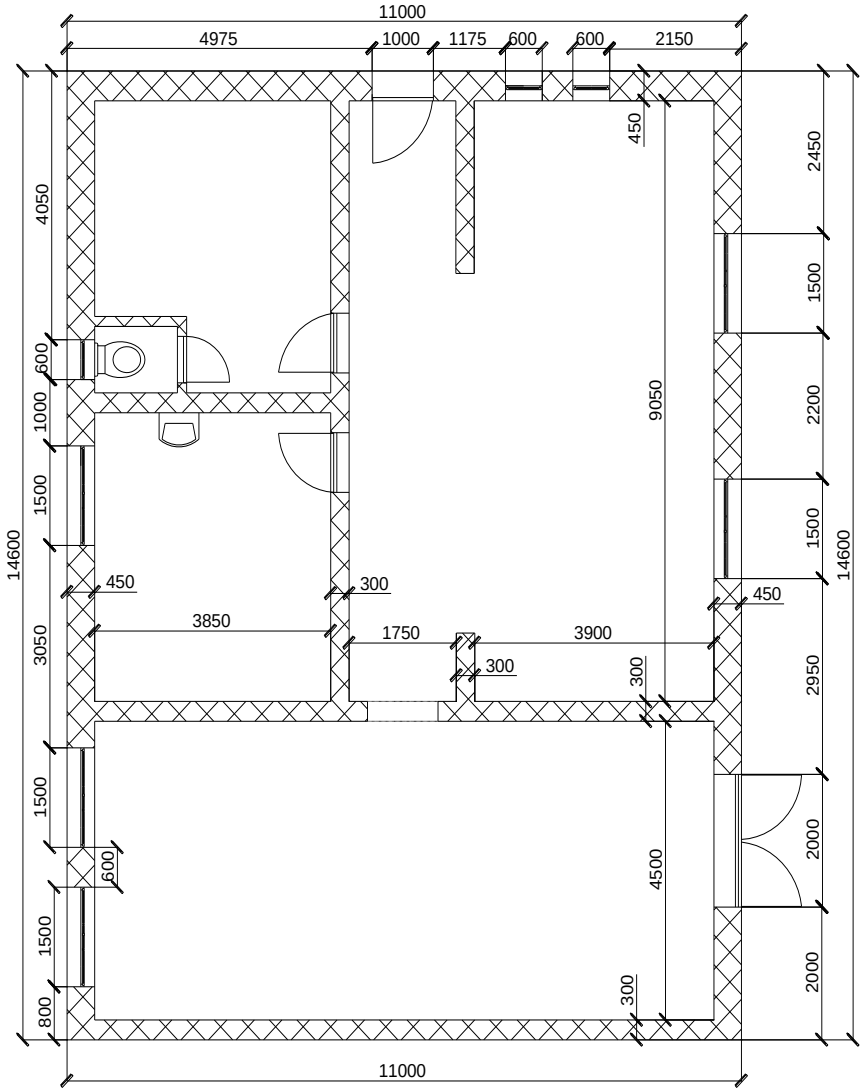

Figure 3. Ground plan of the selected plant – woodworking workshop (Source: own description of workshop)

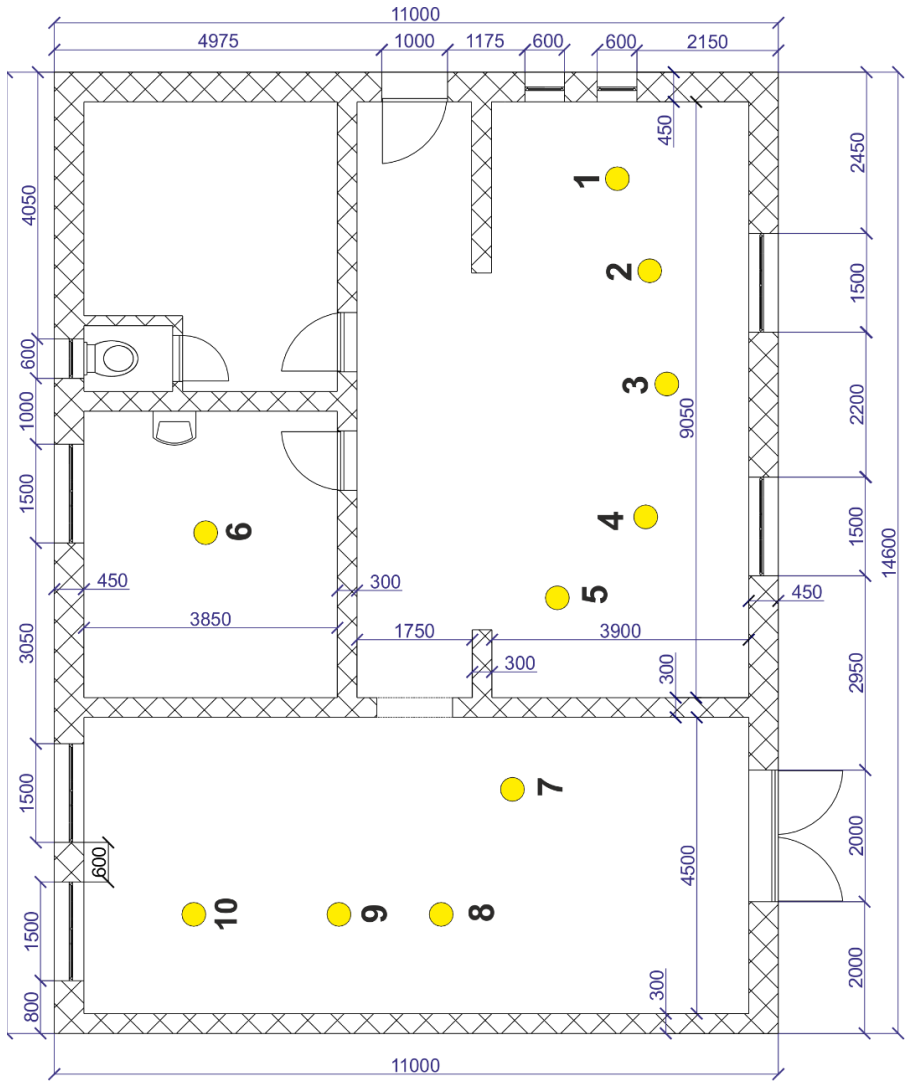

Figure 4. Ground plan of the selected plant – woodworking workshop with dust measurement points in workshop area (Source: own description of workshop)

Table 3. Measurement dates during year 2016 and year 2017

Number of measurement set	Beginning of measurement	End of measurement
1 (waffle texture)	1st July 2016	1st August 2016
2 (light grey)	1st October 2016	1st November 2016
3 (ribbon texture)	1st February 2017	1st March 2017
4 (dark grey)	1st May 2017	1st June 2017

Table 4. Calculated values of dust amount for certain time periods

Time period	Dust sedimentation – Dust fall [kg]		
	For 100 mm^2	For 1 m^2	For workshop area
One day	$5.1071 \cdot 10^{-3}$	0.005107	0.5955
Week	$3.57 \cdot 10^{-3}$	0.0357	4.168
Two weeks	$7.15 \cdot 10^{-3}$	0.0715	8.337
Month	0.0143	0.143	16.675
Year	0.1716	1.716	200.113

The most amount of dust was deposited in the measurement point No.1, then No.2 and No.3, No.5, No.4, No.6, No.7, No.9, No.8 and the less amount of dust was deposited in the measurement point No.10. This order enables to determine the priority of solution (reduction and elimination) for dust fall loading.

In above-mentioned Table 4 there were calculated values of dust amount for given time periods. This Table 4 manifests necessity for the management of working yard Bežovce to plan and to take actions of environmental and health/safety policy because dust fall of year time period presents more strikingly the actual environmental impact.

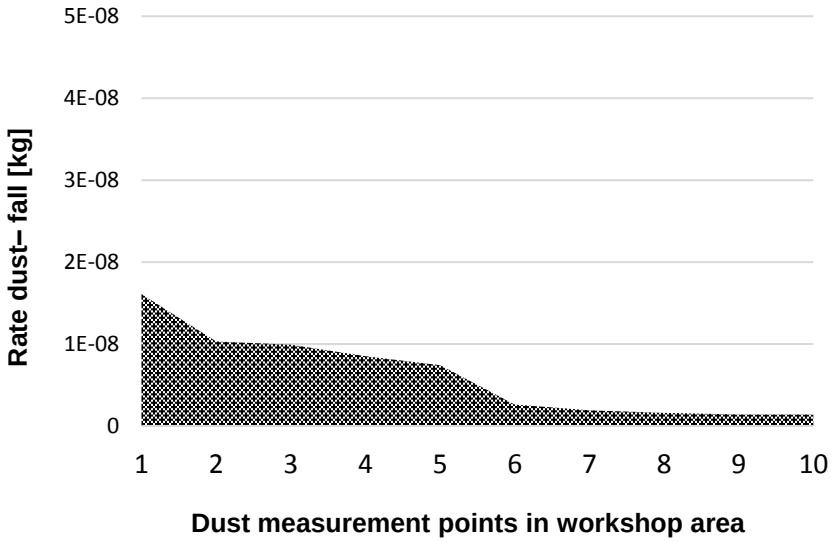

Figure 5. Dependence of dust measurement points in workshop area and rate dust – fall for Measurement Set no.1 - waffle texture (Source: own performance)

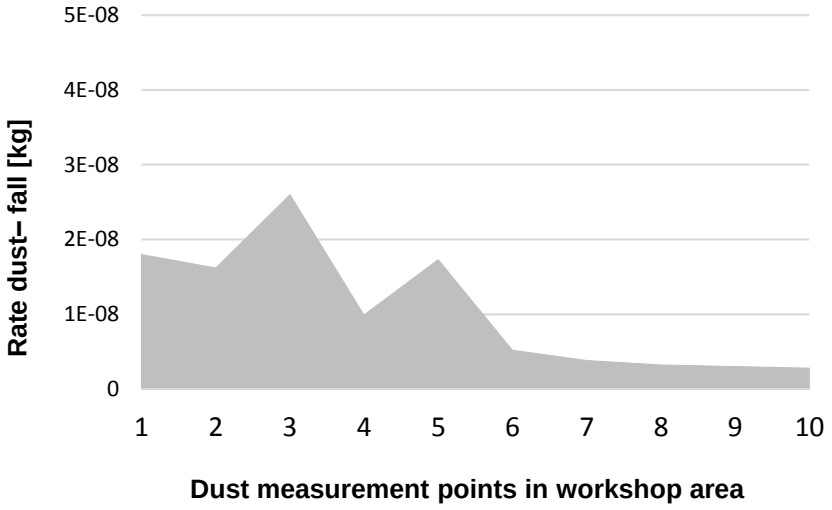

Figure 6. Dependence of dust measurement points in workshop area and rate dust – fall for Measurement Set no.2 – light grey (Source: own performance)

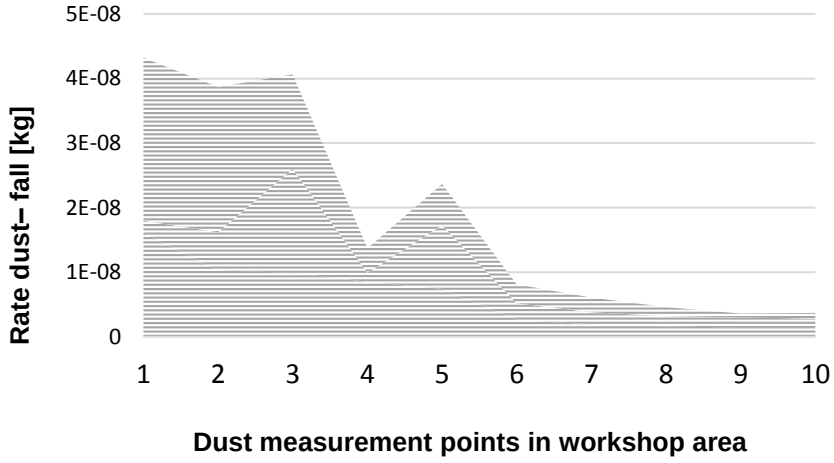

Figure 7. Dependence of dust measurement points in workshop area and rate dust – fall for Measurement Set no.3 – ribbon texture (Source: own performance)

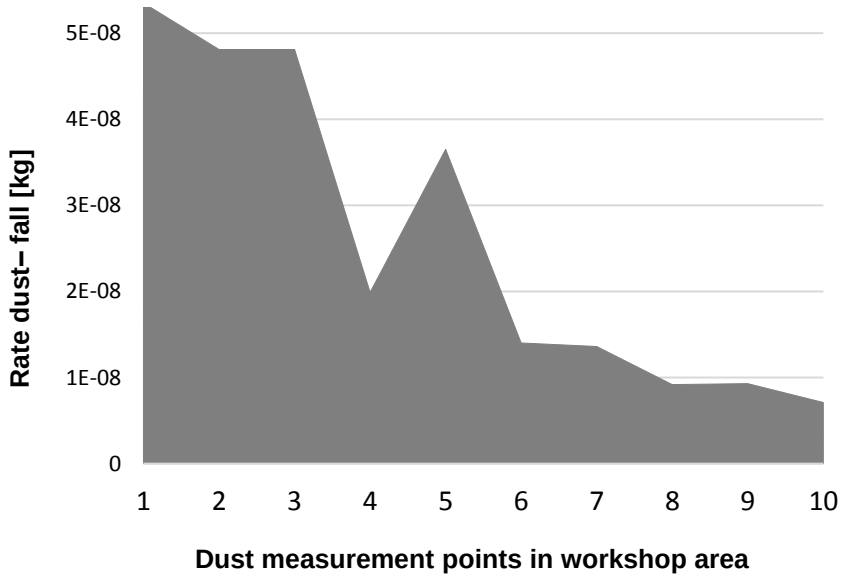

Figure 8. Dependence of dust measurement points in workshop area and rate dust – fall for Measurement Set no.1 – dark grey (Source: own performance)

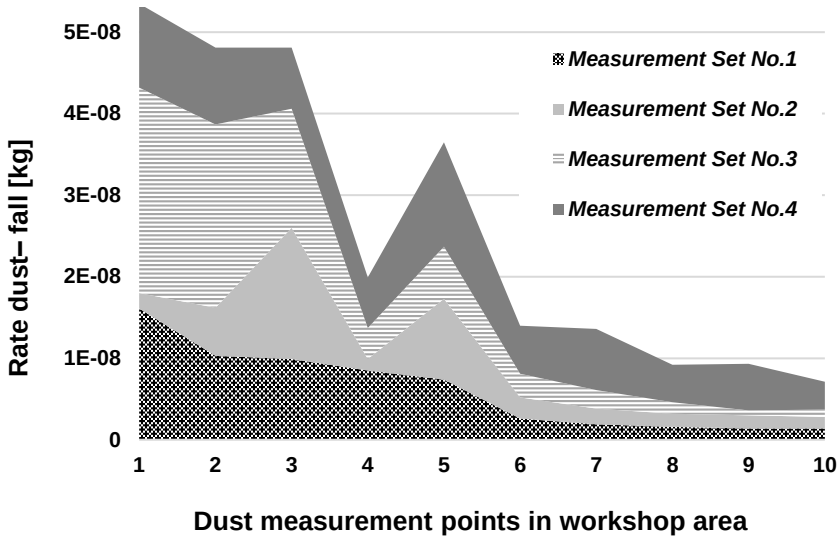

Figure 9. Dependence of all dust measurement points in workshop area and rate dust – fall (Source: own performance)

The management shall establish, implement and maintain the policies that, within the defined scope of their management systems what includes a commitment to protection of the environment as well as the health and safety, including prevention of pollution and other specific commitments according to the relevant standards supporting of integrated management system (Teplická, 2015).

8.9 CONCLUSIONS

1. The workshop area with the saw – measuring point No.1, where the most of dust fall was deposited, it is necessary to separate with a special door like the prevention of dust dispersion and to decreased air movement in consequence of unreasonable human movement. According to planning actions to achieve integrated objectives (ISO standards) the management of working yard Bežovce determine to install the special separating door by means of outsourcing e.g. by the external organization. The resources is required approximately 2,000€ (USD 2,250). The responsible person is the owner of the working yard. The installation will be completed by the year 2017 end.
2. The next step is the complete exchange of old air digesters with low performance and the installation dust storage in containers

No.1; No.2; No.3 and No.5. According to integrated objectives (ISO standards) the management of working yard Bežovce determine to the exchange digesters and the installation containers by means of outsourcing e.g. by the external organization. The resources is required for four work places, i.e. approximately 4*1,100€ (USD 5,000). The responsible person is the owner of the working yard. The installation will be completed by the year 2017 end.

3. The third step is an increasing of cleaning frequency. The present trend of intensive industrial development influences the quality of air very unfavorably. According to integrated objectives (ISO standards) the management of working yard Bežovce work out to the time table of cleaning. The resources is required for every work places. However, the cleaning devices are disposable (they have already bought and they are regularly supported in the framework of general operating costs). The responsible persons are workers at the workplaces in the working yard. The cleaning frequency is scheduled every two working hours.
4. The management planned the saving of costs for wood waste disposal. The obtained year amount of wood dust will be storage, transported and used for briquette compacting which is performed by the external organization with localization about 5 kilometers from the working yard Bežovce.
5. The management modified the environmental and health/safety policies, updating documented information and internal audit program to improve the suitability, adequacy and effectiveness of management systems to enhance performance and preparation for integrated management systems application.

NOTE

In this chapter there are cited references which are related to the Slovak Republic legislation. Similar legal regulations are parts of legislation of the other countries.

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(Decree No. 448/2007 on on details of work and working environment factors in relation to categorization of working activities in terms of health risks and on prerequisites of a petition for working activities categorization)
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9. RISK MANAGEMENT IN THE WOODWORKING COMPANIES – REVISED STANDARD ISO 9001:2015 AND CASE STUDY

Renáta Nováková, Alena Pauliková, Miriam Šefčíková

Motto:
"Don't be afraid of the risk. When it comes out, you'll be happier, if it doesn't work out, you will be smarter. "

9.1 WHY IS IT IMPORTANT THAT THE COMPANY ENGAGED IN RISK MANAGEMENT?

The risk is a historical term that has its roots in the 17th century and it is connected with ship transportation. The term "risico" comes from Italian, and denoted the difficulties that had to be avoided during their voyages by the creeks. At the same time, this term was also referred to as "exposure to adverse circumstances". Currently, the concept of risk is associated with a risk of damage, injury, loss, or destruction, or with a failure in business. This is a net risk in which there is a risk of only unfavorable situations, unfavorable deviations from the required state for which the preservation of property, human resources and health.

Though “risk” should be understood not only as a negative deviation but also as a positive one, which in practice has the concept of “chance”. In the economy, the notion of risk is used in connection with the ambiguous course of certain facts of economic processes and the ambiguity of their results.

However, we know the different types of risks:

- Political and territorial
- Economic – macroeconomic and microeconomic (market, inflation, foreign exchange, credit, sales, payment, etc.)
- Security
- The legal and associated with responsibility for damage
- Predictable and unpredictable
- Specific and non-specific

The concept of risk also needs to add the concept of uncertainty that is part of risk management. Uncertainty is understood in terms of variability that does not allow accurate predictions of future results of certain activities and processes. Uncertainty is random phenomena that can not be accurately measured, only speculation can be said about it. Risk is such a form of uncertainty that can be measured.

Business risk management focuses primarily on:

1. The selection of countermeasures

2. Cost-benefit analysis
3. The implementation of countermeasures
4. Testing of countermeasures

Ability to recognize and effectively manage risks in a timely manner becomes an integral part of the strategic management of business entities. The entities that are not aware of the extent and the force impact of related risks in a timely manner and do not create an effective mechanism for their management, gamble with its stability, reduce the interest and confidence of investors and thus increase the cost of financing. The cost of financing will then be reflected either in a visible form by interest rate hikes, or in a hidden form by increasing the cost of missed opportunities, resolving the crisis, financial management of the company, etc.

Therefore, it is necessary that the company's management in the process of risk management primarily ensures the following activities:

1. Analyzed, monitored, measured risk and understood the risks from both the internal and external environment
2. Defined the targets for reducing the risks of the company, we understand this to determine the most appropriate risk reduction strategy
3. Established and implement the most appropriate methods of reducing risks in terms of a specific company
4. Assessed the application of the risk strategy in practice and then applied the chosen method of reducing risk.

We must note, however, that the risk in any business can not be reduced to zero. That would be then an utopia.

One of the big issues of risk management is the question of casualness, unexpected events, which in the past did not occur at all, or only minimal, but they increase the risk. The author Nassim Nicholas Taleb recalls in this connection the theory of so called **Black Swans.**

It is about unexpected events, or events that have a wide impact, they can not be predicted, and completely deny any expectation, or they do not rusult from any past experience. Black Swans can therefore be the cause of the extraordinary achievements, but also the extraordinary failures. In business, the most of the success depends on the ability to anticipate flying Black Swan rather than the others. At the same Taleb believes that the Black Swan largely depends on the observer - risk manager.

In the woodprocessing industry, we could mention the following examples:

We have many in memory of a devastating whirlwind in the High Tatras. After its rage, bare plains remained in many places, and the whole landscape changed its character. The reason for this was the planting of coniferous trees with shallow roots that, which in the collision of the violent wind uproot and the trees fell like matches. Black Swan

had translated into a destroyed country and fallen timber, which pests started to attack. The opportunity has been maybe established for businessmen who founded their existence on the export of timber abroad, respectively at a lower price for wood that needed to be processed quickly.

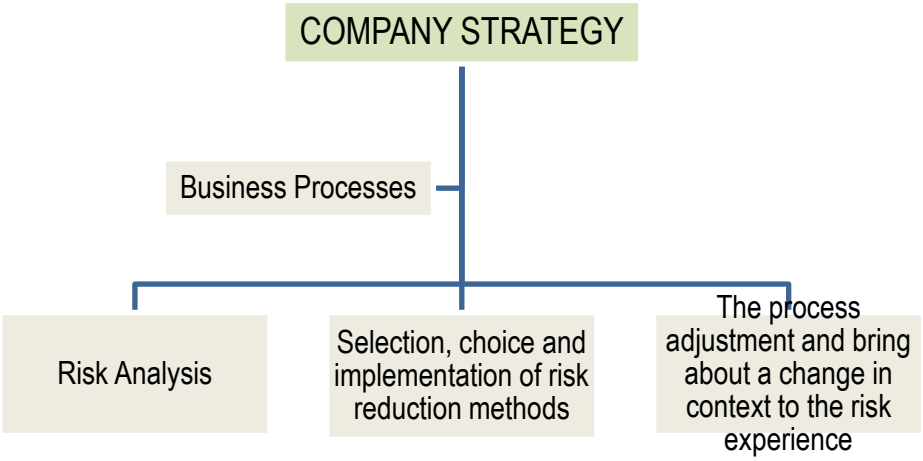

Figure 1. The process of risk management in the business company.

9.2 THE DETERMINATION OF THE RISKS EXTENT

According to potential financial or other losses, we can establish the following breakdown of the risks:

a) critical risk - it is also a threat, which may result in a bankruptcy or in total abolition of the company
b) important risk – the potential loss does not result in bankruptcy, but the next operation will require the company to borrow funds or perform another activity that it would not otherwise need to undertake
c) common risk – the potential losses may be covered by the existing assets of the company, or from ordinary income, without incurring increased financial pressure

Level of risk "**R**" can be expressed through the function of two variables "**f**, where "a" is the impact of the threats and "**h**"is the probability of threats.

$$R = f(a, h)$$

Table 1. Total matrix of risks – impact/ probability

	THE PROBABILITY OF				
	1	2	3	4	5
5	6	7	8	9	10
4	5	6	7	8	9
3	4	5	6	7	8
2	3	4	5	6	7
1	2	3	4	5	6

In the phase of risk analysis and before taking measures to eliminate them we solve the assessment of inherent risks. After the implementation of the measures will be carried out a new assessment of the extent of the risks so that they no longer will include the determination of the extent of the residual risk, or target.

The table below shows the values of the probability of occurrence of risks are defined as follows:

Table 2. The expression of the probability value of the risk occurrence

	The probability of the occurrence of	
The degree of	**% per year**	**Verbal expression**
1	(0 – 5)	Practically unlikely
2	(6 – 20)	Unlikely
3	(21 - 50)	Casual
4	(51 - 70)	Likely to frequent
5	(71 – 100)	Very common

The impact is assessed by the extent of the consequences for the subject on scale 1-5. Thus, numerical data does not represent the value or quantity of numeric data or variables, but belonging to the area. The risk measure according to this method, which is based on the relationship between the amount of impact on the asset and the occurrence probability of such event, is the relevant magnitude on the 2-10 scale and we obtain it as a sum of the probability and impact assessments.This value is based on the dependency of attributes, which are set out in the previous steps of the analysis. The level of risk is then a particular outcome of a risk analysis on the basis of subsequently established security measures and their priority is also determined.

The level of risk 2-4 means that it is possible to accept this risk, it is not excluded from registration, but no measures are taken that would lead to its elimination. Mostly, there are risks where the costs associated with the measure would be higher than the potential impact of the threat.

The rate of risk 5-7 means that it is a risk that requires the adoption of adequate measures, it is necessary to create a plan for the "treatment" of the risk and the relevant activities will be monitored on an ongoing basis in the context of the management of the risks.

The rate of risk 8-10 shows a critical area and requires the immediate adoption of the reform. The action plan foresees the risk elimination by the development of the procedure, that should be given the highest priority within the organization, as the impact of this rigor can reach the critical level for the organization.

In the context of the risk analysis and their subsequent management and administration, it is appropriate to put everything on the principle, that risk is included in the next process of its elimination only if the inherent risk exceeds the threshold set in the strategic allocation for the area of risk management. Risk elimination is possible in two ways:

- the causes of the mentioned risk ceased, respectively the environment has changed so that its inherent risk is lower than the risk specified in the strategy
- the risk was merged with another risk, respectively was divided into several other risks

For the sake of completeness, we explain the inherent, residual and target risks.

Inherent risk this is the level of recorded risk without implemented measures

Residual risk this is the current recorded risk level (taking into account the implemented measures)

Target risk this is a target state that does not require any action to resolve it.

As a result of possible company losses we can still talk about:

- production
- technical
- economics
- market
- financial risks

that are associated with the operation of wood industry companies.

In practice, several risk management recommendations have been noted:

1. Do not waste more than you can afford to lose.
2. Consider the probabilities.
3. Do not waste much for little.

9.3 METHODS OF REDUCING BUSINESS RISK

a) Offensive management of the company

Business management has the potential to significantly affect business risk. One of the ways to prevent the company from business risks is so called offensive approach.

It is characterized by:

1. The right choice of the company's development strategy and its following correct implementation.
2. Preference and development of the firm's strength aspects
3. Efforts to achieve flexibility - a particularly quick response to changes in the internal and external environment - reengineering.

Offensive management can be characterized as follows:

- Operational capability of the company (a combination of employees who are willing to work for the company)
- Marketing management orientation (customer orientation)
- A simple organisational structure (orientation on professional sites with individual creative activity)
- Professional purity (not letting company into unknown areas, which we do not have sufficiently proven)
- People as the most important asset of a company – the pursuit of staff development and communication with them.

All the above mentioned features are characterized by the implementation of quality management in the woodworking company.

b) Risk retention

This method is based on the fact that the entrepreneur is exposed to an unlimited number of risks. Risk retention may be conscious and unconscious, but also voluntary and involuntary. Each company has to decide for itself which risks are to be recorded and tracked, which reduced and that is best to eliminate them.

c) Risk reduction

These methods consist of risk control by contractual terms in business relationships, risk insurance affecting the value of a company's assets, diversification of risk in various aspects of business, and etc. and are related to risk reduction, which can be divided into:

- methods to eliminate the causes of risk (risk transfer, vertical integration)
- methods reducing the adverse effects of risk (diversification and insurance)
- operational analysis methods

d) Transfer of risk

This is the so called defensive approach to risk. The most common ways of transferring risk include:

1. conclusion of longer term contracts for the supply of raw materials and components for a fixed price in advance (the elimination of price risks)
2. conclusion of commission agreements to ensure the sale of products in a foreign trade network
3. conclusion of commercial contracts, which require the collection of a minimum quantity of products
4. conclusion of commercial contracts, which provide the customer with the delivery of production components of the specified quality at a predetermined time
5. issue transfer of technical innovation of production to the cooperating company
6. Futures (e.g. hedging)
7. Leasing
8. Purchase of receivables - factoring, forfeiting
9. Letter of credit, collection, bank guarantees, and others financial instruments
10. Franchising - using the know-how of another company, using its sales system, marketing experience, product quality, brand, franchising image, etc.

9.3.1 Revised ISO standard 9001:2015

In March 2016 was approved revised standard ISO 9001:2015. Part of this standard is the part 6. Planning and 6.1. Actions to address risks and opportunities. Organizations working in wood industry with established quality management system will need to demonstrate how this measure complied in practice. Content of the paper shall be highlight the key issues of Risk management in the woodworking companies in the context of the requirements the amended ISO standard.

The ISO 9000 standards originated in 1987 with a bulletin from the International Organization for standardization (ISO) [11]. The original ISO 9000 series consisted of five standards: ISO 9000, 9001, 9002, 9003 and 9004, plus ISO 8402 (which was published in 1986 and it focused on terminology).

All ISO standards are evaluated on a five-year schedule to determinate whether they remain suitable for their application or if they need to be revised or withdrawn. At the annual meeting of ISOs

Technical Committee 176 in 1990 it was agreed that the series of ISO 9000:1987 should be revised and that the revision should be done in two phases. This approach was adopted because a great numerous of organizations were familiar with the 1987 standards and would likely be resistant to major structural changes. The results of these processes were a small revision of the ISO 9000 family in 1994 and a greater and more important revision with major changes to structure and content of the standards in the year 2000. After the 2000 revision ISO 9000 family consisted of the following three standards: ISO 9000:2000, ISO 9001:2000 and ISO 9004:2000. ISO 9000:2000 was the general standard that serves as an overall guide to the other standards. Its purpose was to provide definitions of terms and a basic explanation of the ISO 9000 standards. ISO 9001:2000 consolidates the former ISO 9001/9002/9003 standards into a single document and was the only standard to which certification was assessed. The 2000 version of ISO 9001 was written to be more user-friendly to small businesses and service organizations.

ISO 9004:2000 provided further guidance for continuous improvement of internal quality management systems. ISO 9001:2008 in essence re-narrates ISO 9001:2000. The 2008 version only introduced clarifications to the existing requirements of ISO 9001:2000. There were no new requirements. ISO 9001 was supplemented directly by two other standards of the family: ISO 9000:2005 and ISO 9004:2009. In 2012, ISO TC 176 - responsible for ISO 9001 development concluded that it is necessary to create a new QMS model for the next 25 years. The revised standard ISO 9001:2015 was published by ISO on 23 September 2015. September 2015 is start of 3 years transition period to September 2018. Certifications to ISO 9001:2008 will no longer be valid after September 2018.

ISO does not decide when to develop a new standard, but responds to a request from industry or other stakeholders such as consumer groups. Typically, an industry sector or group communicates the need for a standard to its national member who then contacts ISO. ISO standards are developed by groups of experts from all over the world that are part of larger groups called technical committees. These experts negotiate all aspects of the standard, including its scope, key definitions and content. The technical committees are made up of experts from the relevant industry, but also from consumer associations, academia, NGOs and government.

The standards are to be applied to any type of organizations; independent to the size of the organizations or the kind of products manufactured or services provided, in private and public organizations, including government services.

9.3.2 New requirement ISO 9001:2015 standard – risk management

Most discussed is an explicit requirement for risk-based thinking. The concept of risk has always been implicit in ISO 9001 such as „Prevention actions"– this edition makes it more explicit and builds it into the whole management system.

Risk-based thinking is inherent in all clause of a quality management system:

- Introduction - the concept of risk-based thinking is explained
- Clause 4 - organization is required to determine its QMS processes and address its risks and opportunities
- Clause 5 – top management is required to (promote awareness of risk-based thinking, determine and address risks and opportunities that can affect product /service conformity)
- Clause 6 - organization is required to identify risks and opportunities related to QMS performance and take appropriate actions to address them
- Clause 7 – organization is required to determine and provide necessary resources
- Clause 8 - organization is required to manage its operational processes
- Clause 9 - organization is required to monitor, measure, analyse and evaluate the effectiveness of actions taken to address risks and opportunities
- Clause 10 - organization is required to correct, prevent or reduce undesired effects and improve the QMS and update risks and opportunities
- Note, risk is implicit whenever suitable or appropriate is mentioned (clause 7 and 8)

All activities of an organization involve risk. Risk is effect of uncertainty on objectives. An effect is a deviation from the expected – positive or negative. Objectives can have different aspects (such as financial, health and safety, environmental goals) and can apply at different levels (such as strategic, organization-wide, project, product and process). ISO 9001 standard combines words risk and opportunities. The risk can be either negative or positive. Opportunity is not the positive side of risk. An opportunity is a set of circumstances which makes it possible to do something.

Organization shall use risk-based thinking to prioritize the way you manage of processes. It means organization shall identify of risk, analyse of risk, evaluating of risk, plan actions to address these risks and evaluate the effectiveness of these actions. Risk-based thinking is

part of the process approach. Not all the processes of a quality management system represent the same level of risk in terms of the organization's ability to meet its objectives. Some need more careful and formal planning and controls than others

Principles and guidelines on risk management are described in ISO 31000:2009 standard. This International Standard can be used by any public, private or community enterprise, association, group or individual. This standard is not specific to any industry or sector. ISO 31000 standard can be applied throughout the life of an organization, and to a wide range of activities, including strategies and decisions, operations, processes, functions, projects, products, services and assets. This standard is not intended for the purpose of certification.

The tools used for risk assessment are described in ISO 31010:2010 standard. This standard describes the process of risk assessment through risk identification, risk analysis, risk evaluation, and risk treatment.

Risk assessment carried out in accordance with this standard contributes to other risk management activities. However, this standard is not decisive for certification or for contractual relations. It should also be said that this standard does not refer to all techniques. Its content consists of the following parts:

1. Standard subject
2. Cited normative documents
3. Terms and definitions
4. The concept of risk assessment
5. Risk assessment process
6. Choice of risk assessment techniques

In section 4.1. "Purpose and benefits" the key benefits of risk assessment are included:

- understanding the risk and potential impact on goals
- providing information to managers – decision makers
- contributing to understanding the risks to help them choose their treatment options
- identifying important factors contributing to risks and weak links in systems and organizations
- comparison of risks in alternative systems, technologies and approaches
- information on risks and uncertainties
- assistance in establishing priorities
- preventing incidents based on surveys after the incident
- collection of various forms of risk treatment
- compliance with the requirements arising from legislation and regulation

- providing information to help assess whether the risk should be taken, when compared to predetermined criteria
- the final risk assessment

In section 4.2. “Risk assessment and the risk management framework” is expressed the assumption that the risk assessment is done on the basis of the risk management process described in the standard ISO 31000. The risk management framework provides policy, procedures and organisational arrangements at all levels of risk management within the organization.

When assessing the risks, we need to focus on the following areas:

- context and objectives of the organization
- the extent and type of risks that are acceptable and how to treat unacceptable risks
- how to assess the risks integrated into organizational processes
- methods and techniques to be used for risk assessment and its contribution to the risk management process
- delegation of responsibility, ability to be accountable and authorization to assess the risks
- resources available to conduct risk assessment
- how the report will be submitted and how it will be reviewed

In section 4.3. the risk assessment focuses on the main elements of the risk management process as follows:

- *Communication and consultation*
- *Setting the context*
- *Risk assessment (identification, analysis and evaluation)*
- *Risk treatment*
- *Monitoring and review*

The risk management documentation is also important. This part deals with subcharter 5.5.of standard ISO 31010. The standard says that the risks are to be expressed in a clear way and the units in which the level of risk is expressed should be clear.

- Scope of the report should depend on the objectives and scope of the assessment. The documentation can then be included:
- Objectives and validity scope
- Description of important parts of the system and their functions
- The summary of the external and internal context of the organization and how this context is related to the situation, system or circumstances considered
- Risk criteria used and their eligibility
- Limitations, assumptions and eligibility of hypotheses
- Methodology of assessment
- The results of risk identification
- Data, assumptions and resources, and validation
- The results of the risk analysis and its evaluation

- Sensitivity and uncertainty analysis
- Critical assumptions and other factors that need to be monitored
- Analysis of results
- Conclusions and recommendations
- References

As far as the ongoing risk management process is concerned, the assessment should be carried out and documented in such a way that the system, organization, facilities or activities can be maintained throughout the life cycle. The assessment should be updated in line with the needs of the management process.

In section 6.2. "The choice of techniques" is declared, that risk assessment can be performed to varying degrees of depth and detail, and using one or more methods from simple to complex. The form of assessment and its output should be consistent with the risk criteria developed as part of the context determination. This means that appropriate techniques must have the following characteristics:

- The technique should be justified and appropriate to the situation or organization under consideration.
- It should provide results in a form that enhances understanding of the nature of the risk and how the risk can be treated.
- It shall be capable of being used in a manner that is unambiguous, repeatable and verifiable.

Once a decision has been taken that the risk assessment is to be carried out and its objectives and scope have been set, should be chosen techniques based on the applicable factors such as:

- The objectives of the study. The objectives of the risk assessment tend to have a direct impact on the techniques used. For example, if it is carried out a comparative study on different variants, it may be acceptable to use less detailed models of consequences for parts of the system not affected by their differences.
- The needs of employees – decision makers. In order to accept good decision, a very detailed description is needed in some cases; in other cases, a more general understanding is needed.
- The types and ranges of risks that are being analyzed.
- Potential severity of consequences. The decision on the depth of the risk assessment should reflect the initial perception of the consequences.
- The degree of necessary expert, human and other resources. A simple, well-designed method can provide better results than a sophisticated but poorly accomplished process. The effort put in the assessment should, as a rule, be in line with the potential level of risk analyzed.

- Availability of information and data. Some techniques require more information and date than others.
- Need to modify/ update the risk assessment. It is possible that the assessment will need to be modified/ updated in the future and some techniques are more easily interchangeable in this respect than others.
- Any requirements arising from legal regulations and rules; and from contracts.

Resources and capabilities that may influence the choice of risk assessment techniques include:

- scope of professional experience and competence of the risk assessment team
- restrictions on deadlines and other resources within the organization
- budget available when external resources are requested

Without claiming completeness, we present at least some of the key methods used in the field of risk management. A more detailed description is part of the standard ISO 31010.

9.3.2.1 Search methods

Table 3. Features of choice of risk assessment tools

	description	resources and capabilities	nature and degree of uncertainty	complexity	it can provide quantitative output
Checklists	A simple form of risk identification. It provides a list of typical uncertainties that need to be taken into account. Users refer to a previously developed list, codes or standards.	LOW	LOW	LOW	NO
Preliminary risk analysis	A simple, inductive method of analysis designed to identify the risky and dangerous situations and events that may damage the activity or system.	LOW	HIGH	MEDIUM	NO

9.3.2.2 Functional analysis

Table 4. Methods for risk assessment based on functional analysis

	description	resources and capabilities	nature and degree of uncertainty	complexity	it can provide quantitative output
FMEA a FMECA	There are several types of FMEA analysis. It can then be followed by a critical analysis that determines the significance of each disorder qualitatively, semiqually, or quantitatively.	MEDIUM	MEDIUM	MEDIUM	YES
Reliability-based maintenance	The method used to identify the policies to be practiced to deal with the failure in order to efficiently and effectively achieve the required safety, readiness and economy of operation for all types of equipment.	MEDIUM	MEDIUM	MEDIUM	YES
Analysis of parasitic phenomena	Methodology used to identify design errors.	MEDIUM	MEDIUM	MEDIUM	NO
Risk and operability study	A general risk identification process to identify possible deviations from expected or intended functionality. They are judged on the basis of the deviations' criticality.	MEDIUM	HIGH	HIGH	NO
Danger analysis and critical control points	Systematic, proactive and preventive system used to demonstrate product quality, reliability, and process safety by measuring and setting specific characteristics that are required to be within specified limits.	MEDIUM	MEDIUM	MEDIUM	NO

9.3.2.3 Risk categories with the highest level of risk

1. Company´s goodwill derogation
2. Economic growth slowing
3. Changing legal and other requirements
4. Increase in competition
5. Inability to attract and retain the greatest talent
6. Inability to innovate products and services in a timely manner
7. Business continuity
8. Fulfillment of obligations towards third parties
9. Computer crime (hacking, viruses, malicious codes)
10. Assets damage

9.3.3 What are the requirements for risk and opportunity management?

If we want to talk about requirements, we will build on requirements that are consistent for individual management systems in ISO 9001:2015, ISO 14001:2015 a ISO 45001:2016.

Organization background

ISO 9001:2015	ISO 14001:2015	ISO 45001:2016
4.1. Determination of external and external issues that are relevant to its purpose and strategic direction and which influence its ability to achieve the intended result of its own SMK. 4.2. Understanding affects or impacts the ability of an organization to permanently provide products and services that meet customer requirements, applicable regulatory requirements. 4.3. Standard compliance can only be declared if the specified inapplicable requirement does not affect the ability or the organization's responsibility to ensure the compliance of	4.1. Identifying internal and external issues that are relevant to its purpose and impacting on its ability to achieve the intended result of an SME 4.3. the determination of the SME subject must be considered the competence and the ability to apply management and affection	4.1. Determining internal and external issues that are relevant for its purpose and that affect its ability to achieve the intended result of SMBOZP 4.3. Consideration of internal and external issues in determining the subject SMBOZP 4.3. Once SMBOZP is designated, organizations must include activities, products, and services that may affect SMBOZP performance

its products and services and increase customer satisfaction 4.4. The organization must identify the necessary processes for SMK, their application in the organization, and manage the risks and opportunities identified according to the requirements of Art. 6.1.		

Leadership and engagement of the employees

ISO 9001:2015	ISO 14001:2015	ISO 45001:2016
5.1.1. Demonstrating leadership and commitment with SMK recognition: d) promoting the use of procedural and risk-based thinking 5.1.2. Customer focus: b) identifying and managing risks and opportunities that may affect product, service and customer satisfaction 5.3. Responsibility and competency for: c) reporting to senior management on SMK performance and on opportunities for improvement: e) ensuring compliance with SMK integrity when planning and implementing changes.	5.2. Environmental policy: a) is relevant to the purpose and context of the organization, including the nature, extent and environmental impact of its activities, products and services; c) includes a commitment to environmental protection, including pollution prevention and further specific commitment to the relevant context of the organization.	5.1. Demonstration of leadership and commitment in relation to SMBOZP by providing senior management: i) ensuring the systematic identification and adoption of measures to address disasters, opportunities and risks and threats related to performance. 5.2. Work safety and health policy must include a commitment to: a) ensuring safe working conditions, prevention of occupational injuries, and must be appropriate to the context of the organization and the extent of the risks and opportunities of work safety (hereinafter referred to as "BOZP") 5.4. Co-participation and involvement of employees in: d) threat identification and risk assessment, discrepancy and accident investigations and corrective action.

Planning

ISO 9001:2015	ISO 14001:2015	ISO 45001:2016
6.1.1. In terms of SMK planning, internal and external issues, stakeholder requirements and risk and opportunity needs to be considered 6.1.2. Measures to address risks and opportunities must be planned 6.1.2. Risk and opportunity measures must be proportionate to the potential consequences of product and service conformity 6.1.3. Planning changes - Consideration must be given to the purpose of the changes and any potential consequences thereof	6.1.1. A process must be created, implemented and maintained necessary to meet the requirements of 6.1.1.-6.1.4.6.1.1 6.1.1.Understanding SME planning should consider internal and external issues, stakeholder demands and identify risks and opportunities related to its environmental aspects, relating requirements, and other issues and requirements 6.1.1. Potential mulfunction incidents, including those that may have an environmental impact, must be identified 6.1.1. Documentary information on risks and opportunities must be kept 6.1.2. To set environmental aspects of activity, products and services, and their associated environmental impacts, which can be managed and influenced by considering the life-cycle perspective, 6.2.1. It is necessary to identify those aspects which have or may have a significant environmental impact, i.e. significant environmental aspects, using established criteria. Documentary information on environmental aspects and their impacts and criteria must be maintained. 6.1.3. Obligatory requirements related to environmental aspects must be identified 6.1.4. Activities and solutions to risks and opportunities need to be planned to integrate these activities into	6.1.1. the internal and external affairs, stakeholder requirements and the identification of risks and opportunities must be considered in the SMBOZP planning. 6.1.1. In determining the risks and opportunities, the following must be taken into account: a) health and safety risks and opportunities; b) legal and other requirements; c) risks and opportunities associated with the operation of the SMBOZP that may affect the achievement of the planned results 6.1.1. Risks must be evaluated and opportunities identified that are relevant to the intended outcome of SMBOZP, are associated with changes in the organization, its processes, or SMBOZP (evaluation must be made before changes implementation). Must be kept documentary information on the risks and opportunities of BOZP and the necessary processes and the management of risks and opportunities. 6.1.2.1. Risk identification - must be created, implemented and maintained procedures for proactively identifying threats 6.1.2.2. Assessment of BOZP risks and other risks SMBOZP - Establish, implement and maintain

	SME processes, to enhance the effectiveness of these activities 6.1.2. Environmental aspects must be taken into account when developing environmental objectives and the risks and opportunities considered.	processes for assessing, identifying and assessing health and safety risks. The BOZP risk assessment methodology and criteria shall be defined in relation to the scope, nature and timing of the methodology, and the criteria shall be maintained and kept as documented information. 6.1.2.3. Identifying opportunities for BOZP and other opportunities - procedures to identify opportunities need to be established, implemented and maintained 6.1.3. Establishment of relevant legislation and other requirements - legislation relating to threats and risks of BOZP 6.1.4. Planning of measures to address BOZP risks - measures to address risks and opportunities need to be planned 6.2. BOZP objectives and planning to achieve them - 6.2.1. The setting of the BOZP targets must take into account: c) the results of the evaluation and the risks and opportunities of BOZP and other risks and opportunities.

9.3.4 Implementing TQM policy into risk management

In order for risk management to be effective, organization needs to respect the following principles at all levels:

A. Risk management creates and protects the value
B. Risk management is an integral part of all organizational processes
C. Risk management is part of the decision making process

D. Risk management explicitly concerns uncertainty
E. Risk management is systematic, structured and timely
F. Risk management is based on the best available information
G. Risk management is tailor-made
H. Risk management takes into account human and cultural factors
I. Risk management is transparent and summarizing
J. Risk management is dynamic, repetitive and responsive to change
K. Risk management facilitates continuous improvement of the organization

Regarding documentation, one of the strategic documents in quality management is Quality Policy. It should include a reason why the organization wants to manage the risks. The linking of risk objectives and policy with the overall goals and policy of the organization should be ensured. The document should also include a statement of responsibility and authority in the context of risk management, addressing specific issues and interests, as well as a commitment to identify and provide resources for risk owners and individuals included in the SMR. It includes monitoring, reviewing and reporting SMR performance and commitment to maintaining and improving SMRs based on changes and other circumstances. The organization must ensure accountability, reference and adequate competence in risk management including implementation and maintenance process of risk management and ensuring the adequacy, effectiveness and efficiency of any controls. Risk management should be integrated into all processes, policies of development, business, strategic planning and review, change management in a way that is effective and efficient.

The risk management process should be:

- an integral part of the organization's management
- implemented in the culture and practice of the organization
- personalized to organization´s business process

An important part of the requirements of the risk management standard is a section devoted to communication and counseling. Communication is a cross-cutting activity that takes place over the course of time and in all risk management activities. The communication plan should be developed within the initial risk management process.

The purpose of the communication plan is to determine what information will be communicated, in what form, how often, who will be involved in communication and feedback. It also includes adequate and appropriate information protection, information security and privacy. The protection of personal data is directly governed by Act no. 122/2013 which regulates the protection of individuals' rights against unauthorized interference in their private life in the processing of their personal data as well as rights, duties and responsibilities in the processing of personal data of individuals.

A counseling team can be set up within risk management. The intention is to involve experts in the definition of risk criteria, risk identification and analysis, risk assessment, risk management, planning of measures implementation, implementation of measures, etc.

9.3.5 Risk range and criteria

Product - risk classification in objects, product/ service, criteria are set according to customer requirements.

Process - breakdown of the risk register by activity and process steps; the criteria are set according to the target process indicators.

Project - risk classification in WBS - project package, criteria are set according to project objectives.

Organization - classification in the risk register according to organizational units or physical locations, the criteria are set according to the functions of the organizational units or the requirements for the working environment.

Subject - classification of risk registers according to the specific subject of the analysis (decision, contract, customer, etc.), criteria are set individually according to the subject orientation.

9.3.6 Examples of risks for different risk class categories

Managerial

There are risks associated with the project schedule, the quality of the project team, the change of the project, the personnel qualification, the management and monitoring of the project and etc.

- short time to implement the project, lack of capacity and capability
- conflict with other projects - insufficiently defined project interfaces, schedule conflicts

- the project team does not include expert professions, teams do not cooperate, conflicts between functional and project management of capacities
- incomplete project plan - goals, resources, capacity, schedule, communication
- nondefined project priorities, dysfunctional project office, inexperienced project manager, resource conflicts
- inadequate control of project progress, delayed problem detection

Purchases

There are risks associated with purchasing, suppliers and their selection, purchase terms, securing supplies, purchasing commodities, assessing suppliers' capabilities and etc.

- limited choice of suppliers - Dominant position of one supplier
- unexpecting termination of production at the supplier, shifting production to another country
- merging supplies from one supplier for several projects - odering better purchase terms
- lack of documents and information to define supplier selection conditions - unclear scope of delivery
- lack of time to select and assess supplier - delay in supplier selection
- increase in commodity prices
- risky outsourcing, its management and control

Technical

There are risks related to technical solution of the project, proposal and development, operation, testing and control, compliance with standards, production risks, etc.

- insufficient information and inaccurate input for proposal and development
- unverified manufacturing technologies and processes, materials, production facilities
- insufficient staff qualification, staff turnover, problem with training
- higher requirements for handling, packaging and shipping
- insufficient source assurance for exercise exam
- specific requirements resulting from technical standards and customer requirements.

9.3.7 Risk assessment techniques

In the literature, in the recommendations of standard ISO 31010, but also in economic practice, we can meet a wide portfolio of risk assessment techniques. It can be said that from the classical ones to more sophisticated methods (brainstorming, structured interviews, Delphi, Preliminary hazard analysis, Hazard Analysis and Critical Control Points, Business Impact Analysis, Root cause analysis, etc.). One of the methods that are commonly used in practice is the FMEA - Failure Modes and Effects Analysis method and FMECA - Failure Modes and Effects and Criticality Analysis. There are several FMEA analysis applications, which can then be applied during proposal, production, or operation. However, in order to increase reliability, it is better to introduce changes already in the proposal phase.

FMEA / FMECA can be used for the following activities:

- it helps to choose an alternative proposal with high reliability
- it ensures that account is taken of all kinds of system and process failures and their consequences for success
- to identify through it the ways and consequences of human error
- it provides the basis for testing planning and maintenance of physical systems
- improves the proposal of procedures and processes
- provides qualitative or quantitative information for analysis techniques, for example tree analysis of fault states

FMEA and FMECA analyzes can provide input to other analysis techniques. In any case, it is necessary to have sufficient detailed information, which may include:

- drawings or flowchart of the system being analyzed and its components, or process steps
- understanding the function of each process step or component of the system
- environmental details and other parameters that can affect the operation
- understanding different faults
- historical fault Information, including data about its intensity, if available, of course.

The FMEA process is as follows:

a) to determine the scope and objectives of the studies
b) to create the team

c) it is necessary to get acquainted with the process, resp. with system subject to FMEA analysis
d) the system shall be decomposed into smaller parts or steps
e) to set the function of each step or part
f) it shall be determined for each component or step determined:
    - how a malfunction can occur in each part?
    - what mechanisms could cause these malfunctions?
    - what could be the consequences if these malfunctions occurred?
    - are these malfunctions serious or not?
    - how do we detect the malfunction?
g) to identify inherent measures in the proposal to eliminate the failure.

This is followed by the classification of each identified malfunction mode by the critical factor by identifying the index of critical mode of malfunction, the risk levels and the risk priority number is established.

The FMEA analysis is documented in a report that contains:

- details of the system that was analyzed
- the way the analysis was performed
- definition of the assumptions in the analysis
- data sources
- results, including the completed worksheets
- calculation of the criticality index and the methodology used for its calculation
- any recommendations for further analyzes, changes in the proposals or attributes, to be included in the test plans and etc.

The strengths of FMEA / FMECA analyzes include the following:

- are wide applicable
- Identify ways of faults of parts, their causes and their consequences for the system, and they are presented in a simple readable format
- problems are identified already at the proposal stage
- identify single point malfuncions and requirements for backed up or security systems
- provides the enter to development monitoring programs using the key features to be monitored

The weakness of the FMEA / FMECA analysis is:

- analysis can only be used to identify individual modes of malfunctions, not a combination of them
- studies can be expensive
- for multilayer systems, they can be time-consuming

Risk management reduces the probability of negative results. The standard ISO 31010 described the tools which can be used for risk assessment. One of the tools is also FMEA, the most widespread tool in practice.

FMEAs have been defined by Pahl and Beitz as “a formalized analytical method for the systematic identification of possible failures and the estimation of the related risks (effects)”. FMEAs can be divided into two categories based on their use: Design FMEA, and Process FMEA.[The focus of design FMEAs is to analyse the product (at a system and sub-system level) to gain an understanding of potential quality concerns arising from product design and functionality. Process FMEAs are performed to investigate manufacturing and assembly procedures to identify, and analyse, potential failures due to improper process design. [25] While conducting FMEAs (both, design and process), the component being analysed needs to be identified first. Next, the type of failure (failure mode) must be determined and recorded. Once this is completed, the consequence of the component failing through the specified failure mode must be investigated and recorded. Based on these assessments, the scenario of the particular component failing through the specified failure mode is assigned a probability of occurrence (O), a score for severity of consequence (S), and a score for detectability of failure during design (D). The values for O, S and D typically range from 1 to 10. A Risk Priority Number (RPN) is calculated by multiplying O, S and D, and is used as a metric to quantify the importance of component failures.

9.4 METHODOLOGY FMEA - CASE STUDY IN WOODWORKING INDUSTRY

The analysed wood-working industrial company has been on the market since 2013 and present they have got 5 branches in the Slovak Republic. The company has implemented an integrated management system (ISO 9001, ISO 14001, OHSAS 18001). Production activity is production of veneered furniture based chipboard as well as production of solid timber furniture. Production is focused on the production of cabinet doors, office furniture, chiffoniers, bookcases and tables. Wood-working industrial company has identified and documentation-supported individual processes. Processes are divided into core, support and management ones. The process, analysed in this article, is manufacturing and packaging process. It belongs to the core processes of the company.

In the process of production and packaging there are the following activities: formatting, pressing, formatting and edge banding, formatting and curved edges banding, surface finishing of the edges, brushing, surface finishing and packaging.

In Table 1 there are shown the monitored quality characteristics, which are checked at individual stages of this process.

Table 5. Quality characteristics

Operation	Monitored Quality Characteristics
Formatting	Thickness according to incise plan, tolerance: thickness ± 0.1 mm
	Dimensions of component according to incise plan, tolerance: dimension ± 2 mm
	Rectangularity according to values for difference of a diagonal, tolerance: rectangularity ± 3 mm
Pressing	Glue spread according to the process scheme: 52g/m^2± 4g/m^2
Formatting and edge banding	Application temperature of glue: 190-210°C
	Dimensions and rectangularity of component according to design documentation
	Accuracy of drilling according to design documentation
Formatting and curved edge banding	Application temperature of glue: 190-210°C
	Dimensions and rectangularity of component according to design documentation
	Accuracy of drilling according to design documentation
Edge surface finishing	Colour shade according to reference samples
	Surface roughness according to reference samples
	Gloss according to reference samples
Brushing	Depth of brushing according to reference samples
Surface finishing	Gloss according to technology technique
	Colour shade according internal colour sample
Packaging	Visual checking of component according to IKEA Handbook (Quality Manual)
	Checking assembly – Checking of drilling

The company performed the analysis of spoilage during time period of three months in 2016. In the Table 2 there are summarised the results.

Tabel 6. Number of spoil works

Month	Operation					
	Formatting	Pressing	Formatting and edge banding	Surface finishing	Packaging	Brushing
October	18,338	3,889	8,456	2,961	14,517	20,848
November	18,708	3,223	7,171	3,716	14,434	20,699
December	13,035	2,679	6,288	2,306	10,802	16,317
Sum Total	**50,081**	**9,791**	**21,918**	**8,983**	**39,753**	**57,864**

The maximum amount of spoil works is produced in brushing activity. After a more detailed analysis it was found that the most frequent nonconformities have come into existence due to overbrushing or vice-versa underbrushing of wooden components. To minimize these nonconformities the company's management performed an analysis of possible failures and their effects (FMEA).

9.5 METHODOLOGY FMEA

The aim of FMEA: Minimisation of spoil works emergent in the process of manufacturing and assembly with the intention of activities related to a brushing.

Team Creation: team leader and members

Methodology Procedure of Brushing:

A process of brushing ensures natural wood look on the base of surface structure-texturing. Summer (soft) wood is pulled out by means of grinding discs and only winter (hard) wood leaves. A result of application of brushing technology on a component is not clearly visible but it is possible to feel touch. A bushed component is at the touch rougher than a moulded melamine component.

Components come into a line on the roll-way, wherein they are moved with sectorial feeder on the conveyor belt of brushing line (see Fig.2a). They continued on the belt towards the brushing booths, wherein the process of brushing is performed (see Fig.2b). After finishing of the process, the brushed components continue to the end of the belt, wherein they are moved with sectorial feeder on the roll-ways, of which they continue to the paint line (see Fig.2c).

a) *b)* *c)*

Figure 2.The brushing line a) input to the brushing line, b) brushing booths, c) output from the brushing line

Requirement imposed on the brushing process:

- mounting of abrasive papers - transverse and longitudinal paper;
- mounting of 5 dead rolls, the first and second roll is used to generate brushed surface (reverse rotation rolls provide removal of the raised fibres). The third roll is used for abrasion of component surface, the fourth roll is a carousel with 19 brushes, which chamfers created groove edges on the component surface and the final, the fifth roll is used for final surface abrasion;
- adjusting of the component thickness;
- adjusting of the conveyor speed;
- setting of the parameters of the longitudinal and transverse brushing;
- setting of the parameters for individual rolls;

Observed quality marks: depth of brushing procedure

The measurement must be performed at least 3 times per a shift as well as when the range of goods is changed. The measurement is performed at 5 points at the direction of a diagonal of a sample. An arithmetic average is calculated from measured values and then it is recorded in the checklist. Tolerance is T = 0.20 ± 0.05 mm.

Failure Mode and Effect Analysis

The team recorded the results of analysis into Tab. 7and Tab. 8. At the assessment of occurrence, significance and detectability we acted upon the tables which are defined in the standard ISO 60812.

Tabel 7. Assessment table of FMEA – actual state

№	Subject of analysis	Possible failure	Possible cause	Possible effects of failure	Occurrence	Significance	Detectability	RPN
1	Brushing procedure	Incorrect adjusted input parameters of brushing line	Incorrect adjusted thickness of component	Underbrushing component	5	7	4	140
2			Incorrect adjusted line speed	Underbrushing component	4	7	4	112
3		Low quality of brushing disks	dust-glazed brushing disk	Underbrushing component	4	7	2	56
4		Incorrect performed measurements	Breach of measurement frequency	Nonconformity occurrence	5	7	5	175
5			Breach of measurement position	Nonconformity occurrence	5	7	4	140
6			Forgotten calibration of depth gauge	Nonconformity occurrence	4	7	4	112
7		Failures of receiver	Incorrect inserted (jammed) component	Overbrushing	3	8	3	72
8		Insufficient pressure in sucking discs of an arm of receiver	Worn sucking discs	Incorrect inserted component into the line	3	5	6	90

Tabel 8. Assessment table of FMEA – after the implementation of corrective action

№	Corrective actions	Responsible	Deadline (2017)	Occurrence	Significance	Detectability	RPN
1	Development of a work instruction Development of a check list Training Retraining once a year Check of record development in a check list for a period of three months	Quality engineer	March 2017	3	7	3	63
2	Development of a work instruction Development of a check list Training Retraining once a year Check of record development in a check list for a period of three months	Quality engineer	March 2017	3	7	3	63
3	Specification of store place for unused disks Covering of brushed disks on the line	Store-keeper	January 2017	1	7	1	7
4	Development of a work instruction Development of a check list Training Retraining once a year Check of record development in a check list for a period of three months	Quality engineer	March 2017	2	7	2	28
5	Development of a work instruction Development of a check list Training Retraining once a year Check of record development in a check list for a period of three months	Quality engineer	March 2017	2	7	2	28
6	Development of a work instruction Development of a check list Training Retraining once a year Check of record development in a check list for a period of three months	Quality engineer	March 2017	2	7	3	42

7	Reprogramming of brushing booth (for a period of stopping of conveyer belt simultaneously stopping of brushing disks)	IT technician	April 2017	1	8	3	24
8	Exchanging of sucking discs once a half-year	Foreman	June - December 2017	1	5	3	15

9.6 DISCUSSION AND CONCLUSION

In the FMEA form there is presented that one of the corrective actions was to develop a check sheet for recording of the parameter machine settings. Observing directly the operation it was revealed that workers had not always set the machine parameters correctly, respectively had not checked the correctness of the entered parameters during the exchange of a shift or at the change of the range of good. Employees' retraining is related to this action. The retraining is oriented at machine setting which is necessary to perform before the actual brushing process. Then there are subsequent recording of the parameters, were adjusted in the machine, in the check list. A shift leader should randomly check the correctness of entered data.

Another proposed corrective action, which is related to up-to four causes, was the redeveloping of work instructions for performing depth measurement of brushing. Therefore there were causes, which are together interrelated it was useless to develop a work instruction for each individual cause. For the reason it was suitable to develop one work instruction, which contains detailed steps of technique in the implementation of the measurement (from the actual calibration of the depth gauge up to the recording measured values). It was also elaborated the record for production supervision of brushing. This record was complemented by a cell with measured values of brushing in diagonally individual points. As well as it was complemented by a cell with an arithmetic mean therefore the company can continue to work with measured values and to assess the brushing process.

Another proposed action is the transfer of abrasive papers to the store with grinding material and abrasive papers. Or it is possible to cover these papers with at least a polythene foil what preventing of dust

glazed of abrasive paper, thereby increasing the quality of the abrasive paper.

Among the latest proposed action belongs reprogramming cycle of brushing booths, so that in the case of hang-up of the conveyor belt, they were stopped and did not produce over brushed components. Further, it is necessary to ensure the functionality of sucking discs for a feeder and a receiver by the exchange in a cycle of half-year. By these actions there should be avoided respectively eliminated the causes of the spoil good occurrence in the brushing line.

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10. THE MACHINE QUALITATIVE CAPABILITY ANALYSIS IN THE WOODWORKING INDUSTRY ENTERPRISE

Renata Stasiak-Betlejewska

10.1 INTRODUCTION

A necessary condition for the enterprise market success is keeping commitments. It means that the most important strategic task for the enterprise is to provide punctual deliveries of products in agreed quantities and quality according to specification. However, its achieving requires ensuring the reliability of the production equipment, i.e. full control over the technical condition of machines, equipment and facilities.

In turn, it requires the predictability of depreciation of all system components and the ability to efficiently restore them to an acceptable state. This activity is carried out in the context of maintenance of daily, systematic work related to the execution of scheduled disposable or periodic tasks in order to prevent deterioration of the technical condition of the equipment and the occurrence of a failure or when it will be removed to restore the means of production to their full functionality.

Therefore, to ensure the full production capacity of the company is required well-organized and efficiently run system maintenance. It depends on efficiency, quality, cost of the production, work safety and environmental impact. Maintaining traffic is usually the largest, unless it is the largest item in the company's operating costs, so it is becoming increasingly sought-after for more effective work and management methods [Ulewicz 2016].

The main goal of the research paper is identification and analysis of the machine qualitative capability in the chosen woodworking industry enterprise.

10.2 THE METHODOLOGY OF MACHINE QUALITATIVE CAPABILITY ANALYSIS

Examining the qualitative ability allows determining the quality requirements meeting by the process. For this purpose indicators of the capability are used [Ożadowicz 2007]. Taking into account tolerance of the tested product properties, it is possible to determine the potential and actual capability of the process to meet the quality requirements. It

results in the specifying the number of products occurred in the specified limits - in the T tolerance field (Figure 1).

$$T = B - A \quad (1)$$

T – tolerance field
A (LSL) - lower tolerance line (lower limit)
B (USL) - upper tolerance line (upper limit value)
To test the process capability, there is taken a process test sample known as a capability test, which contains approximately 200 elements/measurements of a qualitative characteristic. Then the statistical parameters [Skrzypek 2000] are calculated:

- arithmetic average,
- standard deviation,
- range.

The mean value should be equal to the centre of the tolerance field and the standard deviation should be a maximum of 1/6 of that field. Then assuming that the test sample has a normal distribution in the tolerance field, it is 6 sigma or 99.74% of all products. This is a minimum requirement. There are 8, 10 or even 12 sigma values in the tolerance field that should be achieved.

A measure of the process capability that allows meeting the accuracy requirements are c_p and c_{pk} indicators. Prior to the calculation, the following indicators should be determined as follows [Jedliński 2002]:

- Limits of process variability. Typically, the limits of ± 3 sigma are first set around the nominal value of the specification. At the same time, the sigma limits should be the same as those that keep the process regulated by Shewart's control charts. These limits determine the variability of the process. If ± 3 sigma limits are used, then they are based on the normal distribution, it can be estimated that approximately 99% of all piston rings will be within these limits;
- Specification LSL and USL limits. Typically, engineers require a range of acceptable (acceptable) values. In the analysed example, the permissible limits for the the piston rings diameter at of 74,0 ± 0,02 mm can be determined. The lower limit of tolerance (LSL) for this process is 74.0 - 0.02 = 73.98. The upper limit for the tolerance range (USL) is 74.0 + 0.02 = 74.02. These two values set the tolerance range, and the difference USL and LSL is the length of this range.

Potential capability (Cp) is the simplest and most direct indicator of the process ability. It is defined as the ratio of the tolerance range to the length of the process variation interval. Accepting the limits of ± 3 sigma, this indicator can be expressed as [Jedliński 2002]:

$$Cp = \frac{(USL - LSL)}{6 * \delta} \quad (2)$$

Mentioned quotient is the range that is normal curve falls within given specifications (if the standard is consistent with the nominal value, the process is centered). It would be good if the ratio is greater than 1. So, if they get the ability to process, so that no (or almost no) items fall outside the specification limits.

It is interesting that the Japanese in the early 1980s adopted in their enterprises Cp = 1.33 as the standard! The process capability required for the production of high technology goods is even higher; Minolta's factory has set a Cp of 2.0 as its minimum and as a standard for its suppliers. It should be noted that the high process capability is rather less than the increase in costs, taking into account the costs associated with low quality of products [Bryke 2005].

Knowing the process capability index, the capability fraction can determined (***Cr***). This indicator is equivalent to the process capability indicator (***Cp***), and is rather the opposite of:

$$Cr = \frac{1}{Cp} \quad (3)$$

Cr – the capability fraction
Cp – the process capability indicator

A lower / upper potential ability (***Cp*** and ***Cpu***) are important issue analysed in the process capability. The main disadvantage of the ***Cp*** and ***Cr*** indicators is the possibility of misinformation if the process is not set at nominal value, i.e. if it is not centred. Distraction may be disclosed and expressed by the formulas given below. Firstly, the lower and upper capacity indicators can be calculated to show the mean deviation of the observed process from LSL and USL. Assuming ± 3 sigma as a range of process variability, the following indicators are calculated [Jedliński 2002]:

$$Cpl = \frac{\bar{x} - LSL}{3 * \delta} \quad (4)$$

$$Cpu = \frac{USL - \bar{x}}{3 * \delta} \quad (5)$$

If these values are not equal then the process is not centred. In the case of not focusing the process, ***Cp*** can be corrected by calculating the offset factor K [Borkowski and Čorejowa 2004]:

$$K = \left| \frac{(x_0 - \bar{x})}{0{,}5 * (USL - LSL)} \right| \quad (6)$$

X_0 – nominal value

This correction factor expresses zero (nominal vs. average) in relation to the tolerance range (specification). Eventually, ***Cp*** can be corrected for the effect of not focusing by calculating the perceived process excellence (***Cpk***):

$$Cpk = (1 - K) * Cp \quad (7)$$

If the process is perfectly centred then K is zero and ***Cpk*** is ***Cp***. If the process deviates from the nominal value, ***K*** increases and ***Cpk*** becomes smaller than ***Cp***.

The ***Cp*** indicator determines the potential of the process to produce the product within a specified tolerance. The ***Cpk*** indicator is a measure of centring the process, otherwise known as the adjusted capacity index, since it also takes into account the position of the mean value relative to the tolerance limits. The process is capable of meeting the assumed quality requirements when ***Cp ≥ 1*** and ***Cpk ≥ 1*** [Jedliński 2002].

Figure 1 presents the distribution of the process and the characteristic values of the ***Cp*** and *Cpk* indexes. Table 1 presents the scale of the PPM deficiencies based on the values of the ***Cp*** and ***Cpk*** indicators.

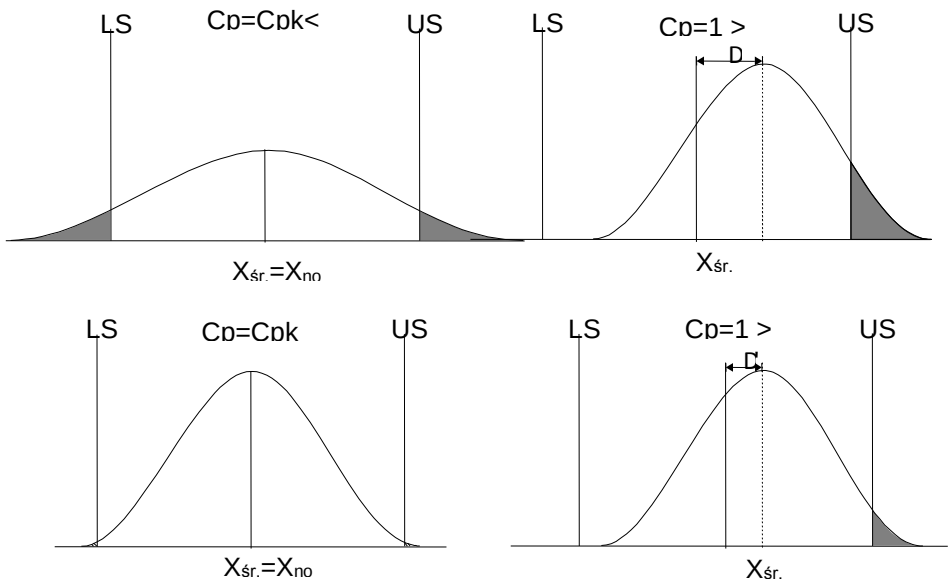


Figure 1. Graphical interpretation of the process capability indicators.
Source: based on Jedliński 2002.

Table 1. The process assessment and the capability indicators values.

The capability indicators	The process assessment
Cpk= Cp	The process is exactly in the centre of the tolerance field
Cp<1 => T<6σ	Process of low quality capability - it is necessary to "improve" the process or extend the tolerance field
Cp≈1 => T≈6σ	Process with average quality ability – there should be expected the nonconformities occurrence
Cp>1,33=>T>8σ	Process with the appropriate quality capability
Cp>1,66 => T>10σ	The great process capability
Cpk≠Cp	The process is not centrally located

The capability of the machine ***Cm*** evaluates of the process behaviour in a short time period. It is an evidence of the new machine capability of a new machine or commissioned, for example after repairs. This indicator is used mainly in the preparation phase for the machine monitoring and for the optimum selection of the machines and equipment in the planning phase of manufacturing. It is determined in a

random sample, during which, under the most unalterable conditions, a large number of elements is processed. This indicator is calculated in relations to [Bryke 2005]:

$$Cm = \frac{(USL - LSL)}{6 * \delta} \quad (8) \quad \text{or} \quad Cm = \frac{(USL - LSL)}{8 * \delta} \quad (9)$$

and the ***Cmk*** adjusted factor is expressed as:

$$Cmk = \min\left\{ \frac{USL - \bar{x}}{3 * \delta}; \frac{\bar{x} - LSL}{3 * \delta} \right\} \quad (10)$$

Process capability indicator ***Cp*** and the equipment (device) ***Cm***, where this process is executed, have the same mathematical form. There is only difference in the process of obtaining measurement data, on the basis of which are determined.

10.3 THE CHARACTERISTICS OF THE ANALYSED ENTERPRISE

The examined enterprise is focused on wooden windows and doors manufacturing with exceptional quality. This enterprise has 40 years of experience, combined with innovative technical and technological solutions, and constantly raised functional and aesthetic standards of the products offered significantly enhance the comfort and satisfaction of customers.

All products of the examined enterprise have technical approvals and certificates of conformity required in the woodworking industry. The quality and reliability of the assortment produced by the company are confirmed by the implemented Integrated Quality, Environment and Safety Management System (ISO 9001, ISO 14001, PN-N-18001).

The flagship products of the enterprise are the WS 6000 single-glazed windows and doors from laminated wood. The assortment includes windows in any shape and size, with wide application in housing, public and religious buildings and monuments. There is, in the windows offer, a wide range of modern construction solutions, increasing the usable values of windows for particular requirements such as protection against nuisance noise, increased intrusion resistance or better thermal insulation. Windows can be equipped with a number of additional elements such as mosquito nets, diffusers, shutters and all kinds of decorative elements. Capital windows are characterized by the following main elements specifications:

- construction - single, thickest on the market - thickness of both the sash and frame 92 mm,
- material of door frames: pine, meranti, oak, glued with four layers,
- Winkhaus envelope fittings with micro-ventilation and adjustment in three planes, with anti-locking protection and additional functions: door lock, door handle controlled by four-point lever. It is possible to use: two-sided handles with key insert, closers, special safety or burglar fittings,
- hinge cover,
- eaves - variant I: aluminium, insulated with a wooden strip in the colour of the window; Option II: aluminium, thermal insulation, LPR,
- two sealing gaskets, flush mounted, thermoplastic, optional additional gasket.

The company has preventive maintenance of machinery and equipment. This procedure is governed by the Infrastructure Surveillance Directive. The purpose of this manual is to establish a procedure for conducting, recording, supervising and preventive maintenance, maintenance and emergency work of individual machines and equipment as well as tools that are equipped with the plant. Responsibility for ensuring the safety of machinery and equipment through supervision of maintenance and repairs carried out by subordinate personnel is attributed to the Technical Director, and the implementation of individual maintenance activities is the responsibility of the Chief Engineer and Chief Electrics. In particular, their duties include:

- preventing and supervising the machinery, equipment and tools used in the individual processes,
- quality and timeliness of preventive maintenance of machines and equipment,
- maintenance of machines and equipment in a documented manner,
- organization of ergonomics at workplaces under staff during preventive actions and breakdown recovery.

Specific goals for maintaining the company's business along with a list of competencies and responsibilities are presented in Table 2.

As part of the infrastructure supervision procedure, all machinery, equipment and tools that are part of the equipment are subject to its accounting. The registration is made on the form DG/PP2/FI-1 called *List of machines and equipment*. It contains information about the machine/machine name, serial number, type, series, date of entry and withdrawal from use. In the case of purchase of new/recalled machines and equipment necessary (obligatory) is noted on the above mentioned form.

Table 2. Goals of the safe and hygienic working conditions ensuring.

	Detail objectives	Responsible person	Measures
1	Ensuring safe technical condition of machines and equipment through supervision of inspections and repairs carried out by subordinate services	Technical director	Timely implementation of plans
2	Maintaining in the proper technical performance of machines and equipment guaranteeing the safety of work by: – systematic maintenance of machinery and equipment inspections, – planned repairs of machinery and equipment, – maintenance of the dedusting and de-dusting system in full efficiency.	Main mechanic	Timely implementation of planned inspections and repairs
3	Complete elimination of the possibility of electric shock when operating machines and devices in the plant: – carrying out tests for protection of the effectiveness of the shock and the insulation of the installations and equipment in accordance with the plan, – repair and maintenance of electrical equipment as planned.	Main electrician	No cases of paralysis
4	Keeping in good technical condition of buildings and structures	Main mechanic	Periodic technical inspection according to the building provisions
5	Ensuring the media necessary for enterprise and its providing in a safe and secure way (for electricity, compressed air, process water, sanitary water)	Main electrician	
6	Ensuring permanent technical – energy service maintenance with appropriate qualifications	Main mechanic Main electrician	The breakdown level

Each machine/device is used in the plant as registered by the Main Engineer in collaboration with the Chief Electrician who prepares and updates the DG/PP2/FI-2 Machine/Equipment Card containing the machine name and number and it specifies in detail the inspection and maintenance procedures. machines/devices and their frequency. This document also records all repairs of the machine / machine.

10.4 THE RESEARCH FINDINGS AND DISCUSSION

The basis for the implementation of the product quality control is to maintain in the production variability of these parameters within the limits established to ensure a level of quality at a sufficiently necessary high probability, therefore, control of the process, which permits to determine whether and at what level met acceptable volatility and stability. Hence, in order to carry out the windows in the correct way, it is necessary to measure stiles of windows and frames fitted with them. These measurements are carried out after pre-treatment blanks of windows on a multi-head milling Griggio. The measurements are made with a VIS digital depth gauge with accuracy of ± 0,01 mm. Average wood moisture content was 12%.

The outline of the profile sections of the rambar is shown in Figure 2 and the dimensions that are subjected to the measurement procedure are indicated by a letter (A, B ...).

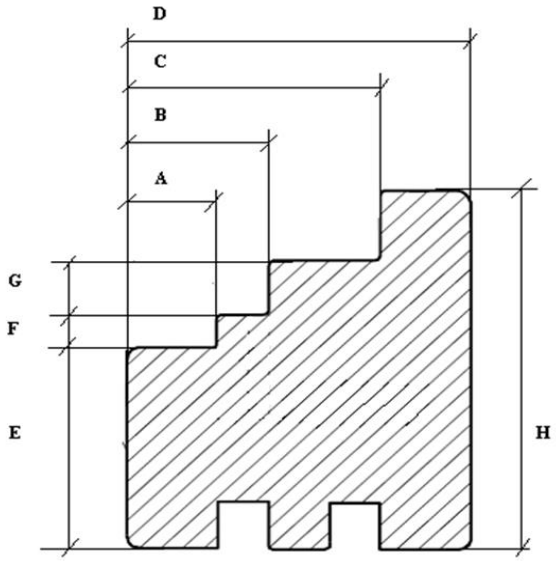


Figure 2. Key dimensions of window frame.

Analysing the case of ***C***, marking it the symbol ***Cn*** we obtain results showing that the normal spread of this dimension field should be in accordance with the equation:

$$Cn = Cmax - Cmin = 6\delta \ (11)$$

Cmax, Cmin – observed dimensions: maximum, minimum.

The dispersion should be less than or equal to the tolerance fit *Tp*:

$$C6\delta \leq Tp \quad (12)$$

To determine the qualitative capability of the machine, it was assumed - according to technological assumptions that for the dimension C:

- the minimum dimension is LSL = 51.5 mm
- the maximum dimension is USL = 53 mm,

Hence, the tolerance field for dimension C is Tpc = 1.5mm. The qualitative capability of the machine ***Cm*** is therefore a relation:

$$Cm = \frac{Tp}{6\delta} \quad (13)$$

Thus, the qualitative capability of the machine is maintained if the value of the ***Cm > 1.*** However, despite its maintenance, nonconformities can occur in the process. It happens when the scattering results are not centred symmetrically to the centre of the tolerance field. To evaluate the centre of the process, the following indicators were used:

$$Cmg = \frac{\bar{X}ss - X\min}{3 * \delta} \quad (14)$$

$$Cmd = \frac{X\max - \bar{X}ss}{3 * \delta} \quad (15)$$

Xmax – dimension C maximum (admissible): Xmax = 52 + 1 = 53 mm

Xmin – dimension C minimum (admissible): Xmin = 52 – 0,5 = 51,5 mm

Xss – the average value of the C frame dimension observed in the sample

The parameter δ (population standard deviation) is defined as the estimator, which is the standard deviation of S in the sample.

Measurements according to the above specification are performed each time the production of a new assortment (new component) is started and after every failure of the machine. Measurements are made every 1 hour, with 5 randomly selected samples from the product on the machine, which gives a change of 40 measurements - 8 * 5 = 40.

Measurements made on 7 April 2017 on the second shift with calculations are presented in quality sheet of machine in table 4.

Data presented in Table 2 present volume and the machine operating time noted in the analysed enterprise what was the basis of the calculation on the machine qualitative capability indicators.

Table 3 presents a summary of the results of the machine efficiency measurement - Griggio multi-head milling machine in the analysed period.

Table 3. Volume and structure of downtime in the analysed enterprise

Research period (a week)	The number					Structure of the machines operating			
	Total fund [mh]	Failure [h]	Aut. Movement Maintenance [h]	Planned conservation of the machines [h]	Total [h]	Failure [%]	Aut. Movement Maintenance [h]	Planned conservation of the machines [h]	Total [%]
26	10584	10	666	40	716	0,09%	6,29%	0,38%	6,76%
27	10584	15	672	21	708	0,14%	6,35%	0,20%	6,69%
28	10584	5	672	20	697	0,05%	6,35%	0,19%	6,59%
29	10584	5	700	28	733	0,05%	6,61%	0,26%	6,93%
30	11088	5	700	40	745	0,05%	6,31%	0,36%	6,72%
31	11088	2,5	712	20	734,5	0,02%	6,42%	0,18%	6,62%
32	11088	0	712	20	732	0,00%	6,42%	0,18%	6,60%
33	12096	10	712	24	746	0,08%	5,89%	0,20%	6,17%
34	11088	0	712	40	752	0,00%	6,42%	0,36%	6,78%
35	10584	0	712	28	740	0,00%	6,73%	0,26%	6,99%
36	12096	20	712	32	764	0,17%	5,89%	0,26%	6,32%
37	12096	5	712	26	743	0,04%	5,89%	0,21%	6,14%
38	10584	0	690	34	724	0,00%	6,52%	0,32%	6,84%
39	10584	0	690	23	713	0,00%	6,52%	0,22%	6,74%
40	11088	2,5	690	21	713,5	0,02%	6,22%	0,19%	6,43%
41	10584	17,5	690	40	747,5	0,17%	6,52%	0,38%	7,06%
42	10584	0	690	24	714	0,00%	6,52%	0,23%	6,75%
43	12096	2,5	720	12	734,5	0,02%	5,95%	0,10%	6,07%
44	12096	5	720	12	737	0,04%	5,95%	0,10%	6,09%
45	12096	1,5	720	24	745,5	0,01%	5,95%	0,20%	6,16%
46	13104	10	734	24	768	0,08%	5,60%	0,18%	5,86%
47	12096	0	720	32	752	0,00%	5,95%	0,26%	6,22%
48	12096	1,5	720	28	749,5	0,01%	5,95%	0,23%	6,20%
49	12096	5	720	18	743	0,04%	5,95%	0,15%	6,14%
50	12096	0	720	12	732	0,00%	5,95%	0,10%	6,05%

According to the above assumptions and the results obtained (Table 2), the qualitative capability indicator of the milling machine producing the window frame with a nominal size of 52mm on April 7, 2017, was:

$$Cm = \frac{1{,}5}{6 * \delta} = \frac{0{,}4}{6 * 0{,}146} = 1{,}708$$

Indicators of centering were:

$$Cmg = \frac{53 - 52{,}04}{3 * 0{,}146} = 2{,}18 \qquad Cmd = \frac{52{,}04 - 51{,}5}{3 * 0{,}146} = 1{,}23$$

Since the centering indicators are not equal (***Cmd*** **<** ***Cpg***), the displacement index K was calculated, the value of which was:

$$K = \left| \frac{(52 - \bar{52{,}04})}{0{,}5 * (53 - 51{,}5)} \right| = 0{,}05$$

Thus, the qualitative capability ***Cmk*** was:

$$Cmk = (1 - 0{,}05) * 1{,}708 = 1{,}618$$

Table 4. Summary of the results of the machine efficiency measurement - Griggio multi-head milling machine in the analysed period

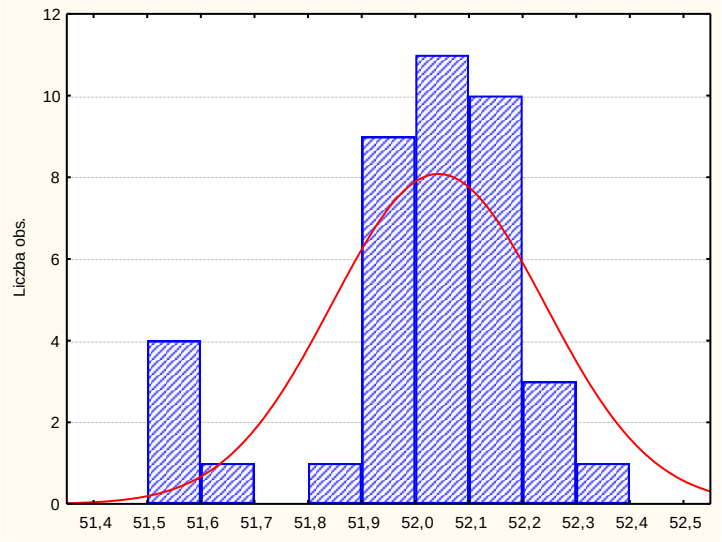
Griggio mulit-head machine Model: G240 P	Shift	Czas awarii	hanging tooling	Adjustments	lacement of blade	acement of drill bi	Downtime	riable working tim fund	TZ - TP	perating factor	Ideal unit time	Actual unit time	oefficient operati speed	Production	P*RCJ	ful operating time	he coefficient of performance	he quality level	quality coefficien	all efficiency of th device
		TA	ZO	R	WO	W	TP	TZ		WE	ICJ	RCJ	WPD	P		UCD	WW	PJ	WJ	OEE
1 April	1	0	0	10	0	0	10	480	470	97,9%	1,52	1,57	96,7%	280	438,67	93,3%	90,3%	3,0%	97,0%	85,72%
	2	0	6	12	0	0	18	480	462	96,3%	1,68	1,75	95,7%	255	446,25	96,6%	92,5%	1,0%	99,0%	88,09%
	3	0	3	3	0	0	6	480	474	98,8%	1,68	1,80	93,3%	254	456,05	96,2%	89,8%	2,0%	98,0%	86,86%
2 April	1	0	6	4	0	0	10	480	470	97,9%	1,28	1,51	84,6%	280	421,79	89,7%	76,0%	0,7%	99,3%	73,85%
	2	0	3	5	0	0	8	480	472	98,3%	1,28	1,51	84,3%	300	453,85	96,2%	81,0%	1,0%	99,0%	78,89%
	3	0	3	12	0	0	15	480	465	96,9%	1,28	1,45	87,7%	300	435,94	93,8%	82,3%	1,0%	99,0%	78,89%
3 April	1	30	6	6	0	0	42	480	438	91,3%	1,28	1,57	81,4%	279	437,10	99,8%	81,2%	0,5%	99,5%	73,74%
	2	0	0	9	0	0	9	480	471	98,1%	1,52	1,57	96,7%	300	470,00	99,8%	96,5%	0,6%	99,4%	94,12%
	3	0	5	9	0	0	14	480	466	97,1%	1,52	1,57	96,7%	297	465,30	99,8%	96,6%	0,5%	99,5%	93,27%
4 April	1	0	5	5	0	0	10	480	470	97,9%	1,52	1,57	96,7%	277	433,97	92,3%	89,3%	2,0%	98,0%	85,68%
	2	0	3	12	0	0	15	480	465	96,9%	1,68	1,71	98,0%	271	463,41	99,7%	97,6%	3,0%	97,0%	91,73%
	3	0	5	12	0	0	17	480	463	96,5%	1,68	1,72	97,4%	266	457,52	98,8%	96,2%	1,0%	99,0%	91,89%
5 April	1	0	5	15	0	0	20	480	460	95,8%	1,68	1,72	97,4%	255	438,60	95,3%	92,9%	2,0%	98,0%	87,20%
	2	0	0	8	0	0	8	480	472	98,3%	1,68	1,73	96,8%	255	441,15	93,5%	90,5%	1,0%	99,0%	88,09%
	3	0	0	5	0	0	5	480	475	99,0%	1,00	1,20	83,4%	388	465,40	98,0%	81,7%	0,4%	99,6%	80,51%
6 April	1	0	3	4	0	0	7	480	473	98,5%	1,00	1,19	83,7%	393	469,42	99,2%	83,1%	0,5%	99,5%	81,47%
	2	0	5	5	0	0	10	480	470	97,9%	1,00	1,18	85,1%	392	460,60	98,0%	83,4%	0,1%	99,9%	81,59%
	3	0	2	7	0	0	9	480	471	98,1%	1,00	1,18	84,9%	388	456,87	97,0%	82,4%	3,0%	97,0%	78,41%
7 April	1	0	5	5	0	0	10	480	470	97,9%	1,28	1,57	81,4%	280	438,67	93,3%	76,0%	0,2%	99,8%	74,22%
	2	0	5	7	0	0	12	480	468	97,5%	1,68	1,57	106,9%	267	418,30	89,4%	95,6%	3,2%	96,8%	90,19%
	3	0	3	12	0	0	15	480	465	96,9%	1,68	1,57	106,9%	270	423,00	91,0%	97,3%	1,2%	98,8%	93,09%
Average		**1,43**	**3,48**	**7,95**	**0,00**	**0,00**	**12,86**	**480,00**	**467,14**	**97,32%**	**1,42**	**1,53**	**92,18%**	**297,48**	**447,23**	**95,75%**	**88,18%**	**1,33%**	**98,67%**	**84,64%**

Table 5. Griggio multi-head testing machine on the qualitative capability.

Machine: multi-purpose milling machine Grigio	SUPERVISION OF MACHINES AND MANUFACTURING DEVICES	F.10//PP.03 Edition 3
Material: Pine 12% moisture	The qualitative capability of the machine/device No 0075	Page 1

Product: Wooden window frame

Symbol and number of the drawing: 862431D



Feature:	Linear dimension 52
Denomination:	mm
Nominal value:	52,0 mm
Lower tolerance limit:	51,5 mm
Upper tolerance limit:	53,0 mm
Tolerance limit:	1,5 mm
Sample number n:	40
Medium value:	55,04 mm
Standard deviation:	0,146 mm
Cm:	1, 708
Cmd:	2,18

Measurement results

51,54	52,00	52,10	52,10	51,60
52,12	52,10	52,00	52,14	52,10
52,00	52,10	52,14	51,54	52,00
52,14	52,17	52,00	52,10	51,90
52,11	52,23	52,10	52,13	52,00
51,70	52,00	52,10	52,00	51,54
52,30	52,10	52,34	52,20	52,30
52,10	52,10	52,15	52,00	52,19

Number of results in the tolerance field 100%

Cmg: 1,23

Comments:

$$Cm = \frac{53 - 51,,5}{6 * 0,146} = 1,708$$

Cmk = 1,618

Machine/process evaluation criteria

Cm ≥ 1,66

Measurements made
First name and last name:

Signature .....
.....

Date: 2017 – 04 - 07

Qualitative evaluation of the machine / proces capability

☐ POSITIVE ☐ NEGATIVE

Based on the above results, it should be concluded that the machine is capable qualitatively, since the Cm indicator is greater than 1 and even greater than the assumed criterion Cm> 1.66. The spread of results around the nominal (nominal) value is not symmetrical. This may be illustrated by the histogram of the C-size distribution and the moderate value of the displacement factor K = 0.05. Thus, the adjusted capability indicator Cmk machine differs from the Cm (Cmk = 1.618 at Cm = 1,708).

Overall, it is important to note that the machine (Griggio multi-head milling machine) milling the post-crash miter remains capable of quality. Significantly, the distribution and distribution of the obtained results (diameters of the window frame) was centred around the nominal value and also coincided with the normal distribution, as evidenced by the

figure in Figure 3, which shows the distribution of the results obtained in the form of the histogram.

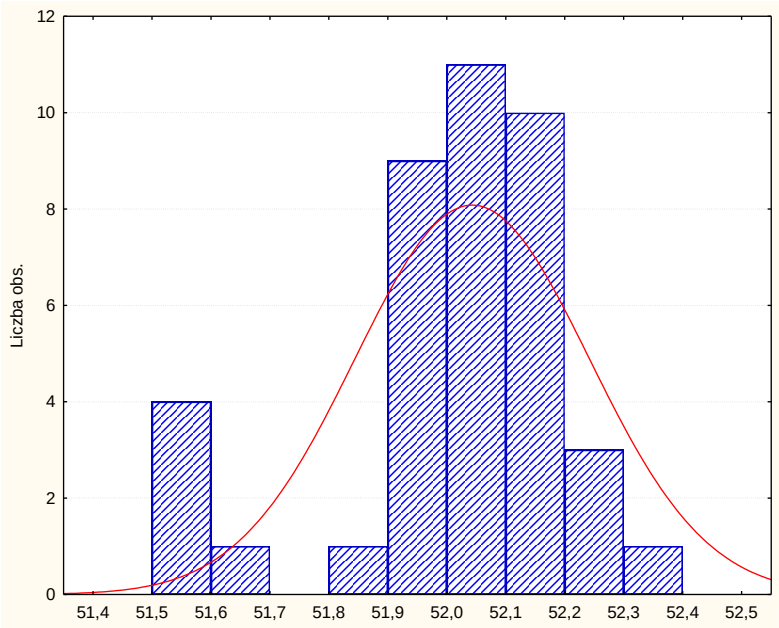


Figure 3. Distribution of the results of the window frame measurement after failure of the machine - Griggio multi-head milling machine.

The histogram presented in Figure 3 also indicates that the distribution is not symmetrical, is asymmetric left-handed, as is also evidenced by the non-zero offset K and the different centring indexes (bottom lower than the upper).

10.5 CONCLUSIONS

The production process is closely related to the operation of machinery and equipment, where various problems arise with regard to the operation of a single device and a group of devices. Within a single device operating problems there are analysed problems connected with starting up the device, its durability and reliability, usage and use, and the degree of its use, evaluation of its effectiveness, modernization and adaptation. As part of the problem of operation of the group of devices, the issues of replenishment and replacement of the traffic organization equipment were analysed in the paper.

It should be noted that the problem of reliability and exploitation theory covers not only the technical aspects of the existence and functioning of devices. At the stage of creating systems, organizing their operation and renewal, there are problems in assessing the effectiveness of different possible solutions and choosing the best option from the point of view of the goal to which it is intended. In addition to the technical indicators determining the quality and reliability of the system, a significant factor is the economic side of the proposed solution - the expected system revenue, the costs involved, or any loss due to downtime.

These issues are conducive to the process of improving operational economy, consisting in making undertake strengthening positive trends and negative trends weakening in the way of technical or organizational changes with the introduction of ad hoc or scheduled too. During these projects, maintenance systems have been developed, ranging from reactive, on-the-spot repairs of technical equipment where needed by a preventive maintenance-focused system to an inspection system focused on diagnostics and reliability theory.

An important feature of new organizations is systematic approach and complexity of operations and sustainable development, which takes into account not only the financial result, but also the relationship with the customer, the effectiveness of organizational processes and the internal innovation and development potential. An example of a systematic approach to organization is the TPM philosophy, which seeks to achieve zero faults, zero defects in production and zero accidents at work. Under this concept of excellence is the management of company resources, which, on the basis of common sense, teamwork and practice developed by companies, mainly Japanese, allows to increase productivity, improve product quality and increase profitability of the enterprise.

The factory implementation of TPM is largely related to the assessment of the existing state using the ratio of OEE, the overall equipment effectiveness calculated on the basis of its performance: the availability of the importance of active work machine utilization in terms of the planned quality of manufactured machine products.

TPM implementation of the system greatly simplifies control of the production system in the plant. Changes in the company improve the communication process between the service users and the technical users. The increase in knowledge and skills of both parties becomes a highly motivating factor facilitating change of tasks and responsibilities. This approach reduces the number of failure with the need for the intervention of technicians. Over time, reduced costs are incurred.

In order to meet new challenges and competition, the analysed enterprise must maintain and develop a high level of organization in all areas of its business. These areas concern the organization of

production, quality assurance, nonconforming product supervision and infrastructure, as well as continuous training of personnel.

Quality assurance is largely a derivative of the appropriate organization of the production process, and in the company under consideration there is a continuous maintenance and quality improvement process that applies to every department, department or even workplace. Each of these components of the process organization creates quality plans based on quality objectives for the individual "owners" of the processes.

Human beings are an essential part of the process. Therefore, the policy of the company's senior management is to continuously improve the qualifications of employees, i.e. training, in terms of their scope, purpose, time and destination. For this reason, the company develops a plan to continuously improve the qualifications of its personnel.

A particular aspect of the development of the company's management system is the policy of maintaining machinery and equipment, which is manifested, among others. implemented infrastructure supervision activities, involving elements of research into the efficiency of the use of machines and equipment and the qualification of machines. The operation of each machine in the company is recorded, and any deviation from the normal operating mode is corrected and even eliminated on the basis of defining and introducing preventive measures, especially in the area of autonomous maintenance.

The preventive nature of the machinery and equipment is regulated in the examined enterprise, and the procedure in this respect is regulated by the supervision of the infrastructure, which is aimed at establishing procedures for conducting, recording, supervising and preventing, repairing, maintaining and emergency works of individual machines and devices. In doing so, the company managed to minimize the number and the short duration of failures to a minimum (less than 0.5% of the nominal fund of machines), and the number of planned shutdowns due to planned repairs are minimized to 0.5% of the nominal fund of machines. In addition, efficient use was made of the productive use of the machine infrastructure.

The presented elements of the implemented TPM system in the company show how productive is the system. A few months of research in the field of production show that the consolidation of existing monitoring and analysis tools with the human cell produces significant effects in terms of stabilizing the availability of production equipment.

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11. QUALITY IN THE PRACTICE OF POLISH FURNITURE INDUSTRY ENTERPRISES

Robert Ulewicz, Renata Stasiak-Betlejewska

11.1 INTRODUCTION

The value of sold production of the furniture industry in Poland in 2016 amounted to PLN 42 billion. Forecasts for the coming years reflect positive sentiment about the development of the analyzed market. It is estimated that by 2020, the value of sold furniture will increase by over 18% and will amount to almost PLN 50 billion. The largest increase in sale value was recorded in 2011 (17.3%). This increase was mainly due to the increase in turnover on the institutional clients market, which in turn was directly connected with the Polish Presidency of the European Union and the organization of the EURO 2012 football championship. Thus, a significant decrease of sales in 2012 was made (-4.6%). The entire furniture industry grew at an average annual rate of 8.7% in 2010-2015, which is better than the figure achieved by Polish manufacturing (5.2%). The difference in average growth dynamics is all the more important when we analyse the shorter period - the growth rate of the furniture industry in the period 2012-2015 was 10.7%, while the industry average was 2.5%.

Poland is an important player in the world furniture market. It is in the forefront of the largest European furniture manufacturers. The value of the Polish furniture market represents more than 7% of the value of furniture production across Europe. Poland is the fourth largest exporter of furniture in the world. Export plays a key role in the Polish furniture industry. The main markets for Polish furniture are European countries, mainly Germany (36% of Polish furniture exports), Great Britain (8%) and Czech Republic (7%). Value of furniture sold in Poland (in PLN billion) is presented in Figure 1.

The furniture industry in Poland has a clear surplus in the balance of foreign trade. The ratio of export to furniture import has remained at a very high level for several years. According to GUS (The Central Statistical Office) data, in 2015 the value of furniture export amounted to PLN 36.3 billion, while import were six times smaller (amounting to only PLN 6.1 billion). In the next 2016 the export of Polish furniture amounted to PLN 40.5 billion. This represents an increase of 11.5% over the previous year, indicating a continuing upward trend in the balance of payments.

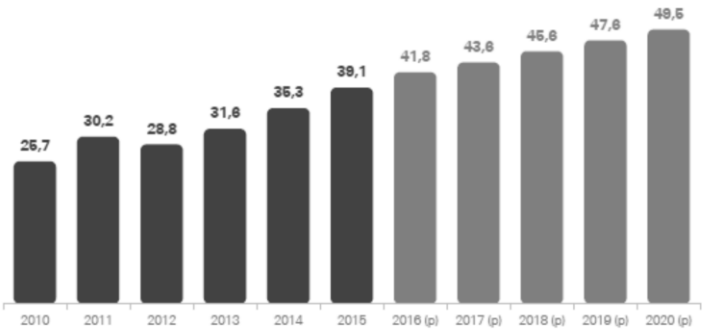

Figure 1. Value of furniture sold in Poland (in PLN billion).
Source: KPMG in Poland based on GUS data and Euromonitor International;
(p) - total output sold for the years 2016-2020 are projected values based on the annual average rate of change in the production value forecast for 2016-2020 from Euromonitor International database

The main market for Polish furniture products is the European countries market, where the main partners of Poland are: Germany (over 36% of Polish export), Great Britain (8%) and the Czech Republic (7%). Only about 13% of Polish furniture is exported outside the European Union, including to the USA, Russia and China. This is due to the very high transport costs that cause the product price to become unattractive on the basis of local products. Furniture from Germany and China has dominated over more than five years with a combined share of over 40%.

In 2014 - 2017, as many as 61% of all survey respondents have purchased new furniture. Only 7% of respondents have not purchased any furniture since 2014. It is worth noting the upward trend in purchasing new furniture as the household's net income grows. More than three quarters of respondents with a household income of more than 10 thousand zloty have declared buying new furniture in the last three years, while in the lowest income group (up to 2 thousand zlotys) this figure was only 53% (KPMG 2017).

There was noted a growing role of the Internet as a place for furniture purchase. With the dynamic development of technology and the level and variety of online store offerings, the role of the Internet as a place of purchase has increased noticeably - almost every third respondent buys online furniture. Even more, as 41% of Poles are considering buying furniture online over the next year. The average amount of furniture purchased by a household in 2014 - 2017 is 4,500 PLN (approximately 1 000 Euro). Nearly half of the respondents who have purchased furniture in the past three years have declared a sum of between 500 Euro and 1200 Euro for this purpose. The source of

furniture financing was most often the savings deposited for this purpose and current funds.

Analysing a number of factors that affect the furniture purchase decisions, the most important factor that influence on the consumer purchase decision are: the functionality of the furniture (88% of respondents identified this factor as an important or very important) and the furniture stability (87%). The third place in terms of the furniture purchase determinants structure is relation of the quality to the furniture price (84%). As many as 82% of the respondents said that the high quality of the product as well as the ability to match furniture offer to their individual needs have a big impact on their purchase decisions. There is also important to be able to return or complain about purchased furniture, as well as attractive appearance.

The main aim of the paper is the analysis of Polish furniture enterprises with regard to applying of the quality management instruments in the product quality management.

11.2 CHARACTERISTIC FEATURES OF POLISH FURNITURE ENTERPRISES

Representatives of the furniture industry assess positively the current situation of Polish furniture market. Its opinion is depended on the type of their business. Entities operating on the Polish market evaluate it more positively than exporters. Even companies with a short history are more optimistic (80% of respondents asses very positively the current state of the industry). Table 1 presents evaluation of the individual elements of Polish furniture industry enterprises.

As it results from the data presented in Table 1, Polish furniture enterprises very positively evaluate furniture market offer variety and modernity of the production means since Polish enterprise are involved in the production machines investments with using European funds. The product quality level is highly evaluated as the factor that is important for Polish furniture industry. It is worth to noted, that 58% of Polish enterprises underline shortages in personnel availability.

Companies are optimistic about the current and future situation in the furniture industry. Almost one third of respondents expect further improvement and more than half believe that they will remain at the current level. In addition, 37% of companies forecast revenue growth from the previous year.

The key areas of the company's strategy are the safety and quality of the product and the adaptation of the business to the prevailing consumer trends. Aesthetics, functionality and simplicity will shape the furniture industry in upcoming years. Representatives of companies operating in the furniture market say that furniture will be maintained

primarily in light shades of wood, white and gray. The trends shaping the level and dynamics of sales also include the representativeness and lightness of forms and shapes.

Table 1. A evaluation of the individual elements of Polish furniture industry enterprises.

Evaluation element	Negative evaluation [%]	Positive evaluation [%]
Variety of offer	2	88
Modernity of the production means	4	82
The product quality	3	76
Timely delivery of orders	2	75
Competitiveness / maturity of the sector	8	74
Size of the market	6	73
Innovative solutions	10	68
Management experience	4	64
Settlement dates	9	61
Consumer awareness	12	55
Availability of capital	18	44
The use of environmental solutions	14	42
The ability to enter new markets	15	42
Availability of staff	58	17

Source: based on KPMG 2017.

11.3 QUALITY MANAGEMENT INSTRUMENTS IN THE DESIGN AND PRODUCTION

The enterprise, in order to achieve its goals and tasks, must have measures that will allow the product quality development at all stages in the cycle of its existence. In the literature is referred to the so-called quality management instruments. These are principles, methods and tools that affect quality. In essence, it is about effective mechanisms for responding quickly to problems, analysing the causes of their occurrence and taking remedial action.

Knowledge and, above all, the effective use of quality management methods and techniques are a testament to the organization's high culture and are associated with the maturity of the quality management system and managerial awareness. It should be noted that few organizations benefit from these tools, and if anything, this is more the effect of extortion customer requirements or standards than the desire to own the company.

There are many quality assisting instruments and they are widely described in the literature [Łańcucki 2006].

11.3.1 Characteristic of the selected quality management methods

The basis for the success in the management projects is the risk management importance increase. One of the methods of risk analysis in the management process is FMEA, which identifies the weak points in the product design. FMEA is one of the most commonly used techniques for analysing the risks of engineering projects, by identifying possible causes of defects and specifying the potential for defect prevention [Maddoxx 2005]. This allows identification of potential problems with the product before it reaches the final customer [Puente et al. 2002, pp. 137-150]. This method is used to prevent the effects of defects that may occur in the design phase and in the production phase. According to W. Deming (1994) 75% of the causes of errors occur in the product design phase, but their detection in this phase is small. As much as 80% of the errors are revealed only during production, during inspection or at the customer's expense, i.e. where costs are greatest. The FMEA method was developed to maximize error detection at the early stages of design or production and at the same time minimize the cost of poor quality. When the product goes into serial production or even to the customer, the ability to eliminate errors is limited and at the same time very costly.

In order to analyse the causes and effects of errors, the risk priority number, called the risk index, is calculated as the product of probability of the error occurrence, significance of error for client and error detection [Stamatis 1995]. For the application of the following method there were made observations [Dale 2003]:

- there are two types of applications: improved internal processes and minimal use to meet customer needs,
- the use of FMEA is less difficult than the SPC because the latter requires an understanding of statistical methods,
- engineers consider the FMEA a laborious and resourceful task,
- teamwork is not sufficiently used for FMEA preparation,
- the main difficulties are related to time constraints, improper understanding of FMEA, inadequate training and lack of management involvement.

The FMEA method emphasizes the importance of cost when defects are detected by the customer and the costs associated with it in the form of a warranty return.

The next instrument that is used in the product design phase is the QFD method (Quality Function Deployment). The QFD method has been developed to meet customer requirements through process design and production systems [Evans and Lindsay 1999, p. 405]. Akao [1990, p. 12-22] emphasized that the QFD method relies on the transfer of

customer expectations, referred to as "voice of customer" to the product characteristics expressed as "counterpart characteristics". The goal of QFD is to capture the "voice of the customer" and make sure it is transformed into the right strategy, product, and process requirements. In a broader sense, the QFD methodology is given in steps by Daetz, Barnard, and Norman [1995, pp. 9-11].

The QFD method should take into account all factors that affect the quality of the product or process designed from the beginning of its creation, i.e. from design through production [Cohen 1995].

Quality Function Deployment should streamline the process of communication between the client and the company and contribute to the growth of mutual satisfaction.

This method is a systematic process of the business concentration on the customer and his needs. A precondition for the correct application of the method are market research of the customer needs. These studies have to answer three basic questions:

- What do customers expect?
- How is it important for them?
- Is there compatibility between customers' expectations and the product?

Knowledge of responses to the above questions is absolutely necessary and determines the effectiveness of further analysis (Stasiak-Betlejewska 2016).

This is a Japanese method, and actually a kind of culture (culture) of continuous improvement of the organization including all employees [Horvath & Partner 2005]. The goal is to systematically improve the performance (parameters) of the processes by improving them in small steps, orienting them on the wishes of their internal and external customers, and using the skills and experience of all employees to solve existing problems. Kaizen is a process management tool, and its focus is on partial processes (actions) within the economic process, rather than on the economic process itself [Schmelzer and Sesselmann 2003, Tuček and Dlabač 2012]. In this way, this method complements the concepts of improving entire business processes (such as BPR).

The five golden rules of the KAIZEN management are following (Titu et al. 2010):

- When a problem first occurs, go to GEMBA,
- Check Gembutsu – unconformable product,
- Take temporary measure on the spot,
- Find the main cause (use the five WHY? questions),
- Standardize to prevent reoccurrence.

According to Titu M.A., Oprean C., Grecu D. (2010), KAIZEN must be a way of being, an attitude, a spirit to be permanently present within each team; Our lifestyle, both at home and at work, should focus on our constant efforts to improve; The application of the Kaizen principles

supposes a continuous dialogue between the manager and the employees (vertical communication) on the one hand, and between the employees on the same hierarchical level (horizontal communication), on the other hand.

The Taguchi method of product design is an experimental approximation to minimizing the expected value of target variance for certain classes of problems. Taguchi's method is extended to designs which involve variables each of which has a range of values all of which must be satisfied (necessity), and designs which involve variables each of which has a range of values any of which might be used (possibility). Tuning parameters, as a part of the design process, are also demonstrated within Taguchi's method. The method is also extended to solve design problems with constraints, invoking the methods of constrained optimization (Otto and Antonsson 2008).

The most important difference between classical experimental design and a Taguchi-method-based robust design technique is that the former tends to focus solely on the mean of the quality characteristic while the later considers the minimization of the variance of the characteristic of interest. Although, the Taguchi method has drawn much criticism due to several major limitations, it has been able to solve single response problems effectively (Jeyapaul et al. 2005).

Comparing the traditional and contemporary approach to quality assurance and product reliability, it can be said that the traditional rule of non-abandonment of the enterprise was first replaced by the principle of the high quality and reliability, followed by the principle of continuous improvement and as its result by the quality and reliability of the product and manufacturing technique and the continuous quality improvement of the entire enterprise. Nowadays, companies are increasingly adopting the "zero defects" principle and "continuous improvement processes".

The rule, called "zero defects", was proposed by P. Crosby (1994). It depends on the faultless production of products, without shortcomings, defects and the need for corrections. The implementation of this principle is possible through the use of appropriate undertakings, including:

- measurement of product characteristics and manufacturing process parameters and presentation of results in a way that allows them to be objectively evaluated by comparison with the required values and in case of deviations - taking appropriate corrective actions,
- encouraging employees to work together and creatively formulate their own goals and ways to improve the quality of their manufacturing processes and reduce production defects,

- creating a system of communication between employees and management in order to achieve the least possible production defect.

11.3.2 Characteristic of the selected product quality management tools

The quality of manufactured products is currently one of the most important issues raised in relation to business management. Actions aimed at identifying and excluding defective products, and based on post-production control, give way to projects aimed at bringing about a situation in which defective products will be significantly reduced.

The huge number of potential causes resulting in the final defective product means that attempting to propose preventive measures for all possible situations would entail the need to work on a large scale and incur high costs. In this situation, it is necessary to take action to identify the most important causes for the effect of the production process. Quality management tools can be used to identify important causes.

Quality management tools are used to collect and process data related to various aspects of quality [Borkowski 2004]. Applying of those tools allows monitoring, analysing and influencing processes throughout the life cycle of your product. Due to its simplicity are widely used both in design and in the monitoring and control of manufacturing processes of products or services. In literature [Borkowski 2004, Hamrol and Mantura 2011] there are two groups of quality management tools: traditional and new quality management tools. Traditional quality management tools are following:

- Cause and effect diagram of Ishikawa,
- Pareto analysis,
- block diagram,
- correlation graphs of variables,
- histogram,
- graphical presentation of the results,
- control sheets.

The second group are tools complementary to traditional tools [Hamrol and Mantura 2011]. They are not new in terms of the common practice of business management, however quality management is a step forward in relation to the state in which only the tools listed in the first group were used. The tools provided here solve problems and help streamline the flow of information and their effective exchange.

The new quality management tools include [Borkowski 2004, Hamrol and Mantura 2011, Wolniak and Skotnicka 2011]:

- relationship diagram,

- affinity diagram,
- matrix diagram,
- systematic diagram,
- PDPC diagram (decision diagram),
- arrow diagram,
- matrix analysis of data (analysis of main components).

The cause-effect diagram is a very popular tool in the quality management. Its name is derived from the author's name, but sometimes due to its shape it is also called a fish bone or a herringbone pattern. For the first time this method was used in Japan at Sumitomo Electric. Like most Japanese tools, it is simple and very effective. It is currently one of the most widely used quality management tools. The essence of Ishikawa's diagrams is the graphical presentation of the interrelationships between the effects that can cause them to be caused by various causes. Appropriate visualization, on the one hand, supports the process of searching for causes, on the other hand ensures the preservation of structured structure between the identified elements. This method is very often used during teamwork. Provides excellent support during brainstorming.

The causes identified in the Ishikawa diagram may be the ultimate solution to the problem. They may also be the starting point for finding reasons for even greater detail. Visualization of the next level of causes can take place within the same diagram or in subsequent diagrams, if the readability of the results is compromised. Identifying groups of causes, you can use solutions that suggest a specific structure. One such proposal is the basic formula of Ishikawa diagram based on the 5M approach, whereby the reasons should be sought in one of the five main areas: MANPOWER, METHOD, MACHINE, MATERIAL, MANAGEMENT [Borkowski 2004, Hamrol and Mantura 2011, Wolniak and Skotnicka 2011].

Pareto analysis, also called the ABC method, is based on the empirically established fact that 20-30% of the causes cause 70-80% of the effects. This was first discovered and described by Italian economist Vilfredo Pareto. Using statistical data, he analysed the income distributions of the population in designated intervals. He observed that 80% of Italian resources were in the hands of 20% of families. Given the existence of such uneven distribution also in other situations, Pareto formulated the principle now known as rule 80:20. The universality of this principle makes it widely described in literature [Borkowski 2004, Hamrol and Mantura 2011, Wolniak and Skotnicka 2011]. The ABC method is very widely used in a variety of areas related to the organization management. As a result of the analysis, it is possible to propose preventive measures against a narrow group of precisely selected causes. This makes it possible to reduce the number of

occurrences of certain types of defects without the need for costly, large scale operations.

11.4 QUALITY INSTRUMENTS IN POLISH FURNITURE ENTERPRISES – RESEARCH FINDINGS

Contemporary furniture enterprises in Poland are forced to innovative approaches to managing their business. Growing competition in the furniture market and increasing customer demands cause that, it is important to develop a new type of organization management that will select and use the many concepts, methods, and tools that will help transform it into a reliable and reliable organization of success.

The variability of market environment is constant, so the enterprise organization and organizational adaptation processes should also be continuous and comprehensive. It is necessary to change thinking and acting in the business. The subject of the research analysis in this paper is the evaluation of selected Polish furniture companies in terms of the use of quality management instruments.

Evaluation on the one hand is an integral part of the quality management system, and on the other hand it forms a certain subsystem of the organization management system. An assessment of the quality management system consists of activities performed in an enterprise management process whereby the manager recognizes the state of achievement of a specific objective or set of objectives for the course of product quality development and the process of its supervision.

The analysed enterprises group is located in Silesian and Łódź region. Silesian voivodship is one of the most developed voivodships in Poland. Its share in the creation of gross domestic product in 2011 was 13.0% and he only surrendered to Mazovia (22.3%). This situation has not changed since the introduction of the new administrative division (1999). Also in terms of the total number of employees, which in 2011 amounted to 1648.1 thousand. of people, which constituted 11.8% of workers in Poland. The Silesian Region is one of the most economically dynamic regions of Poland. 13.7% of Gross Domestic Product (GDP) is produced here, giving the province the second place in the country. GDP per capita is 23,700 PLN and is higher than the national average by 2.3 thousand PLN. The change in the economy of the region is a significant change in the structure of the gross value added here (the value of newly created). The share of market and non-market services is currently 60.5%, which is 3.5% higher than in 1999.

The Lodz Region is located in the central part of Poland and covers the border region of the established historical regions of Mazovia, Wielkopolska and Małopolska. The capital of the region is the city of

Łódź, which brings together almost 30% of the population of the region (747 thousand inhabitants). The active economic policy of the voivodeship authorities is aimed at the development of friendly administration for small and small entrepreneurship and for the creation of attractive employment conditions.

Figure 2 presents the number of furniture enterprises in Polish regions.

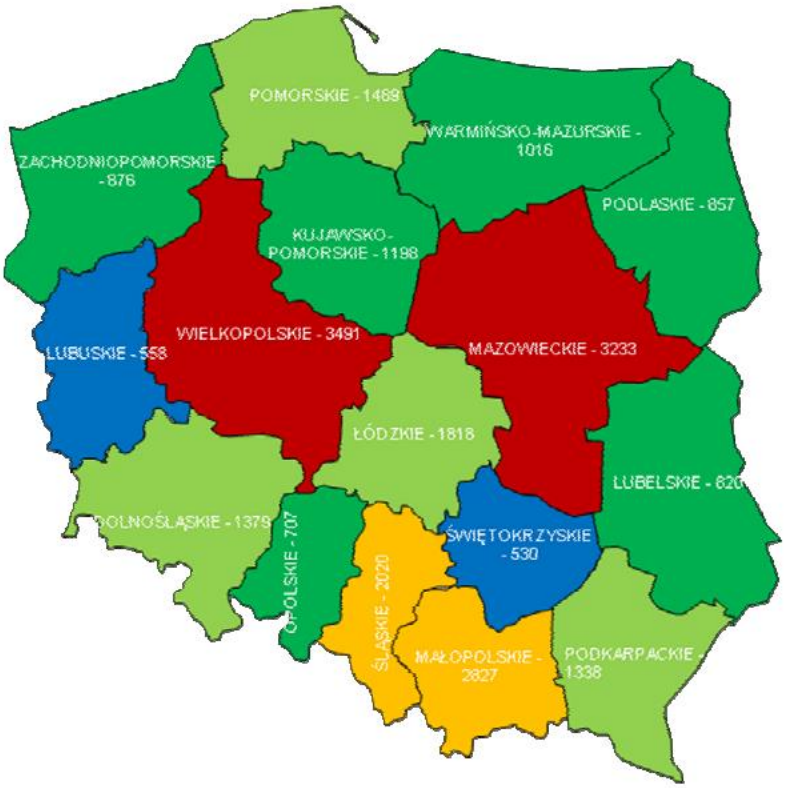

Figure 2. The number of furniture enterprises in regions in Poland. Source: GUS 2016.

The research group consists of 20 Polish enterprises from furniture industry: 2 large enterprises employing more than 250 workers, 7 medium enterprises (51 – 250 workers) and 11 small enterprises (less than 50 workers).

Figure 3 presents the enterprises type structure.

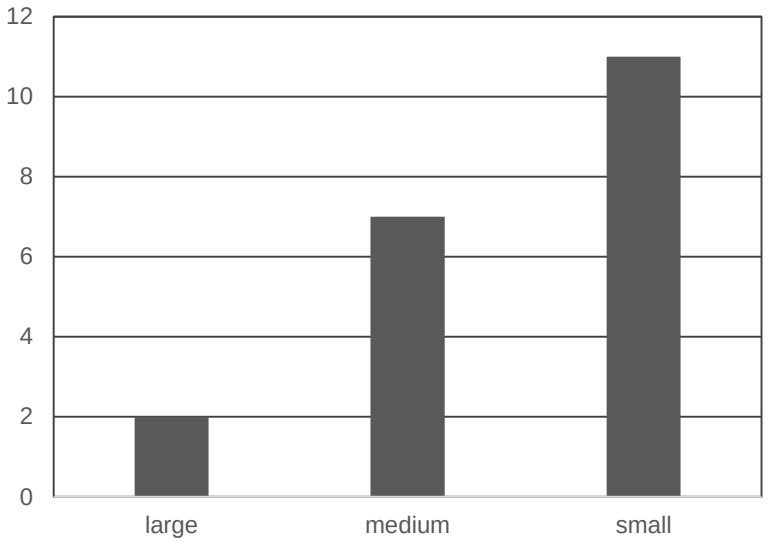

Figure 3. The structure of analysed Polish furniture enterprises types. Source: own study.

Furniture manufacturing in the analysed enterprises group is mainly based on wood and wood products. In addition, other materials used as fasteners, edge finishes, binders, packaging are also necessary. The basic division is as follows: plates, timber and accessories (edging, glue, staples, metal hardware, screws, plastic parts, packaging).

It should be written, that in the analyzed group of companies have not been implemented so far no quality management systems, or the owner does not provide for such a move in the near future. This does not mean, however, that quality problems are not perceived or are permanently ignored. Although there are no formal procedures that would monitor the production cycle in a comprehensive way, with the exception of the standards established, production usually takes place in a manner that is not disturbed and the finished products almost always meet customer requirements.

Most of the analysed entities operating in the field of industrial processing belong to the branches of low or medium-low technical level. This is a situation that does not significantly differ from the national structure (Figure 4).

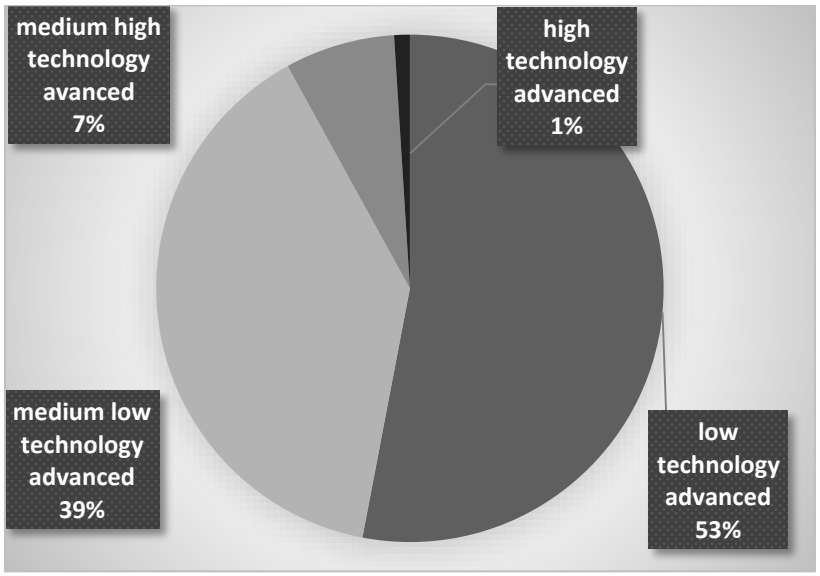

Figure 4. Level of technological advance in analysed Polish furniture enterprises. Source: own study based on GUS/Eurostat.

Approximately a half of the enterprises in Poland are low technology advanced (53%). For less numerous in the region and the country group of entities manufacturing medium-high technology (called. Medium high technology) are related to the manufacturing enterprises specializing in the machinery and an equipment. Although the quoted classification is tied R & D 11, it does not mean that the dominant or low-tech companies in the region are not involved or cannot engage in such development activities.

Polish enterprises operating in the field of wood and furniture manufacturing show a very high level of competence in the use of information and communication technologies. Nearly all surveyed entrepreneurs declare that they provide - to most or most of their employees - access to the Internet in the workplace. Only 10% of respondents indicated that Internet access had a small proportion of employees. Internet access in almost every case is associated with access to e-mail (90% of companies surveyed). Nearly 90% of surveyed entrepreneurs also indicated that non-MS Office software was used in the workplace. In 51% of surveyed MS Office companies use all employees and in 36% most employees. This demonstrates the advanced skills of using computers to work.

One of the most effective tool of the competitiveness advantage of Polish furniture enterprises is the quality management instruments set

implementation. One of the well-known in the enterprises a quality management tool is Ishikawa diagram (Figure 5).

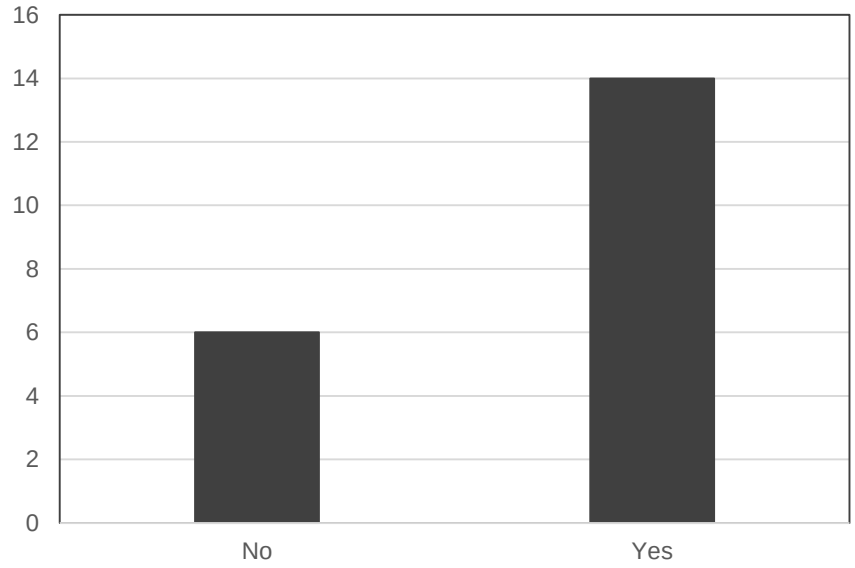

Figure 5. Number of analysed Polish furniture enterprises using Ishikawa diagram. Source: own study.

Using Ishikawa diagram is popular since it is comprehensive instrument for the enterprise management based on the brain storming and for workers it is easy to understand. Ishikawa diagram allows identifying factors that cause the problem occurrence in the multidisciplinary way. Problem is analysed in a group of workers who come from different enterprise departments but they have a knowledge about the problem and its occurrence. It is often used to analyse causes of the work accident or product sale decrease. Identification of the product defects causes is the most effective when Ishikawa diagram is applied by the group of workers involved in the problem solving.

Analysis of the problem causes and identifying of the problem causes hierarchy is possible owing to Pareto – Lorenz diagram that is recognized by every fourth analysed Polish furniture enterprise (Figure 6). It is associated mainly with costs structure and identification of the nonconformities in the quality control analysis. Identifying of the product nonconformities hierarchy allows finding the group of preventive activities that result in the product quality increase.

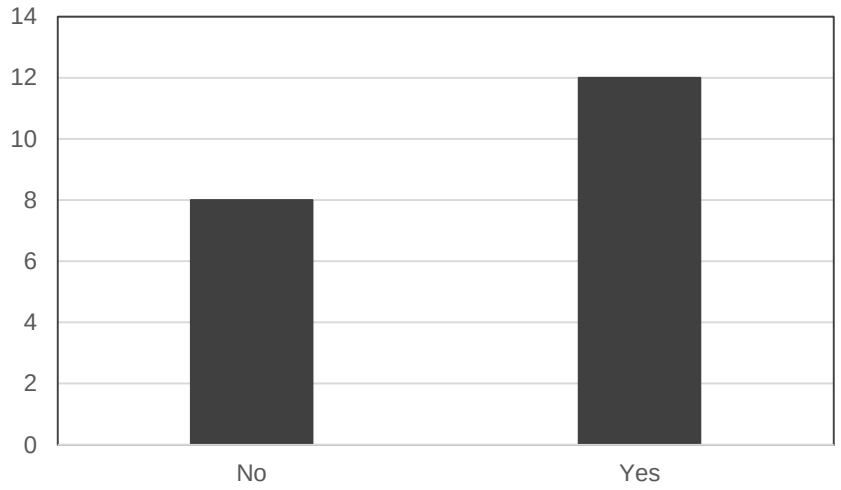

Figure 6. Number of analysed Polish furniture enterprises using Pareto – Lorenz diagram
Source: own study.

The FMEA and QFD methods are mainly used in the design area. Their application allows for better adaptation of the manufactured product or service to the needs of the customer. All design methods for quality can be divided from the point of view of application:

- methods to prevent defects in the product or process,
- methods of designing process or product parameters.

Figure 7 presents research findings on the FMEA method using in selected Polish furniture enterprises.

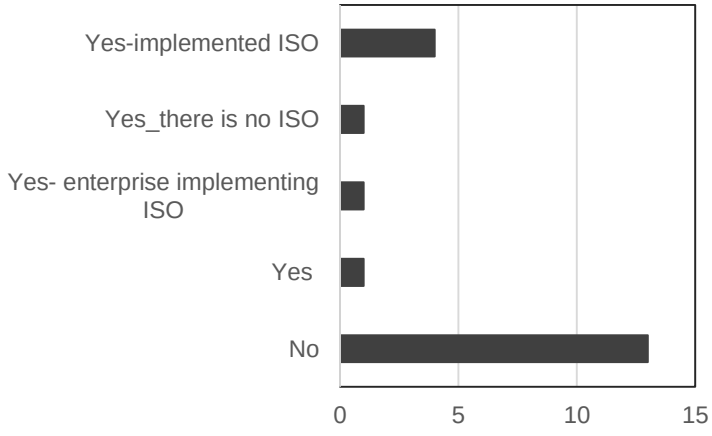

Figure 7. Number of analysed Polish furniture enterprises using FMEA method.
Source: own study.

Analysed furniture enterprises believe that FMEA should not be used once. The idea of the method is its periodic repetition in order to continuously reduce the effects and aim for the job of failure-free. The periodic use of the FMEA method is consistent with the Deming spiral and the principle of continuous improvement. Owing to the FMEA method, the customer receives the product in which it occurs significantly fewer defects with less negative impact force. This increases the degree of satisfaction with the use of the product or service provided.

The QFD method is applied in only some analysed Polish furniture enterprises to translate the information that comes from the customer and it is expressed in the customer's language into the technical language used in the company in the design and construction department. At the source of the method lies the incompatibility in perceiving the same product parameters by the customer and the engineer. Both sides speak different languages, which is not quite understandable and it is a significant barrier in the design of the high quality products and in the provision of the high quality services. Using the QFD method, enterpirse can build your customer's needs at the design stage to create a product or service that is better suited to customer's needs. If it is applied to Polish furniture enterprises, it is applied or with a help of Design Office or partialy (Figure 8).

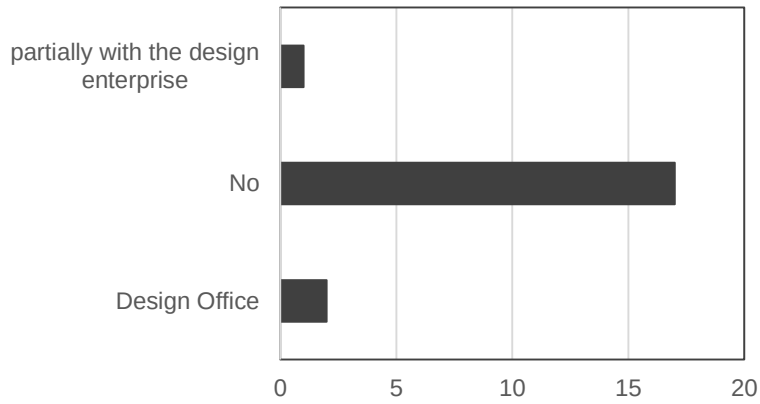

Figure 8. Number of analysed Polish furniture enterprises using QFD method. Source: own study.

Kaizen (Figure 9) that is applied in majority of the analysed furntiure enterprises keeps the system up-to-date, systematic, responsive, and fault-free in every area, to ensure defined standards (e.g. quality, performance, security, and cost). These actions involve the rapid

identification of the problem and the effective solution of the problem. An appropriate internal reporting system, teamwork, methodological description, and resolution of the problem with a detailed analysis of the reason for its creation and dissemination of applications to each entity within the organization that may occur now and in the future are used.

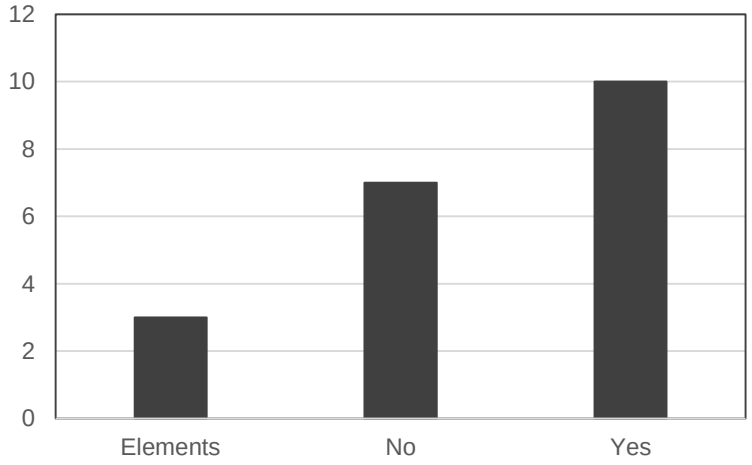

Figure 9. Number of analysed Polish furniture enterprises using KAIZEN method. Source: own study.

KAIZEN is realized in the analysed furniture enterprise mostly in the form of 5S, that is, maintaining high quality workstations that directly translate into productivity, waste elimination and continuous improvement. The 5S name is derived from the first letters of the Japanese names that make up this concept, and in turn means: selection, systematization, ordering / cleaning, standardization, and self-improvement. Other elements of KAIZED include: PDCA and DAMI, work standardization, comprehensive quality control, kanban system, teamwork, and more. It is also worth noting that the effective implementation of the Kaizen system for an enterprise usually requires the establishment of a dedicated team that will be responsible for promoting, training and introducing a culture of continuous improvement to the entity. In addition, its role is to establish a hierarchy of objectives, how to measure their performance, and adapt the internal reporting system to the needs of the system.

In companies that have implemented Kaizen, internal reporting is also aimed at continuous improvement and the search for operational excellence.

11.5 CONCLUSIONS

The goal of continuous improvement of the quality management system is to increase the likelihood of increased customer satisfaction and other stakeholders.

The analysed enterprises should establish the methods and criteria needed to assess the processes to assess whether they are running properly. All processes should be monitored, measured and analyzed for possible improvements. These improvements can be achieved through the use of a variety of quality management methods and techniques that can achieve planned objectives by monitoring, measuring, analyzing and improving the process. It is also important to identify the sources of problems related to poor quality of products and services using appropriate methods, techniques or tools. Each quality improvement process involves the elimination of losses that are identified as everything that does not add value to the customer. Therefore, every action is a process that can be improved.

In the presented research findings it was noted that in the analysed furniture enterprises the choice of quality management tools in an enterprise depends on the nature and nature of the problems that you want to solve. Not every tool allows and it is suitable for solving every problem. There are often many tools needed to improve quality and, after several successive steps, draw the appropriate conclusions.

Better results are achieved when the individual tools are used not as a separate project, but as complementary, at least in some stages. These tools provide the best information analysis when used in conjunction with each other. Without the efficient mixing of tools and techniques, it is difficult to solve problems.

Tools and techniques play a key role in a company that is constantly improving. Effective use of tools and techniques allows evaluating and monitorring processes, capture each process / problem in the improvement process, striving for continuous improvement, transfering experiences from quality improvement activities for everyday business operations, strengthening teamwork through methodical problem solving.

The understanding and use of tools and methods of quality management by enterprises who want to improve their quality can be considered as a prerequisite for success in this field. Dynamic development of the quality management has led to the development and effective implementation of a large number of such methods and tools.

The quality management tools described and analyzed are highly useful for business practices that can stimulate the growth of the performance of the business entities in which they are utilized. However,

it should not be forgotten that not often simple and first solutions are most relevant.

The use of methods, tools and techniques for improving quality is unfortunately not always possible to implement for such reasons as: lack of time for thorough analysis or trouble understanding them. Often in companies with competent people, it is necessary to organize additional training for employees, which is related to financial and time inputs, and employees are not always enthusiastic about them. The lack of time proved to be the biggest barrier.

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12. INNOVATIVE APPROACH TO PRODUCT PACKAGING

Erika Loučanová, Martina Kalamárová, Ján Parobek

12.1 LITERATURE REVIEW

For centuries wood has been used in the preparation packaging for storage of different goods. The importance of the packaging system and its various functions is increasing over the last decades. Wood is the only major material used in packaging that grows naturally and is renewable. In traditional terms, the packaging is intended as a mean of protection, preservation, handling, transport and storage of products. Nowadays, the other functions of packaging, such as promotion, getting the attention of customers and brand communication are becoming more recognizable. As a result, the current interest of the company is, therefore, to offer a customer such a packaging that will meet the marketing requirements and the needs of handling and transport at the same time. In the case of innovation, it is important to target it to the specific customer segment and therewith it is in the company's interest to properly identify the target groups of the packaging innovation. According to this the aim of the monographic study is to identify the age categories which are most interested in packaging innovation and to monitor the perception of the active packaging functions in comparison to intelligent packaging function among different age categories.

12.1.1 Packaging

The package can be understood as a tool or set of tools to protect the products from a potential damage. It allows better handling, facilitates the marketing and consumption of products. The package moves through various stages of marketing and consumption. Accordingly, the package can be divided into three stages which are – transport, sales and consumer package. The transport package has the protective and rationalizing function during handling, storage and transport process. It is used for the transport of foodstuffs in the consumer packaging, for the sales packaging and for the transport of non-prepacked foodstuffs (Zeman, 2005).

Two types of packaging materials are distinguished with a high degree and low-degree of proactive behavior. At the present time wood is still very required material. The auxiliary packaging material is a part of the package. It ensures full functionality of packaging and fulfills specific packaging tasks. For example, auxiliary packaging material

involves nails, adhesives, labels, corks or caps (Dzurová, 1997 Kačenák 1996; Zeman, 2005).

The packaging is one of the most important parts forming the product. Its size, shape, design, selected color and font significantly influence the consumer decision-making process and thereby affect the marketability of the product itself (Kotler, 2001).

When creating product innovations it is necessary to think about the product at different levels whereas each level increases its value to the customer. Regarding the packaging innovation is necessary to monitor packaging functions and find out if it can be used also for another function than just the primary ones as security, handling and information function. Companies should monitor changes in consumers' preferences and also focus on an attention to the new technology of packaging when selecting and introducing the packaging to the market.

In the past, there was a change in design about every 15 years, but now due to the changes in the market environment and the impact of environmental pressure the companies should apply more innovative and creative approach to packaging. Therefore the function facilitating recycling and reducing environmental damage is becoming increasingly important to the main packaging functions such as contain and protect products, promote products, and facilitate the storage, use and convenience of the product.

Traditional perception of packaging classifies the main functions of packaging into four basic categories: protection, communication, convenience and containment (Paine 1991, Robertson, 1993 In Yam et al. 2005), nevertheless, these functions are not totally exclusive – for example, the communication function of the package can also help to enhance food protection and convenience. The package is used to (Yam et al., 2005):

- protect the product against the deteriorative effects of the external environment,
- communicate with the consumer as a marketing tool,
- provide the consumer with greater ease of use and time-saving convenience,
- contain products of various sizes and shapes.

Based on the literature review, different authors deal with several ways of the packaging functions classification. For example, Zeman (2005) and Kačenák (2001) referred to 6 key functions of classification: protection, guarantee, rationalization, economic, communication and ecological. Dzurová (1997) refers to the classification according to Schulte, who lists five functions, namely: protection, storage, transport, handling and information. According to Kollar (1999), essential functions are the protection, handling, information and publicity, environmental and economic.

The importance of packaging started to increase after the Second World War when the doctrine about packaging evolved from the empiric to the relevant scientific discipline. With the development of this discipline, other branches of science were interconnected, for instant discovery and invention of plastics (Kačeňák, 2001).

Plastics are substitutes of wood based materials and they are an everyday part of our lives and we are in contact with them almost everywhere. Plastics are lightweight, long-lasting and their production is relatively cheap. One of the most important advantages is the low price of oil. Producers prefer to buy new raw material than to invest in recycling technology. This technology is not able one hundred percent guaranteed the quality. The largest producer of plastic materials is China where 39.5% of plastic production belongs to the production of packaging, 20.1% belongs to the building industry and 8.6% belongs to the car parts and electronic equipment production. The second place in the manufacture of plastic materials belongs to Europe. Association of Plastic Manufacturers “Plastic Europe” presents, that each year over 29% of the plastic waste is recycled in Europe. However, 31% of the plastic waste ends in landfills and more than 39% in incinerators. The level of recycling in the European countries varies. For example, the highest rate of recycling energy appreciation is in countries where the dumping site of plastic products is banned. Plastic Europe also states that Austria appreciates or re-uses up to 98% of plastic packaging. Germany, Netherlands and Sweden indicate similar standards. By contrast, in Slovakia just over 30% of plastic waste is recycled, 20% of waste ends up in incinerators and the rest in landfills (EUROACTIVE, 2016). Recycling of plastic packaging can save resources themselves as well as nature.

At present, recycling has been very popular in Slovakia as well as a solution to this problem since it is more favorable in economic terms and also facilitates their re-utilization. From January 1st, 2016 a new Act came into force – Act on Waste No. 79/2015 and on amendments to certain acts. This Act governs programming documents for the waste management system, waste prevention measures, rights and obligations of legal and natural persons related to waste prevention and waste management, extended producer responsibility, etc. Thus, plastic packaging, which will be in color-coded containers will be re-used or energetically recovered. For instant, an impending fine of up to € 1,500 if a paper is disposed to the glass container. According to the new rules of this legislation, companies will fund the separation of waste and the collection of unseparated waste will remain as inhabitant’s costs. This new approach should motivate residents to increase interest in waste separation because the proportion of sorted waste will be higher. The above-mentioned approach will have an influence on the lower ratio of residents reimbursed costs to producers (Aláčová, 2015). According to

above mention hypotheses wood as renewable and ecology material has a lot of advantages and it is necessary to prefer it as material in the packaging industry. The key benefits of wooden packaging are a lifelong natural product with great design variety. We have to mention that wood has individual character, underlining quality awareness. It is a renewable, resource-friendly raw material that behaves completely CO_2-neutrally in. In general, wood is used at all levels of transportation. Wood crates are one of the best materials for packaging. They are self-supporting structures that are the ideal choice for shipping various products, especially lightweight or breakable items. The advantages of wooden crates are that can be manufactured and repaired locally. Wood is relatively resistant to different weather conditions and is often used on more than one journey (Mujtaba, 2015).

12.1.2 intelligent and active packaging

Innovative packaging is the result of creative, unconventional thinking outside the usual framework of thought (Yam et al., 2005). The result of an innovative approach to packaging is the creation of packaging with interactive features. Actually, two groups of such packaging systems are distinguished: intelligent and active packaging. They focus to improve packaging functions to meet current consumer demands, increased regulatory requirements, as well as increased interest in security (Fig. 1).

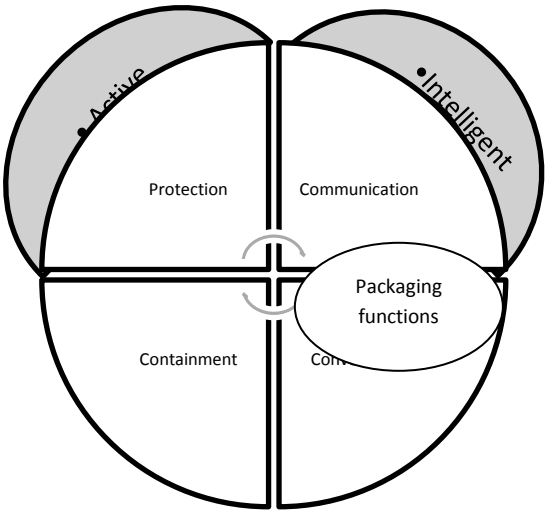

Figure 1. Model of packaging functions
Source: Yam et al. (2005)

Active packaging represents a shift in the perception of functions, namely, the protection function of packaging has been shifted from passive to active. In the traditional perception, the protection function of the package meant a passive barrier between the product and its environment. Regarding active packaging, the aim of the protective function is to actively protect the product (Yam et al. 2005). Active packaging allows actively changes the condition of the package to extend shelf life or improve food safety while maintaining the quality of the food (Kačeňák, 2011). Following the definition of active packaging materials, we can group them according to the way in which they affect the characteristics of the product as follows: absorbers – active packaging systems based on absorption and emitters – active packaging systems based on the release of substances (Sosnovcová, 2008).

Intelligent packaging is a packaging system that is capable of carrying out intelligent functions (such as detecting, sensing, recording, tracing, communicating, and applying scientific logic) to facilitate decision making to extend shelf life, enhance safety, improve quality, provide information, and warn about possible problems (Yam et al., 2005). According to Kačeňák (2011), the intelligent packaging is the term for systems that monitor conditions around the product and thus provide information about the quality of food during transport and storage. The time-temperature indicators, indicators of oxygen and carbon dioxide, the temperature indicators, pathogen indicators and breakage indicators are distinguished (Sosnovcová, 2008).

The importance of active and intelligent packaging means mainly significant expansion of two packaging functions: protective function – especially in active packaging shift from passive to the active protection and information functions – especially as intelligent packaging providing information monitoring the packing conditions. According to Loučanová et al (2016), the requirements of customers to the innovation of packaging functions are as follows: the majority of respondents expect the packaging to be ecological and to fulfill principally information and protection function. These results confirm the actuality of intelligent and active packaging in terms of required packaging functions and therefore innovative packaging thus respond to the current market requirements.

The companies should orientate mainly to these functions and innovate the packaging to be easily biodegradable in nature, produced from friendly, recyclable materials, ensuring a high degree of protection of the products as well as consumers. Potential customers are more and more demanding information of product composition, quality, date mark and durability, thereby the companies should respond to that kind of innovation to meet these requirements. Regarding that research (Loučanová et al, 2016) the target group for packaging innovation

represents the age category from 41 to 50 years according to their highest innovation status. This age category recognizes its own requirements in purchasing and selecting products and it considers protection and information function as the main important and ecological function as attractive.

12.2 METHODOLOGY

The principal method of the research for the perception of packaging innovations in terms of the functions is a method of the Kano model. The aim of the Kano model is to capture customers' opinion according to the requirements of an observed object (Goodpasture, 2003).

The methodology consisted of several steps:

- compiling questionnaire to individual functions of packaging innovations,
- questionnaire measures for gathering specifiable information,
- evaluation,
- processing the results in a matrix of a typology of perception of packaging innovations in terms of the functions by respondents and subsequent interpretation.

As the first step, it was necessary to compile questionnaire, which provided concrete questions–statements. The questionnaire consisted of pairs of positively and negatively conceived questions and statements. According to the methodological approach of the model, respondents had an opportunity to respond every question (statement) on a scale from 1 to 5 representing a strong agreement to strong disagreement with that question (statement) based on the draft.

Afterward, questionnaire measures were determined. The sample of respondents was set at 120 respondents in Slovakia, keeping the same proportion of respondents for each given age category. The survey was conducted through electronic forms as well as by personal questioning.

In the following analyses, received responses are evaluated according to the cross rule (Figure 2). The responses are subsequently evaluated by two-factor analysis based on age categories. Based on the Kano model, the findings were included in the following categories according to how respondents perceived new packaging:

- M – are obligatory requirements that customers consider as normal and are automatically expected. These requirements can be identified as primary or basic and therefore. They only deal with customers in the event of non-compliance. Identifying them is an elementary importance mainly

because even though their fulfillment is reflected in customers' satisfaction, their deficit and failure are reflected in customers' dissatisfaction as they immediately realize it.

- O – are one-dimensional requirements that are represented by those product attributes that lead to fulfillment and satisfaction in the event of non-compliance to customers dissatisfaction, i.e., the higher the degree of compliance with these requirements, the customers are more satisfied, but compared to the mandatory requirements customers automatically do not expect them.
- A – are attractive requirements that have a clear impact on customers satisfaction because it is a requirement that customers did not expect.
- R – are contradictory or reverse requirements in some literature.
- I – are requirements which do not have any influence on customers. They are also called irrelevant requirements. This category involves the attributes that are not critical for customers and their pass or fail does not affect their satisfaction or dissatisfaction (Ducár et al. 2006).
- S – are sceptical requirements (Grapentine, 2015).

		Answer to the Dysfunctional Question					
		Like	Acceptable	No Feeling	Must-be	Do not like	Other
Answer to the Functional Question	Like	S	A	A	A	O	
	Acceptable	R	I	I	I	M	
	No Feeling	R	I	I	I	M	
	Must-be	R	I	I	I	M	
	Do not like	R	R	R	R	S	
	Other	"Other" responses are ignored					

Legend:
O: One-dimensional Evaluation
A: Attractive Evaluation
M: Must-be Evaluation
I: Indifferent Evaluation
R: Reverse Evaluation
S: Skeptical (considered to reflect a mistake)

Figure 2. The Kano Model
Source: Grapentine, 2015

The results of Kano model allowed us to divide the monitored packaging functions into categories of mandatory, attractive, indifferent and reverse functions.

Subsequently, the comparison analysis, which aims to identify and measure comparable data, was used. It was used to identify the differences between customers' perceptions of intelligent packaging functions and customers' perceptions of active packaging functions. According to packaging functions definition by Yam et al. (2005) we considered expansion of protection and containment function as a nature of active packaging and the expansion of communication and convenience function as a nature of intelligent packaging.

The comparison analysis was based on the customer requirements identification by Kano model. In the next step, the weight was assigned to these requirements. Every identified requirement represents value 1, which was multiplied by weight according to identified category as follows: "M" obligatory requirements have weight 3, "A" attractive requirements have weight 2, "O" one-dimensional requirements have weight 1, "I" indifferent requirements or not having an impact have weight 0, "R" contradictory requirements have weight -1, "S" sceptical have weight -2 in different age groups and their sum (Loučanová, 2015; 2016). Based on the sum of values, we can compare customers' perceptions of active and intelligent packaging functions and we identify the target age group for active and intelligent packaging.

As the next step of methodology, typology matrix of consumers' was created. This is modified typology matrix of perception of packaging innovations in terms of their functions in order to better illustrate the matter of packaging innovations and consumer's perception. The matrix describes two factors, on the x-axis are age groups and on the y-axis is innovative status. Innovation status is determined based on the results of the questionnaire as a sum of the identified requirements imposed on the new packaging by their functions according to the assigned weights as indicated by Loučanová (2015, 2016). The significance of the identified requirements influence for new packaging according to their functions is defined as the weighted average of the identified requirements percentage. The conclusion is made by deduction and induction. To conclude the recommendations and conclusions of the phenomenon of perception of packaging innovations in terms of their functions are made according to the Kano model.

12.3 RESULTS AND DISCUSSION

The survey results indicate different attitudes to intelligent and active packaging according to age. The Kano model identified requirements of the packaging functions among the monitored age categories. The customer's value (table 1) was calculated as the sum of the points that have been assigned to the individual categories of the questionnaire, according to the methodology.

Table 1 The comparison analysis of perceptions of intelligent and active packaging functions in Slovakia

		Packaging functions				
		Containment	Protection	Communication	Convenience	Total
18-30	Requirement	I	I	I	O	-
	AP function	0	0	-	-	0
	IP function	-	-	0	1	1
31-40	Requirement	R	O	I	O	-
	AP function	-1	1	-	-	0
	IP function	-	-	0	1	1
41-50	Requirement	A	O	O	A	-
	AP function	2	1	-	-	3
	IP function	-	-	1	2	3
51-60	Requirement	O	O	O	O	-
	AP function	1	1	-	-	2
	IP function	-	-	1	1	2
61+	Requirement	A	I	I	I	-
	AP function	2	0	-	-	2
	IP function	-	-	0	0	0

Notes: AP – Active packaging, IP – Intelligent packaging
Source: Authors' computation

The results indicate that the most significant value from the perspective of active and intelligent packaging functions is for customers' age category 41 to 50, followed by age categories 51 to 60 and older.

Active packaging has value mostly for the customers in the age of 41 and older, for whom the active packaging represents an attractive and one-dimensional requirement. It represents those active packaging attributes that lead to fulfillment and satisfaction and in the event of non-compliance to customers' dissatisfaction. The higher the degree of compliance with these requirements is, the customers are more satisfied and in addition, the attractive requirements have a clear impact on customers satisfaction increase. The younger ones (less than 40 years) are not affected by active packaging and their functions. The functions are indifferent to them, it involves the attributes that are not critical for customers and their pass or fail does not affect their satisfaction or dissatisfaction, figure 3.

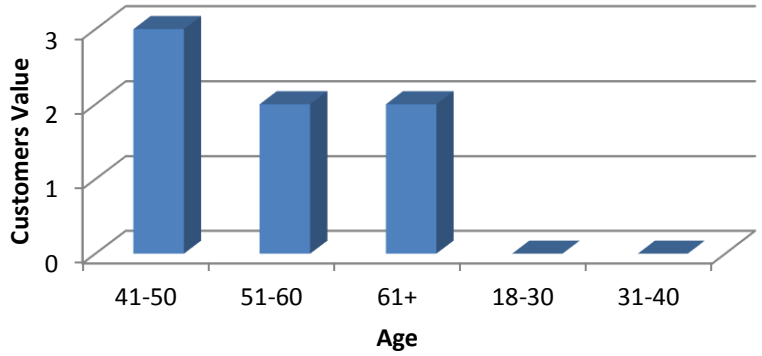

Figure 3. The customer value of active packaging functions
Source: Authors' computation

Regarding intelligent packaging, the most influenced group is age category 41 to 50, followed by 51 to 60 and then with the same value 18 to 30 and 31 to 40. Basically, the intelligent packaging influences the customers in the age 18 to 60 very similarly: they represent one-dimensional requirements – the higher the degree of compliance with these requirements, the customers are more satisfied. The age category 61and older does not react to intelligent packaging, they are indifferent to them, figure 4.

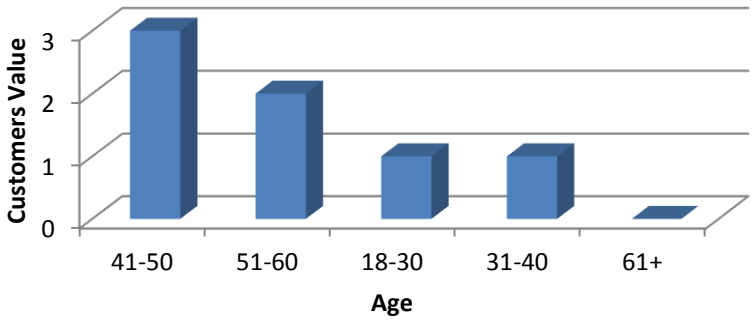

Figure 4. The customer value of intelligent packaging functions
Source: Authors' computation

The comparison of the value of active and intelligent packaging functions for the customers indicates the differences in target groups of customer affected by these functions, figure 5. The respondents in younger age are more oriented to the intelligent packaging. The

generation of middle-aged is interested in intelligent and also in active packaging equally. And finally, the older age categories rather prefer only active packaging.

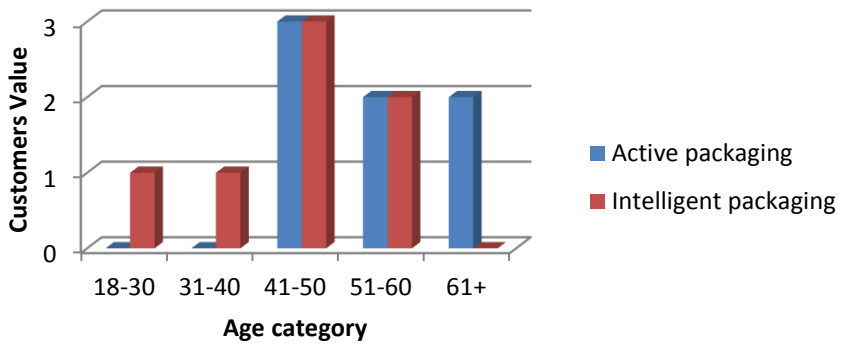

Figure 5. The comparison of the value of active and intelligent packaging functions for the customers
Source: Authors' computation

Active and intelligent packaging influence customer decisions mainly as a one-dimensional requirement, i.e. those active packaging attributes that lead to fulfillment and satisfaction and in the event of non-compliance to customers dissatisfaction – the higher the degree of compliance with these requirements, the customers are more satisfied. Occasionally they can be perceived as an attractive requirement for the customers that have a clear and significantly increasing impact on customers satisfaction because it is a requirement that customers did not expect is (Regattieri, Santarelli, 2014).

According to the innovative approaches to the packaging can be concluded that younger respondents are more focused on the intelligent functions of the packaging. That one according to Yam et al. (2005) is able to perform intelligent functions to facilitate decision-making, enhance safety, improve quality, provide information and warn of potential problems, causing the mental shortcuts to facilitate cognitive processes in decision-making (Helus, 2015). These respondents decide according to the first impression caused by the innovation, which is closely connected to the communication function of the package evolving especially by intelligent packaging.

As age increases, the older generation emphasizes active protection of the product and appreciate easy-handling. Exactly active packaging focuses on protection and containment, representing a shift from passive to the active perception of packaging. In case of interest to reach customers by active packaging, it should be focused on the elder ones.

According to collected data, we consider the different attitudes of the respondents consistent with the age. The differences in the perception of the innovation of packaging functions based on the respondents' needs, attitudes, values, expectations, marital status and interests in various categories are significant.

The results summarize collected data to the Kano model typology matrix of the packaging innovations perception in terms of the functions. The Kano model identified the innovative status and the size of an impact of the packaging innovations among the monitored age categories. The innovative status was calculated as the sum of the points that have been allocated to the individual categories of the questionnaire, according to the methodology. The size of the impact was calculated as the sum of multiples of the individual identified categories percentages of the Kano model by the individual weight that prevailed in the age group, table 2.

Table 2. The calculation for the assembly nut typology

Ages	18-30		31-40		41-50		51-60		61+	
Handling function	I	0	R	-1	A	2	O	1	A	2
Protective function	I	0	O	1	O	1	O	1	I	0
Informative function	I	0	I	0	O	1	O	1	I	0
Economic function	I	0	I	0	I	0	O	1	I	0
Ecological function	O	1	O	1	A	2	O	1	I	0
Promotional function	I	0	I	0	I	0	I	0	I	0
Social function	I	0	I	0	I	0	I	0	I	0
Innovation status	18-30		31-40		41-50		51-60		61+	
Handling function	48	0	48	-1	28	2	56	1	48	2
Protective function	52	0	36	1	44	1	32	1	44	0
Informative function	52	0	40	0	36	1	32	1	72	0
Economic function	52	0	48	0	48	0	56	1	25	0
Ecological function	32	1	36	1	40	2	24	1	64	0
Promotional function	60	0	36	0	44	0	56	0	52	0
Social function	68	0	64	0	64	0	48	0	44	0
Size impact	32		8		54		40		96	

Source: Authors' computation

Subsequently, the analyzed innovative status and size of the innovation impact of packaging in terms of the functions to the individual age groups are described in the cluster of typologies perception of packaging innovations in terms of the functions.

In the first age group (18-30 years) respondents identified only one of the available functions and packages for them as an important

innovation in packaging with ecological function. As there is displayed in Figure 6, the Kano model assigned them the lowest innovation status. Due to the large impact on this age group (32), it seems the most appropriate to use for these innovations halo effect. Helus (2015) consider the effect among the mental shortcuts to facilitate cognitive processes in decision-making. This is a guide to automating a particular situation or simplify intuitive decisions when choosing from several options. Consumers decide according to the first impression of innovations.

In the age group, 31-40 years the respondents already know more specifically what is important for them. As we mentioned above, it is associated with the change in the attitudes of people in this age in general. In this age usually, people plan the future and family. Most of them identified ecological functions and protective packaging as the most important issue. Therefore companies should mainly focus on innovations of these two functions of packaging with this age group of respondents consider as important. On the other side, companies should avoid innovations of handling functions of packaging, which have negative effects on them. Most of the respondents in this age group are not a very sensitive target group for packaging innovations because their low innovation status is influenced mainly by the negative attitude towards handling functions of packaging.

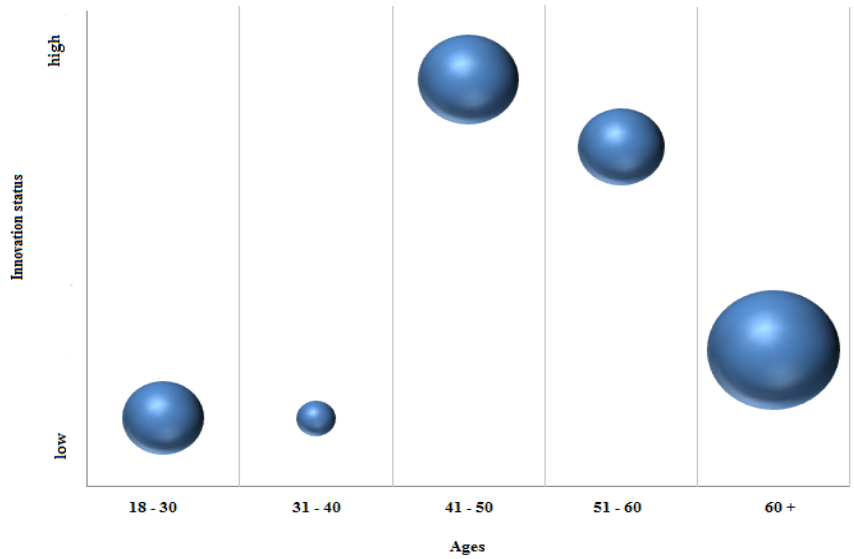

Figure 6. Matrix of typology of perception of packaging innovations in terms of their functions by respondents
Source: Authors' computation

This analyzes confirmed that the respondents included in the category of 41-50 years have the specific requirements. They know what they consider important when choosing products and they also recognize what is unnecessary. As the most important factor, they chose the protective and informative function of a package. For them the handling and environmental function are attractive. The above-mentioned age group is the target group for new packaging innovations, given the highest innovation status with the influence size of 54.

Respondents in the category of 51-60 years as well as in the former category know exactly what they specifically require and what they consider unnecessary. In this, age category consumers consider important the handling, preservative, informative, economic and environmental functions of packaging. For them, these functions are one-dimensional requirements where the higher rate of fulfillment the consumers are more satisfied. However, compared with the mandatory requirements, customers do not expect them automatically. With this age group, companies should focus on innovations in general functions of packaging and also on the specific innovations of product packaging. It becomes obvious from the highly innovative status.

In the last age group same as in the first categories respondents identified only one of the packaging functions as important, namely innovations of handling functions. Therefore, companies should focus on new packaging that would simplify product handling. Although their innovative status is low, simplify product handling has the biggest impact on this target group and often this is the key factor for buying a product. It has a clear effect on the satisfaction of these age category. As Lesáková (2012) mentioned the reason is related to the type of transport because a percentage of people using their own transport to shop with higher age gradually decreases. The respondents in this age group are becoming dependent on assistance when they come to the purchase. According to her research, the increasing age is associated with increased mobility problems of older people.

Based on the results of responses in the various age groups, generally, we can conclude that the majority of respondents agreed that the packaging should be ecological and should meet the informative and protective functions. These three functions can be attributed to innovations that are most preferred among all respondents. Within the innovation policy companies should consider a new packaging act, social responsibility, which will take into account economic efficiency, the environment and impact on society.

In addition to above, the paper has both theoretical and practical benefits. Theoretical benefits are at the level of application of the new approach of Matrix typology of perception of innovations by respondents and determining the status of innovation through the Kano model. In

terms of practical approach, it focuses on information for innovators, what packaging aspects need to be upgraded according to different age categories. This can then be reflected in the performance of companies and their investment decisions as stated Balteş, Dragoe, Adelean (2014); Ipate, David, Ipate, Bogdan, (2015) and Borlea, Mare, Achim, Puscas (2016).

12.4 CONCLUSIONS

Every company wants to successfully establish itself on the market, but it is up to the company how to reach the aim. One of the possible ways is innovation in packaging, which the paper analyzed. Based on the results of the Kano model, requirements for new packaging in terms of all seven functions of packaging were identified, in particular, handling, preservative, informative, economic, environmental, promotional and ecological functions of packaging. The results indicate that the main target group for the new packaging innovations is consumers of age categories from 41 to 60 years. They have the highest requirements for packaging innovation given the highly innovative status. However, almost at all age categories respondents require ecological innovation packaging and applying wood as a renewable material. The older generation requires mainly innovation of the handling function of packaging, which has a low innovative status but has a very big influence on their purchasing decision with a clear effect.

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13. INNOVATIVE APPROACH TO TRADITIONAL CASE STUDIES: ECONOMIC, SOCIAL AND ERGONOMIC ASPECTS OF WOODEN CHURCH PEWS FUNCTIONALITY - THE CASE OF POLAND

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13.1 INTRODUCTION

The importance of religious building, including churches, chapels and prayer houses in the process of shaping social life in Poland is a fact that does not require proof. One can argue about the scope or power of sacred buildings influence on the development of material and spiritual culture of the society. The presence of churches and chapels in everyday life of Poles remains undisputed, and it also concerns the spiritual and cultural identity of Europe. It is thus understandable that the researchers are interested in the aspects of sacral architecture and art. Much less attention was paid to the issue of religious buildings furnishing. In particular, the research deficit concerns church pews. Although benches are usually a third part of the area of religious worship buildings, their choice is usually a question of the designer's individual vision. So far research or social consultations have rarely been carried out in this field. The Protestant churches refer to this problem in a different way [2]. Therefore, a scientific discussion about the material and practical aspects of religious buildings functioning as well as reviewing the activities of religious communities using these buildings seems justified and necessary.

Church pews are an example of sacral furniture used most often and in the largest amount. Based on the literature of the subject and authors' own research, factors used to plan studies on the functionality of sacral furniture, especially church pews, have been determined.

These factors, apart from design and technology aspects, can be identified in at least two additional areas: social and economic [12, 13]. In the social dimension, the answer to the question about the extent to which the presence of sacral furniture in the public sphere influences social relations is sought. This applies both to aspects of material culture (architecture of sacral furniture, sacral art), and spiritual culture with its religious dimension (the quality of religious life). The question is how the architecture and functionality of sacral furniture affects the quality of religious experience and the 'comfort' of religious practices. In economic terms, we seek answers to the questions about both financial costs

(design, execution, ongoing maintenance and maintenance of sacral furniture), usability (ergonomics, functionality, comfort of use), and economic efficiency (the ratio of expenditures to potential benefits, measured for example, by the number of the faithful participating in religious practices and the amount of donations to contributed to the Church community).

The starting point in the search for answers to the questions raised may be the study of the most popular sacral furniture - church benches - in terms of their structural and functional characteristics. The inspiration to undertake the study was the variety of pews, commonly found in Polish churches, depending largely on their age, i.e. the date of manufacture. In the extensive literature on furniture functionality there are no publications that directly relate to this specific piece of furniture. The research question about the potential link between the period of manufacture and the constructional characteristics of church benches is not a matter of negligence. The response may provide interesting information for both designers and producers of church pews (most often wooden ones) as well as for users who understand the social significance of religious life and culture.

13.2 THE OBJECT AND THE SCOPE OF RESEARCH

Church benches essentially fulfill four functions, namely to sit, to kneel, but also to allow for a comfortable standing and to move within them. Taking into account the various functions of benches, it is difficult to find in literature and technical standards special recommendations for their construction. As a rule, the contractors are usually guided by the Polish Standards Furniture to Sit and their own experience.

The research covered 76 types of benches located in 70 Roman Catholic churches of Poznan. In order to find statistical correlation between church benches, they were divided into three groups, according to their age and construction. Old and historic benches (31 bench types) were included in the first group. The second group contained ‘new’ benches, distinguished by modern and simple finishes (33 bench types). In contrast to the third group were benches with a characteristic, simple structure, in which metal panels were attached to the seat, backrest and kneaders (they were listed in 12 churches). The benches were measured, described and photographed.

On the basis of the inventory analysis it was found that many benches did not meet basic benchmarks in terms of the height and depth of the bench seat, as well as the ergonomic backrest angle. The structure and shape of the bench also determine the comfort of the seat. During kneeling, the size of the kneeboard and the angle of inclination play an important role. In turn, standing in the bench and the ease of

passing between the benches is conditioned by the width of the pass. Benches with dimensions that differ considerably from the general principles used in practice, become uncomfortable and impractical.

The variety of benches found in churches has stimulated the research on the impact of their age, i.e. the date of manufacture, on the structural and functional characteristics of the benches studied. In the rich literature on functional furniture there was no publication directly related to the analysis of pews. This manuscript which refers to authors' own studies makes such an attempt [2,16 and 3,4].

The bench is defined as a piece of furniture, usually wooden, used to sit, with a backrest or desk [9]. By characterizing pews in terms of shape, one should comment on the function that they should fulfill. Church benches are primarily used for sitting and kneeling, but they should also allow for comfortable standing and moving. So far, no special recommendations have been made regarding their construction. The contractors may be guided by the Polish Standard Furniture to Sit of 1979 [9], as well as their own experience. This situation leads to a tendency to be arbitrary in design. Contractors also take into account: dimensional limitations, decorative forms, functional aspects, and above all financial constraints (Roman Catholic Church in Poland lives primarily off the voluntary donations of the faithful).

Based on anthropological and physiological studies, the conditions are determined that must be met to ensure that the sitting position of the person is correct. Wykowska [12] indicates that the sitting position should be characterized by:

- high torso stability (associated with the limitation of the apparent movements and allowing the body to maintain a given position);
- the best possible coordination of the limbs;
- relief of lower limbs;
- relief of the circulatory system.

A sitting position can be harmful if you have:

- hanging feet due to the lack of footrest and behind the high seat;
- too shallow a seat;
- buttock pressure (resulting from a soft or poorly formed finish).

According to the Polish Standard Furniture to Sit, the back of the bench should form an open angle, within the range of 100 ° to 110 °. The full backrest should be considered the most comfortable, not the one that was made only in the form of a backboard. In the case of church benches, the footrest is fitted with a knee board, which makes the sitting position more comfortable. The comfort of kneeling is influenced by the inclination of the kneeling board, while the width of the board is less important.

The position of the kneeboard in relation to the front edge of the seat, measured in a vertical projection, is important for the movement of persons in the bench. This dim also affects the comfort of kneeling and sitting. Too little transient width can cause difficulties during standing, as well as entering or leaving the bench.

Looking for the optimal size of the church bench, it is necessary to point out the basic difficulty that is a combination of two important functions, i.e. kneeling and moving. The bench desktop should be set at an angle that allows for the use of prayer books in kneeling, sitting and standing positions. At present, the desktop usually functions as a backrest, and its width creates a space between the person sitting in the front bench and the person kneeling in the back bench.

A separate group of benches are antique, carved church benches. These are works of art, whose ornaments and dignity influence the atmosphere in the sacred interiors. It has been noted that this situation, even subconsciously, makes them identifiable by users as more comfortable.

The research process also included data on benches decorations, used ornaments and colors, wood, technical condition, platforms, hangers, and the date of manufacture. Data on churches and their equipment came from tourist guides, historical publications, and authors' own observations [4,5,6,8]. In addition, all examined benches were photographed (front and back) and cataloged.

The ergonomic evaluation of benches in the churches of Poznan was already presented in partial publications [2,3]. However, due to the superficial statistical analysis, no significant correlations were found. For these reasons, an attempt was made to analyze the collected data in a new perspective and using a new method based on the authors' own research scenario.

13.3 MATERIAL AND METHODS

The material was collected on the basis of measurements taken in Roman Catholic churches from the administrative area of Poznan, subordinated to the Metropolitan Curia of the Archdiocese of Poznan, from the deaneries: Poznań - Rataje, Poznań - Nowe Miasto, Poznań - Piątkowo, Poznań - Starołęka, Poznań - Winogrady. The list of churches was downloaded from the website of the Archdiocese of Poznan [12].

The measurements included 18 parameters of the church benches, characterizing the seat, the kneeler and the desktop. Those were: the seat height, seat depth, backrest height, seat inclination angle, backrest angle, distance between benches, kneeler length, kneeler width, kneeler inclination angle, kneeler height, desktop width, desktop height, desktop length, desktop inclination angle.

For the measurement of the parameters described, one representative bench located in the middle of the row was selected. The measurement of length, width and height of the bench was made with a steel tape 3 meters long, up to 1 mm. The spirit level was used to evaluate the rake angle. The angles were calculated based on the pattern..

To analyze variations, 76 bench types were selected, which were divided into three groups:

- **old benches** (type 1), which included 31 oldest furniture of this type, adopting a contractual boundary connected with the Second Vatican Council, that is, the half of the 1960s (Fig.1);
- **new benches** (type 2), which included 33 pieces of furniture, which in shape and style referred to simple and functional shapes, characteristic of modern times and adapted to new churches (Fig. 2);
- **board benches** (type 3), new benches with characteristic and similar metal and wooden construction, consisting of a seat board and a backboard. This type of benches were found in 12 churches (Fig. 3).

Figure 1. Old benches (type 1)
Source: Own elaboration [photo by W. Kusiak]

Figure 2.New benches (type 2)
Source: Own elaboration [photo by W. Kusiak]

Figure 3. Board benches (type 3)
Source: Own elaboration [photo by W. Kusiak]

The adopted division into three groups of benches resulted from a deepened exploratory analysis carried out for the whole set. In the detailed research, 8 characteristics were considered, i.e.: bench height, seat height, bench depth, kneeler width and rake angle, height, desktop width and rake angle.

13.4 RESULTS

In the study of selected church benches, analysis of confidence intervals (0.95) was performed for all analyzed features [8]. Variance analysis has shown that there are significant differences between bench types. They concern 6 characteristics tested, both in terms of change tendencies and their size. Features clearly distinguishing different types of benches were:

- seat height;
- bench height,
- kneeler rake angle,
- desktop width, height and rake angle.

The seat height is a feature of variable tendency (noticeable decrease, followed by an increase of this characteristic, see Fig. 4). In addition to the change trend, a significant scale of those changes was noted: significant differences between type 1 and type 2 (discrete confidence intervals). Type 3, on the contrary, shows less variation, as compared to types 1 and 2 (common parts of confidence intervals, see Fig. 4).

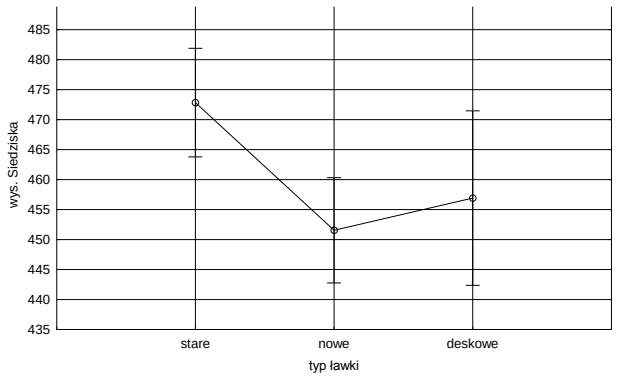

Figure 4. Confidence intervals for bench seat height (stare=old, nowe=new, deskowe=board benches)
Source: Own elaboration

When analyzing the height of benches, a decrease in this dimension was noted, both between type 1 and type 2 benches, and between type 2 and type 3. The highest drop in height occurred between type 1 and type 2 (disjoint confidence intervals). Another tendency (lower drop in height) was shown for types 2 and 3 (common parts of confidence intervals, see Fig. 5). Type 1 benches are much smaller than benches type 2 or type 3.

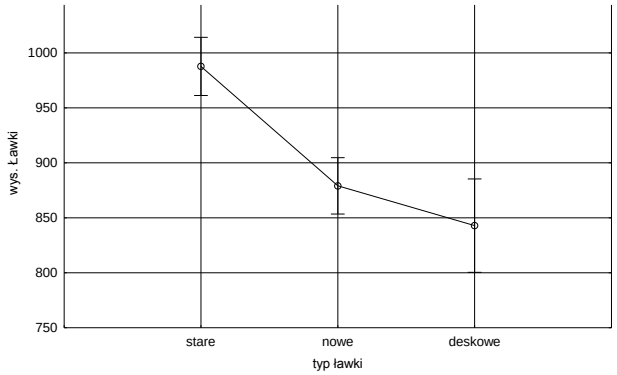

Figure 5. Confidence intervals for height benches (stare=old, nowe=new, deskowe=board benches)
Source: Own elaboration

An important part of benches is the kneeler. The analysis of the kneeler features shows the decrease in its width and rake angle.

The analysis of the kneeler width does not show any significant differences (no detachable confidence intervals, see Fig. 6). Conversely, in the case of the kneeler angle analysis, a general downward trend was observed. For benches type 1 and type 2 - the drop is negligible.

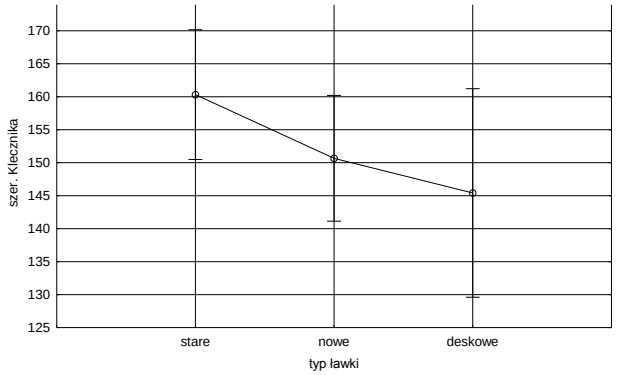

Figure 6. Confidence intervals for the width kneelers (stare=old, nowe=new, deskowe=board benches)
Source: Own elaboration

A significant change in the rake angle occurs when benches type 2 and 3 are compared (see Fig. 7). This is due to the construction of the bench and the use of almost flat (horizontally mounted) kneeling boards.

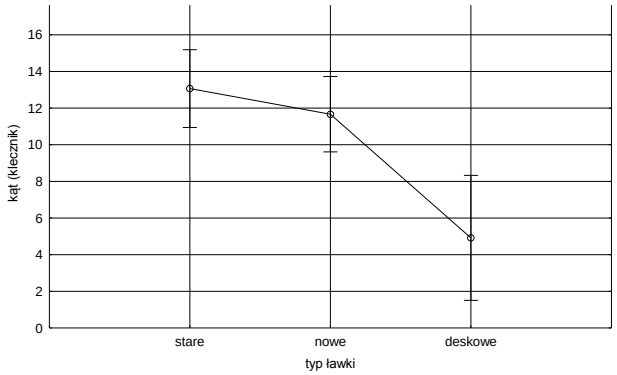

Figure 7. Confidence intervals for the angle of inclination of the kneeling board (stare=old, nowe=new, deskowe=board benches)
Source: Own elaboration

Analysis of the bench desktop sizes showed a lot of variability, especially in terms of the desktop width, bench height and rake angle of the desktop board. The height of the desktop, checked for separate types of benches, has decreased (see Fig. 8). Type 1 and Type 3 comparisons show nearly double decrease in the height of the desktop.

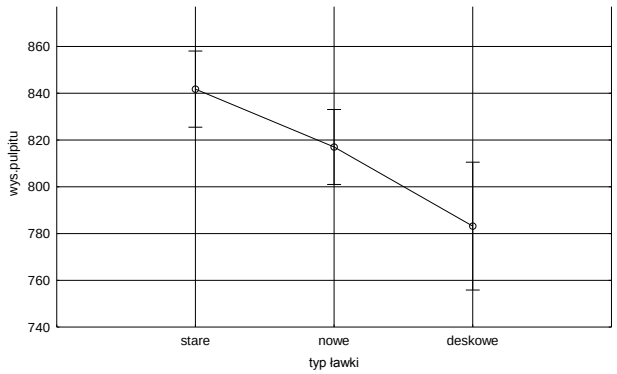

Figure 8. Confidence intervals for the height of the desk bench mount (stare=old, nowe=new, deskowe=board benches)
Source: Own elaboration

A similar trend has been observed with respect to the rake angle of the bench desktop (see Fig. 9) and the width of the desktop (see Fig. 10).

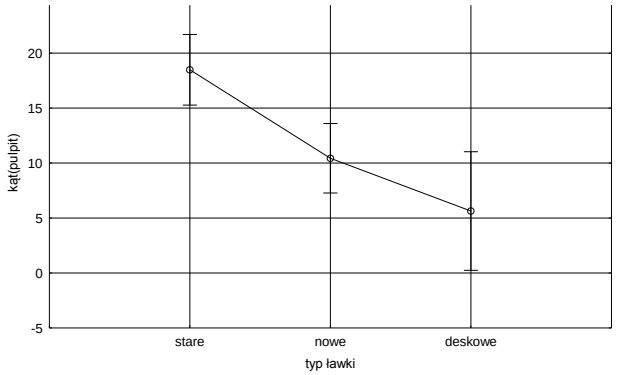

Figure 9. Confidence intervals for the angle of inclination of the desktop benches (stare=old, nowe=new, deskowe=board benches)
Source: Own elaboration

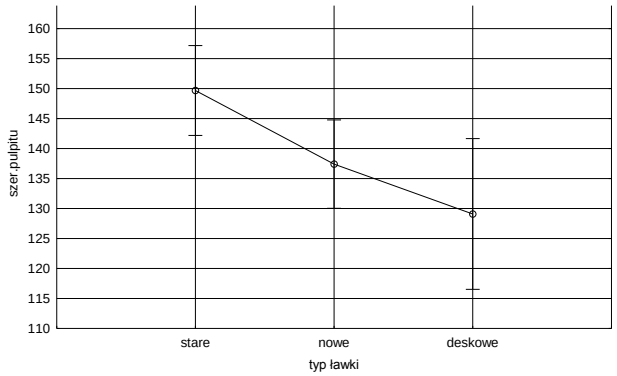

Figure 10. Confidence intervals for the width of the desktop benches (stare=old, nowe=new, deskowe=board benches)
Source: Own elaboration

When it comes to the benches functionality, their most important construction element is the seat. Comparative analysis of bench seat depth parameters shows a variable trend of this parameter. Benches type 1 were noticeably smaller than benches type 2.

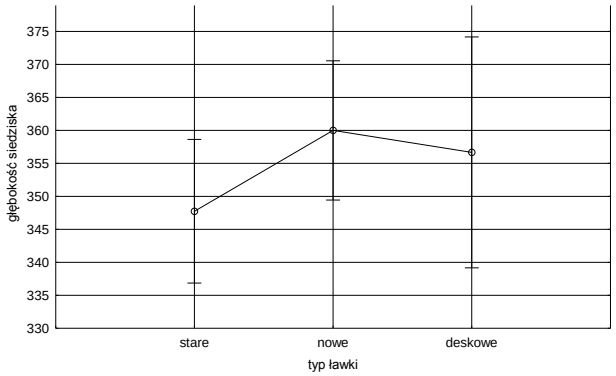

Figure 11. Confidence intervals for the depth of the seat benches (stare=old, nowe=new, deskowe=board benches)
Source: Own elaboration

Changing this parameter in newer construction types results primarily from the need to improve the comfort of sitting. When comparing the results of the tests with the Polish standard 'Furniture to sit' it was found that its seat depth requirements (360-450 mm) were only met by 49% of the church benches tested (see Fig.11).

13.5 CONCLUSIONS

In conclusion, both the limitations of the research method and the need for a multi-faceted analysis of the functionality of church benches should be pointed out. Unfortunately, it was not possible to include variance analysis in the scenario of the classical study because of the failure to meet the assumption of variance homogeneity. The analysis was performed for confidence intervals determined for selected constructional features of the benches studied.

Benches were divided into three types, distinguished by the period of manufacture (age) and constructional characteristics. In such a way, it has been shown that in addition to the increase in the depth of the seat, the size of benches has generally decreased. The width of the desktop, its height and the rake angle decreased. This is probably due to the change in functionality of individual construction elements of the benches studied. The kneeler rake angle was also changed, from the more inclined in type 1 benches to the horizontal (flat) level of the kneeboard in benches type 3.

It seems that the evolution of the pews began parallel to the changes introduced in the liturgy of the Second Vatican Council. This process is ongoing as well as the research on pews construction,

comprising both ergonomic and economic aspects (including the problem of Polish parishes incomes dependence on the functionality of furniture devoted to religious worship), but also social, cultural and psychological ones [1, 13]. The modern man is increasingly looking for places of quietness and spiritual renewal, where he not only wants to experience mortification and repentance, but also devote time to religious reflections in the best possible comfortable conditions.

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