THE MULTI-CRITERIA MODEL FOR OPTIMAL SELECTION OF CROATIAN WOOD INDUSTRY COMPANIES

Maja Moro, Mario Šporčić,
Ksenija Šegotić, Andreja Pirc, Renata Ojurović

Ministry of Regional Development, Forestry and Water Management, Department of Wood Industry, announced a tender for assignation irrecoverable dedicated funds for stimulation and sustainability development of wood processing and furniture production in Republic of Croatia for the year 2010.

Companies from industrial wood processing proposed a projects for financing and for this purpose they had to fill-in the several forms.

We recognized that as a problem of multicriterial decision making for funds distribution and for this purpose a model for Optimal Selection of Croatian Wood Industry Companies was developed.

The model is based on the

***Data Envelopment Analysis (DEA) method*.**

The paper shows that the DEA may be useful tool at a strategic and operational level of decision making in wood industry.

In order to achieve the goal above-mentioned, the *Government of the Republic of Croatia* has in 2006 prepared *an*

Operative Program for the Development of Industrial Wood Processing in the Republic of Croatia 2006 - -2010,

(hereinafter: Operative Program) as the instrument for the operationalization of the Development Strategy for Industrial Processing of Wood and Paper, enacted in 2004.

The *Operative Program* defines main, strategic goal of development of wood processing and furniture production till 2010 - increase in the value of wood raw material through products with the high level of finalization having the quality, design and recognizability features and in the end, fulfilment of the vision of the Croatian wood industry as economically successful, profitable and export-oriented with harmonized and sustainable development, following worldwide development trends.

MATERIAL AND METHODS

Data required for this paper had been gathered from the database of subvention donors.

They include business entities, i.e. holders of capital investment who are oriented toward export and are sorted as

- ✓ per size (small, medium-sized and large entities) and
- ✓ levels of main activity (primary, semi-final and final wood processing).

Thirty One (31) *medium-sized entities* out of total number of reviewed subject oriented toward export had been selected, whose level of main activities is *final processing* (Table 1.).

DEA method had been applied as help at decision making on how to distribute subventions per respective entity.

Table 1. *Data set of results for input and output factors regarding different decision making units*

DMU	Inputs			Outputs	
	Company age (years)		Number of employees (N)	Total income (mill. Euro)	Share of export (%)
	Unscaled data, N	*Scaled data, 1/Nx100*			
1	2	3	4	5	6
3	20	5	124	7,34	19,56
7	16	6,25	217	9,64	86,34
14	11	9,09	156	2,57	93,41
16	4	25	174	7,14	93,32
17	8	12,5	87	2,71	49,77
20	18	5,56	135	3,95	27,5

Inputs are variables whose desirable direction is reducing and entities of longer operation periods are more acceptable.

In this way entities with longer operation periods receive lesser numeric value in inputs through data scaling and have therefore advantages in comparison with those entities that have been in the business for a shorter period of time or have been recently established.

'Data Envelopment Analysis', developed by Charnes et al., 1978 is a well-known non-parametric method for the assessment of relative efficiency of comparable entities/decision making units (**DMU**) with different level of inputs and outputs.

Efficiency is expressed as the ration of the sum of weighted outputs of the base DMU to the sum of weighted inputs.

By linear programming, DEA models determine empiric efficiency frontier (frontier of production possibilities) based on data of used inputs and achieved outputs of all decision making units.

Efficiency level is calculated for each production unit, and consequently, efficient and inefficient units may be differentiated.

The best practice units, those that determine the efficiency frontier, are rated '**1**',

while the degree of technical inefficiency of other decision making units is calculated based on the difference of their input-output ratio with respect to the efficiency frontier (Cooper et al; 2003).

In order to determine DMU efficiency by the application of DEA models, it is necessary to define inputs and outputs, to be used as the input for the analysis.

Two variables are selected for both inputs and outputs.

The number of employees and the company age are entered into the model as **inputs**.

Outputs are represented by the income per year and by the share of export.

RESULTS AND DISCUSSION

Technical and scale efficiency were determined individually for each decision making unit.

Results obtained by the application of the output-oriented Data Envelopment Analysis (DEA) are given in Table 2. and Table 3.

Table 2. Results of CCR and BCC output oriented models

	CCR model	BCC model	Scale eff. (SE)
Number of firms (DMU)	31	31	31
Relatively efficient DMUs	5	15	7
Relatively efficient DMUs (in %))	16,1	48,4	22,6
Average relative efficiency, E	0,741	0,866	0,854
Maximum	1	1	1
Minimum	0,327	0,463	0,475
Standard deviation	0,213	0,174	0,165
DMUs with efficiency lower than E	16	10	12

Table 3. Efficiency of DMUs

DMU	CCR score	BCC score	Scale eff.
3	1	1	1
7	0,973	1	0,973
14	0,694	1	0,694
16	0,951	1	0,951
17	0,827	0,84657763	0,977
20	0,574	0,580860084	0,989
23	0,481	0,506132606	0,951
30	0,613	0,883450366	0,694
34	0,6	0,900398972	0,667
43	0,56	0,560310032	0,999
60	0,754	0,896768542	0,841
62	1	1	1
64	0,488	1	0,488
83	0,776	1	0,776
100	0,886	1	0,886
105	0,398	0,598957259	0,664

Table 3. Efficiency of DMUs

DMU	CCR score	BCC score	Scale eff.
107	1	1	1
109	0,928	1	0,928
123	0,968	0,979441723	0,988
135	0,995	1	0,995
136	0,715	0,912863475	0,783
140	0,704	1	0,704
141	0,935	1	0,935
158	1	1	1
165	0,629	0,63541602	0,989
180	1	1	1
196	0,688	0,70536165	0,975
197	0,65	0,738605565	0,88
199	0,422	0,888305719	0,475
200	0,418	0,74511877	0,561
201	0,327	0,462703095	0,706

CONCLUSION

This paper provides insight into additional techniques of efficiency assessment applicable in comparing companies in wood industry, where their success in not only determined based on financial profit but also based on percentage of export in total income.

We have used DEA method to rank the companies, to make optimal selection of Croatian Wood industry companies.

We hope that the analyses carried out in this work will be helpful in decision making in wood industry.

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