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Dear Readers!

Starting from 2011, Intercathedra – a Scientific Bulletin of the Economics Departments of European Universities, has been published regularly as a quarterly.

International scientific collaboration presented in the first volume of *Intercathedra 2012* links a number of cities: Poznań (the Host City), Brno, Košice, Kraków, Presov, Tarnów, Trnava, Warszawa, Zagreb, Zvolen, Žilina and other Polish and foreign scientific centers. The *Intercathedra* brings together university cities, departments, but first and foremost - it unites people. We invite you to co-operate in the frame of the next volumes of *Intercathedra*.

The *Intercathedra 2012* quarterly, which publishes a range of scientific papers from various universities, resulted from the co-operation of Central European academic research centers. The papers primarily relate to economic issues in the following areas: economy, management and marketing, especially but not exclusively, in the forest and wood products industry as well as other related fields.

We are pleased to provide you with the first quarterly volume of *Intercathedra 2012*. This volume marked as 28/1 includes, inter alia, papers presented at the Economic Forum 2011 and new, submitted to our editorial board. This year's Economic Forum, held in Laski near Kępno, at the Conference Center of Poznan University of Life Sciences on 18 - 20th September 2012, covered problems of economics and business management of the wood industry enterprises in the perspective 12+ years of the third millennium.

Academic conferences known as the Economic Forum have been taking place annually since the early nineties of the 20th century. As is tradition, the Economic Forum 2012 was organized by the Department of Economics and Wood Industry Management of Poznan University of Life Sciences, in co-operation with:

- IATM – the International Association for Technology Management,
- The Forest Experimental Station in Siemianice,
- SITLID – the Wood Section of the Association of Engineers and Technicians of Forestry and Wood Industry in Warszawa,
- The Institute of Wood Technology in Poznań.

The Economic Forum 2012 has been the 28th international scientific meeting of academic researchers conducting scientific work in common and related areas of research. This meeting brings together engineers, specialists in particular sectors as well as young scientists and entrepreneurs. These initiatives are supported by IATM – the International Association for Technology Management, an international scientific organization, which brings together the universities of Central Europe that conduct research in the field of economics and management in industry, in particular in the forest and wood industry.

Intercathedra 2012 has been issued under the auspices of IATM, whose members provided materials for the volume, were responsible for its review, and prepared both mentioned scientific conferences. They deserve our deepest gratitude.

We cordially invite you to read this volume.

Wojciech Lis

Barbara Ciecińska[1], Igor Liberko[2]

THE USE OF MACHINERY FMEA IN MACHINE TOOLS STOCK MANAGEMENT – CASE STUDY OF WOOD CHAFF CUTTER

Abstract: one of the aims of maintenance services in modern enterprises is to achieve certain production efficiency. As a result of processes during the operation, component parts or elements of machines may wear and lead to shutdown of work. Thus, the achievement of necessary efficiency is obtained by proper planning of machine operation. The applied preventive approach - prevention rather than repair - requires the use of certain methods of failure analysis.

The FMEA methodology adopted in the context of machines assessment is presented in this thesis. The case study is an assessment of selected components of the wood chaff cutter, in case of which operational reliability depends on identified factors. The Machinery FMEA allowed to create a list of potential sources of failure, which was especially useful to plan the range of service during inspection, a list of spare parts, the potential shutdowns caused by not applying to occupational safety and health rules were also emphasized.

Keywords: Machinery FMEA, wood chaff cutter, preventive maintenance

INTRODUCTION

Currently the main target of maintenance service in modern enterprises is to achieve certain production ability, productivity, machine work efficiency with maintaining high quality of manufactured products and at the same time ensure minimal costs of production. In order to achieve this goal it is necessary to properly manage the machine tool stock. It is important to ensure that at at any stage of the production process we are in possession of working machine tools. However, it is not an easy task. The first stage of the production may abound with many problems – in the phase of designing new machines and component parts, e.g. the necessity of providing easy and intuitive servicing. Sometimes it is associated with more complicated construction and more difficult, later maintenance of performance (check-ups and presumptive repairs due to the fact that advanced mechanisms or component parts can be repaired only by qualified repairers, post guarantee repair, which equals with considerable costs of spare parts, costs of outsource service etc. Problems may also appear at the time of operation: intricate constructions and appliances are expensive, so the prolongation of their time of operation has huge, economic significance, especially in periods of funds deficiency. In regard of the manufacturing process, high efficiency of contemporary machines causes that the loss due to failure may be considerable. At the same time, because of the presence of electronic control systems and fault information, the chance of failure detection in machines and modern appliances is generally higher than in simpler machines and appliances. It may be associated with major cost of repair or replacement of these elements [2].

Similarly to other management systems, machine tool stock management is crucial to constantly improve the tasks and actions, implementation of corrections at an early stage and the analysis of possible failures that may occur in the final product. Failure prevention, preventive actions are clearly visible in the modern approach to machine management [1].

FMEA

The problem of reduction of failures at source, i.e. at the stage of design, can be solved with analytical methods. One of them is the Failure Mode and Effect Analysis which made real the idea

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of ‘no defect products’. Its usefulness has been widely recognised, resulting in a recommendation in the ISO 16949 [6].

FMEA consists of systematic analysis of possible failures during production and assembling products. Consequently, a list of weak spots in the product (construction) or in the process (the methods of treatment) is created. Furthermore, it is possible to identify the reasons behind the failure and further prevention. FMEA of new products allowed to avoid failures identified through analysis both at the stage of designing and the stage of production [5, 7].

The degree of analysis formalization enables to categorize problems and predict implications.

MACHINERY FMEA

FMEA, when used in the assessment of machine condition, can be applied as a standard technique of machine tool stock management. It can be treated as an analysis of machine reliability and its potential performance incapacity, when carried out in reference to all mechanisms or component parts which may result in unplanned shutdowns.

As in the FMEA of a product or process, in reference to machines, the following features can be analyzed:

- functions of each component parts and machine,
- reliability during operation,
- facility of handling,
- facility of service.

FMEA is recommended when:

- a new machine is implemented,
- a machine is used after upgrade or with modified or replaced component parts,
- untypical machines are used or machines with new settings have not been used so far,
- processing of a new material or one with different features (hardness, machinability) begins,
- operation in difficult conditions starts (temperature within the production plant, humidity, pollination, considerably difficult actions in processing that may cause machine damage or chances for machine failure),
- hazard for humans or the environment may occur at the moment of machine failure(e.g. disturbance within the safety switch system, in the performance of shields, the risk of accidents by swirling elements).

As for the task of identifying subsystem failure modes there are *two approaches*:

- *hardware approach* – involves listing each part and its probable failure modes, this approach is used often when detailed parts design information is available; includes general types of failure modes: fractured parts, corroded parts, sticking, short circuit, warped parts, backlash, crack, leak.
- *functional approach* – involves listing each subsystem, its functions, and the failure modes leading to the loss of each function; this approach is used when machinery design details are not complete; it includes general types of failure modes: failure to operate at the prescribed time, failure to stop operating at the prescribed time, intermittent operation, wear of material.

Potential Effects of Failure are defined as the consequences of the failure mode of the subsystem, named 7 Big Losses + Safety. E.g. [4]:

- then the Risk Priority Number is the product of the severity - S, occurrence - O and detection - D: breakdowns – functional, chemical, mechanical functional loss; function reduction;
- reduced cycle – losses that are the result of differences between the ideal cycle time and the actual cycle time;
- tooling – failures, breakage, deterioration or wear of cutting tools, fixtures, welding tips, punches;
- setup and adjustment – retooling, changeover, die change, requiring operator intervention;

- start-up losses – losses that occur during the early stages of production following extended shutdowns at weekends, holidays;
- idling and minor stoppages - losses that are the result of minor interruptions in the process flow, such as a process part jammed in a chute or limit switch sticking, requiring operator intervention;
- defective parts - losses that are the result of process quality defects of parts resulting in reworking, repair, non-useable parts;
- cuts, falls, impacts by swirling mechanisms, slips on the floor, absence or broken shields etc.

Severity is the rating corresponding to the degree of the effects of a potential equipment failure mode. It comprises of three components: safety considerations for equipment operator or downstream customer, equipment downtime and defective parts. Safety of the personnel is the primary criteria in determining the rating score [4].

The Risk Priority Number is the outcome of the severity - S, occurrence - O and detection - D:

RPN = S x O x D

The analysis of MFMEA was carried out based on guidelines of Ford Motor Company in terms of functionality; values: S, O and D were chosen according to guidelines given in Tables 1-3 [4, 8].

Table 1. Severity Evaluation Criteria – S [4, 8]

Effect	Criteria: Severity of effect	Ranking
Hazardous without warning	Very high severity ranking – affects operator, plant or maintenance personnel, safety or affects non-compliance with government regulations, without warning	10
Hazardous with warning	High severity ranking – affects operator, plant or maintenance personnel, safety or affects non-compliance with government regulations, with warning	9
Very high	Downtime of more than 8 hours or defective parts causing loss of more than 4 hours of production	8
High	Downtime of 4 to 7 hours or defective parts causing loss of 2 to 4 hours of production	7
Moderate	Downtime of 1 to 3 hours or defective parts causing loss of 1 to 2 hours of production	6
Low	Downtime of 30 minutes to 1 hour or defective parts causing loss of up to 1 hour of production	5
Very low	Downtime of 10 to 30 minutes but no production of defective parts	4
Minor	Downtime of up to 10 minutes but no production of defective parts	3
Very minor	Process parameter variability not within specification limits. Adjustment or other process control measures need to be taken during production. No downtime and no production of defective parts.	2
None	Process parameter variability within specification limits. Adjustment or other process control measures can be taken as part of standard maintenance.	1

Table 2. Occurrence Evaluation Criteria – O [4, 8]

Probability of failure	Criteria: Possible number of failures within hours of operation	OR	Criteria: The reliability based on the user's required time	Ranking
Failure occurs every hour	1 in 1	OR	R(t)<1%: MTBF is about 10% of the user's required time	10
Failure occurs every shift	1 in 8		R(t)=5%: MTBF is about 30% of the user's required time	9
Failure occurs every day	1 in 24		R(t)=20%: MTBF is about 60% of the user's required time	8
Failure occurs every week	1 in 80		R(t)=37%: MTBF is equal to the user's required time	7
Failure occurs every month	1 in 350		R(t)=60%: MTBF is 2 times greater than the user's required time	6
Failure occurs every 3 months	1 in 1000		R(t)=78%: MTBF is 4 times greater than the user's required time	5
Failure occurs every 6 months	1 in 2500		R(t)=85%: MTBF is 6 times greater than the user's required time	4
Failure occurs every year	1 in 5000		R(t)=90%: MTBF is 10 times greater than the user's required time	3
Failure occurs every 2 years	1 in 10000		R(t)=95%: MTBF is 20 times greater than the user's required time	2
Failure occurs every 5 years	1 in 25000		R(t)=98%: MTBF is 50 times greater than the user's required time	1

MTBF – Mean Time Between Failure

Table 3. Detection Evaluation Criteria – D [4, 8]

Detection	Criteria	Ranking
Very low	Design or machinery controls cannot detect a potential cause and subsequent failure, or there are no design or machinery controls	10
	Teams are free to use a ranking score of 9 and 8 as needed	9
		8
Low	Design or machinery controls do not prevent the failure from occurring. Machinery controls will isolate the cause and subsequent failure mode after the failure has occurred	7
	Teams are free to use a ranking score of 6 as needed	6
Medium	Design or machinery controls may detect a potential cause and subsequent failure mode. Machinery controls will provide an indicator of imminent failure	5
	Teams are free to use a ranking score of 4 as needed	4
High	Design controls may detect a potential cause and subsequent failure mode. Machinery controls will prevent an imminent failure and isolate the cause	3
	Teams are free to use a ranking score of 2 as needed	2
Very high	Design controls almost certainly detect a potential cause and subsequent failure mode, machinery controls not required	1

CASE STUDY

It is the analysis of the sawing machine for which an innovative construction design has been worked out at the Rzeszow University of Technology (Niemiec W., Bieniasz W.). This machine is intended to cut branches and chits of trees, bushes and other wooden parts of plants. It is especially dedicated to grind branches of osiers on osier plantations. Its reliable work is necessary because of the required constant delivery of grinded energy material.

The main systems of the sawing machine are: drive unit, power unit (electric installation) and transport system. The drive unit, in which the process of cutting and grinding is performed, was analysed in this study. It consists of:

- three-phase motor,
- belt drive,
- rpm limiter (reduction gear),
- cutting head in the shape of a roll with knives.

The torque from the engine is transmitted to the rpm limiter through belt transmission (gear train), and the working head constituting rolls equipped with changeable knives. The position of the knives can be adjusted, they can also be taken out for sharpening, or their number may be changes as is the length of cutting elements. Rpm limiter is filled with transmission oil, its construction has a hole to fill and a hole to empty the container (with plug) [3].

The MFMEA results are shown in Table 4.

The next step is the interpretation of obtained numeral outcomes. The minimal value obtained in the analysis is 1 (1x1x1), the maximum 1000 (10x10x10). Thus in practice, expected outcomes should range <1, 1000>.

The obtained value 1 means that:
- the failure has no effect,
- it is impossible to occur,
- detection is 100%.

In turn, the value 1000 means that:
- the failure has crucial meaning for machine working,
- the probability of its occurrence is huge,
- the detection of failure is quite impossible.

The threshold value should be determined, which will assign critical defects for a certain case. The range was determined in the conducted analysis:

L – minor failures - <1, 30>;

M – possible failures, sources of which should be immediately removed - <31, 99>;

H – major failures, source should be removed as soon as noticed – from 100 points up.

RESULT ASSESMENT

All elements of the driving unit are important. The crucial elements are the engine and the rpm limiter (reduction gear) (no. 1 i 3), without their proper performance any processing is impossible. The condition of these elements must be under discerning observation to prevent them from failure. Points at the medium stage are: 2, 4, 5 i 6.

The condition of the machine must be monitored and decisions must be made to include data in a separate service sheet of spots that require systematic, everyday check-ups.

Additionally, it is recommended to predict the necessity of replacing broken or worn out parts (spare parts should be supplied in advance), to fix and replace broken elements as soon as possible.

SUMMARY

The methodology in Machinery FMEA, slightly differs from the analysis of a product or process, and as such allows not necessarily for identification of weak spots in construction (meaning failure in terms of production), but to determine facts - what may happen in case of failure of a particular part or component of the machine. It can be helpful in preparing a list of maintenance for an operator and for preventive service. Each element which is possibly prone to failure, should be checked-up as often as possible in order to prevent machines from shutdowns.

In addition, the list of assessed areas may be a basis for implementation of remedial procedures, with the emphasis on work safety, which is often neglected by workers.

MFMEA methodology can be implemented into any standard system management procedures – as a unified method of search for potential weak and failure spots in a machine. This method can be used in the work of operators and executives, and completed by another method of analysis used in systems based on ISO 9001, e.g. Ishikawa's cause and effect diagram or brainstorming.

Table 4. The MFMEA results

No.	Subsystem	Potential failure mode	Potential effects of failure *Severity*	S	Potential causes or mechanisms of failure *Occurrence*	O	Current machinery control *Detection*	D	RPN	Recommended actions
1	engine	- it doesn't work	- intermittent work - loss of power at the head of the cutting knives - no cut	8	- no power - damage to cables - activator failure - engine failure - working in a damp environment	6	high	3	***144***	- routine daily check of the efficiency of the engine - daily check connectors and electric insulation pipe - check the efficiency of the switch key - provide an additional source of current for power loss - work in appropriate, dry conditions
2	transmission pulley	- belt displacement - irregular work	- the lack of transmission capacity to gear - intermittent work, reinstallation of belt needed	7	- belt failure - shields failure	3	high	3	<u>63</u>	- once a week check that the belt has no traces of wear - validation of position of belt scales - in the event of the destruction,the belt is to be replaced by a new one
3	reduction gear	- noise - warming	- errors in speed settings	4	- wear of teeth - oil leak	7	medium	4	***112***	- refill with lube - daily check the lube levels - exchange of used gears
4	cutting knives	- they don't cut	- badly cut branches - intermittent work	5	- blunt blades - loose anchorage in the head	7	high	2	<u>70</u>	- everyday blades control - screws tightening - replacement of blunt knives
5	the shield	- no shield	- risk of accident	3	- no control - no instruction	9	high	2	<u>54</u>	- training - everyday control
6	the head with cutting knives	- no cut	- downtime	4	- cutting materials other than wood (eg. metals, plastics)	9	very high	1	<u>36</u>	- training - everyday control

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ASSESSMENT OF BANKRUPTCY THREAT OF FURNITURE MANUFACTURING COMPANIES WITH FUZZY LOGIC

Abstract: The aim of this paper is to present a conception of fuzzy logic based expert system for assessment of bankruptcy threat of furniture companies. The proposed solution employs both financial and non-financial sector specific factors. The work focuses on the selection of input data and the fuzzification process. For the purpose of fuzzification qualitative factors are classified as statistical factors, share-related factors and seasonality factor. Authors also propose a solution for incorporation of data from surveys conducted among professional expert or customers in fuzzy model.

Key words: bankruptcy, furniture manufacturing companies, fuzzy logic.

INTRODUCTION

The risk of bankruptcy threat of a company is important information for investors, creditors and the company itself. Recent data show that 218 manufacturing companies became bankrupt in 2011, among which 12 companies were furniture manufacturers [7]. The most popular approach of assessing of bankruptcy threat is using discrimination models [2, 4]. However, the discrimination models have some significant disadvantages. First of all, they use only common financial factors neglecting qualitative data or specification of particular sector. Moreover, expert system that are based on discrimination models may provide misinterpreted output for the results near threshold values. There are solutions that employ computation intelligence methods like neural networks or fuzzy logic for assessing of bankruptcy threat of companies. Among them, [5] one is of particular interest, because this is probably the first application of fuzzy logic for that purpose in Poland. Generally fuzzy logic seems to be very promising for the evaluation of company condition, because of its ability of handling of imprecise data and generalized imprecise relations. However, the above cited paper still concentrates only on financial issues disregarding other circumstances.

The aim of this paper is to present a conception of fuzzy logic based expert system for assessment of bankruptcy threat of furniture companies. The proposed solution employs both financial and non-financial sector specific factors. The work focuses on the selection of input and the fuzzification process.

1. THE OVERVIEW OF FUZZY LOGIC

Fuzzy logic is considered to be one of the artificial intelligence methods. It is widely used in many areas, for example tax advisory [11], inventory management [8], investment decisions [1], etc. Unlike classical logic, in which each statement is either true or false, in fuzzy logic a statement is assigned a degree of truth. Each continuous factor has to be fuzzified, which means that its value has to be classified into one or more fuzzy sets with a particular degree of membership. The classification is done with so-called membership functions, which return values from set <0, 1>. The output equal 0 means that the value does not belong to the corresponding set, the output 1 means full membership of the set, whereas values between 0 and 1 indicate partial membership. In that way fuzzy logic deals with imprecise statements.

The common practice is to define a fuzzy set that represent low, medium and high values of each continuous input factor. However, the number of sets for a particular factor may vary according to the expected precision of the model. Figure 1 presents membership functions for classification of value as very high, high, medium, low or very low.

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The further processing is done with fuzzy rules, that relate fuzzy input to fuzzy output. For the fuzzy representation illustrated in Figure 1 an example of a fuzzy rule may be formulated as follows:

if input_variable_1 is low and output_variable_2 is very high then output_variable_3 is high.

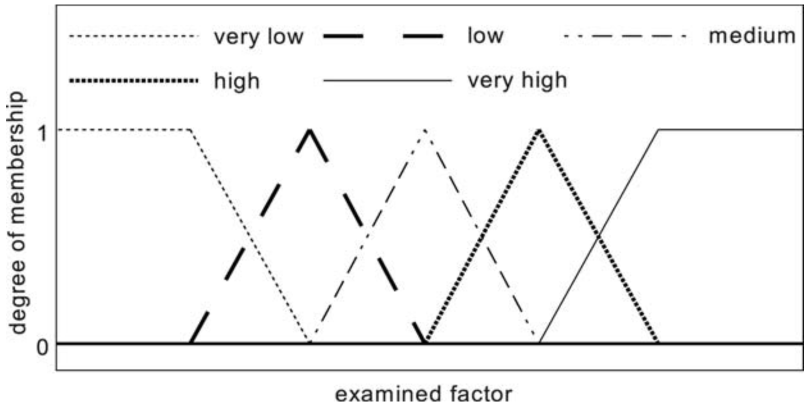

Figure 1. Example of membership functions for classification of value as very high, high, medium, low or very low

source: own elaboration

Fuzzy rules are developed by experts. Their construction imitate the process reasoning made by human beings. Because the individual rules are not precise it is particularly easy to formulate rules based only on expert experience. Fuzzy rule developers do not need to specify arbitrary threshold values, which may be difficult to establish due to the lack of data or insufficient knowledge of underlying phenomena.

In most application the last step is the deffuzification, i.e calculation of quantifiable results based on responses of fuzzy rules. More details on fuzzy logic can be found in [9].

2. GENERAL ASSUMPTIONS ON THE PROPOSED EXPERT SYSTEM

The idea of the proposed expert system is illustrated in Figure 2. The input data constitutes quantitative data that can be obtained from financial and sales reports of the evaluated company or from third-party vendors. The other data, which is of qualitative character, refers mostly to subjective issues, like product quality. Such kind of information can be acquired by conducting surveys among professional experts or customers through web services.

The proposed approach employs two-step processing of fuzzy rules. First step should summarize each group of conditions separately. For example, the conditions can be categorized as internal financial, internal non-financial, and external. The fuzzy output from first step should be passed as the input for the second step and, at the same time, displayed to the decision maker together with final advice. This approach has two important advantages. First one is that individual fuzzy rules become less sophisticated, because they have to deal with less input data. It makes the whole system easier to maintain and less error prone.

The other benefit is that the decision makers are provided with both final and intermediate output, which gives them a wider view on the situation. Moreover, the intermediate output may serve an explanatory mechanism, which is an important functionality of expert systems.

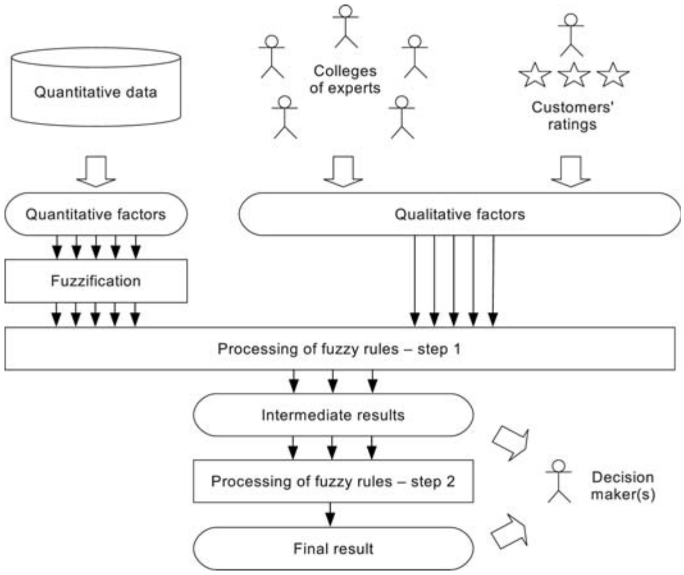

Figure 2. The idea of the proposed expert system

source: own elaboration

3. INPUT AND FUZZIFICATION

Proposed factors to be analyzed in the assessment of bankruptcy threat are presented in Table 1. First group of factors are financial factors that are available in financial reports and are commonly used in discrimination models of bankruptcy threat. Factors within that group are the same as those used in the model of Hamrol, Czajka and Piechocki [3] referred to as the "poznański" model.

Table 1. Factors proposed for considerations in the analysis

Common financial factors	Sector specific quantitative factors	Sector specific qualitative factors
1. net profit / total capital 2. rotational capital – stock inventory / short-term liabilities 3. fixed capital / total capital 4. profit from sales / sales	5. share of exporting 6. currency rates 7. issued building permission 8. seasonality of demand 9. offered delivery time 10. share of solid wood use 11. shares of production types 12. share of flexible CNC working centers in overall machinery	13. overall product quality

Another group are internal and external sector specific quantitative factors. Some of them, like the number of issued building permissions may be closely related to the forthcoming demand for furniture. Even though factors like currency rates or share of exporting affect various sectors of industry, they are considered to be sector specific, since for various sectors they may be related to other conditions in different ways, ie. they may require different handling in fuzzy models. The share of flexible CNC working centers represents the technological level of the enterprise and the ability to perform flexible production.

Production type refers to the common cathegorisation of goods and their manufacturing process as make-to-stock, assembly-to-order, make-to-order and design-to-order [10]. This factor may be important during the evaluation of company potential, because make-to-order and design-to-order production allow for mass customisation and one-to-one marketing. This in turn establishes a learning relationship between customers and manufacturer, giving the company an excellent competitive advantage [6].

For the purpose of fuzzification the authors propose to classify qualitative factors as statistical factors, share-related factors and seasonality factor.

Statistical factors are variables that undergo natural changes against time and for which significant history and statistical distribution can be obtained. Statistical factors are all common financial factors and offered delivery time; each of them should be analyzed against its history for consideration by companies. Further statistical factors include the number of issued building permissions and currency rates. The membership functions for statistical factors may be established using a percentile scale as it is illustrated in Figure 3.

Share-related factors represent variables that can be expressed in percents within the range <0%, 100%>. Such factors include: share of exporting, share of solid wood use and share of flexible CNC working centers in overall machinery. Because possible minimum and maximum values of these factors are known, the fuzzification can be performed as shown in Figure 4.

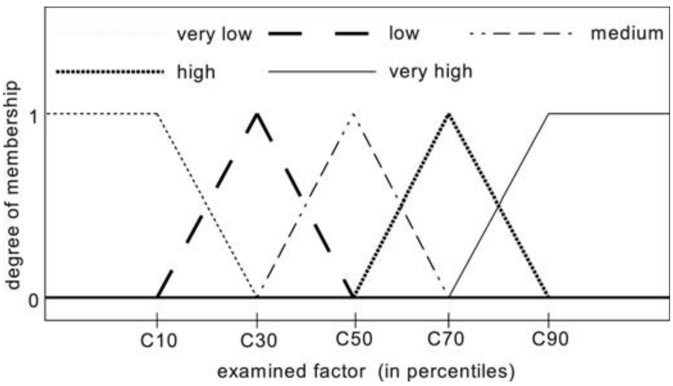

Figure 3. Fuzzification of statistical factor

source: own elaboration

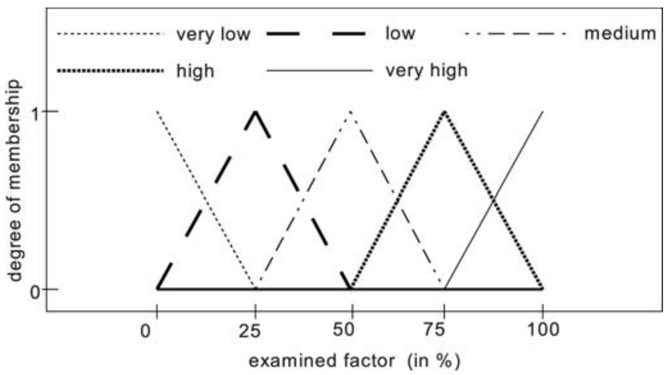

Figure 4. Fuzzification of share-related factor

source: own elaboration

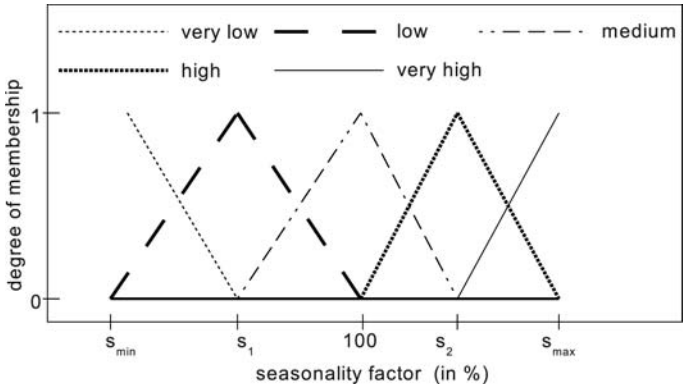

Figure 5. Fuzzification of seasonality factor

source: own elaboration

When the seasonality of demand is expressed in percents, the value of 100% corresponds to mean demand. Therefore this value can be established as the center of a medium fuzzy set. Since current minimum s_{min} and maximum s_{max} values of seasonality are also known, the fuzzification can be done with membership functions that are presented in Figure 5, in which s1 and s2 are equal:

$$s_1 = \frac{100 + s_{min}}{2} \text{ and } s_2 = \frac{s_{max} + 100}{2}.$$

Production type can be considered to be a fuzzy factor itself, when the following fuzzy sets are assumed: make_to_stock, assembly_to_order, make_to_order and design_to_order. The degree of membership to an individual set then equals the share of production that falls into the corresponding category. In that way no assumptions on membership functions are required.

Similarly, furniture quality does not require fuzzification when experts or customers are asked to express their opinion on a product or products using the following grade scale {very low quality, low quality, medium quality, high quality, very high quality}. Therefore, the share of votes for individual grades may be considered a degree of membership of the corresponding fuzzy sets.

4. PROCESSING AND OUTPUT

The establishment of fuzzy rules for processing requires further research on large data sets to discover dependencies between individual inputs and output. It is also accepted that future studies will reveal more factors that may be feasible as input data.

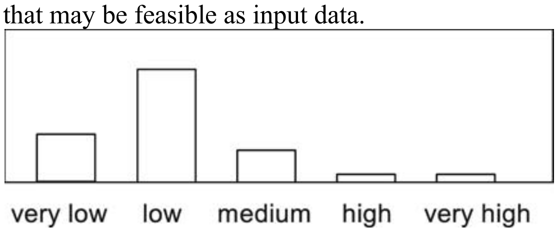

Figure 6. Example of graphical output

source: own elaboration

In the current solution the authors propose to omit the deffuzification step, since fuzzy output should be more “human readable”. In that way the output may be presented graphically in a form illustrated in Figure 6. The presented example shows that bankruptcy risk for a company is generally low, but most responses of fuzzy rules fall between very low and medium. Another advantage of this approach is that the distribution of strength of individual fuzzy responses is displayed, providing the information on the uncertainty of the given recommendation.

RECAPITULATION

Fuzzy logic is considered to be one of the artificial intelligence methods. It is widely used in many areas. Fuzzy logic seems to be very promising for the evaluation of company condition, because of its ability of handling imprecise data and generalized imprecise relations.

The work focuses on the selection of input and the fuzzification process. For the purpose of fuzzification qualitative factors are classified as statistical factors, share-related factors and the seasonality factor. The authors also propose a solution for the incorporation of data from surveys conducted among professional experts or customers into the fuzzy model.

The establishment of fuzzy rules for processing requires further research on large data sets to discover dependencies between individual inputs and outputs. It is also accepted that future studies will reveal more factors that may be feasible as input data.

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BANKRUPTCY OF WOOD INDUSTRY COMPANIES IN POLAND AS COMPARED TO OTHER SECTORS OF THE ECONOMY

Abstract: In the era of global economic crisis, the issue of bankruptcy is becoming more important. Since 2007, growth of the insolvency of companies in many countries around the world was significantly increased. This crisis has also affected the Polish economy. Due to the significant role of the wood industry, this article examines the phenomenon of bankruptcy in Poland, with particular emphasis on this sector.

Keywords: bankruptcy, wood industry, financial condition of enterprises

INTRODUCTION

Bankruptcy as an immanent feature of the market economy has appeared in Poland in the 90's, and the basic reason for this was transformation introducing the market economy system. This does not mean that in centrally planned economy only entities having good financial standings were functioning. State ownership was the guarantor of maintaining almost every enterprise, despite the lack of economic efficiency and the insolvency of some of them. Economic transformation in Poland and all the resulting political and economic consequences caused, that in the early 90's a selection mechanism that removed from the market both unprofitable state-owned enterprises and newly established private companies, which didn't meet its requirements, began to operate. Thus, apart from many negative aspects of bankruptcy, i.e., increased unemployment, increased business risk, this phenomenon also entails positive implications as it "clears" the market from unprofitable companies and thus prevents the insolvency spiral of the next enterprises.

Bankruptcy applies to each sector of the economy, and therefore also the wood sector. Due to the limited supply of raw wood material and the associated significant risk in management, companies in this sector may sometimes be more at risk of bankruptcy than other companies operating in the market.

The purpose of this paper is to analyse the phenomenon of bankruptcy in the Polish economy, with particular reference to the wood industry. The study included the years 2007 - 2011. A scenario of companies failure in 2012 has also been presented.

THE PHENOMENON OF BANCRUPTCY IN POLAND

The issue of corporate bankruptcy once again took on significance in face of the economic crisis that began in the United States in 2007, and its negative effects were felt by all countries, including Poland.

Statistics on the number of announced bankruptcies are run by commercial institutions. One of them is the credit agency Coface[6]. Its reports show that the total number of bankrupt companies in Poland grew gradually in the years 1997-2002 and at the end of this period amounted to 1863 (Figure 1). The primary cause of changes in the dynamics of the insolvency of companies in the late 90's were adjustment difficulties arising from the transformation process. In addition, the main causes of this phenomenon can be seen in the collapse of existing markets, liberalization of foreign trade and the emergence of competing foreign products, and low adaptive capabilities of state-owned enterprises to the new management conditions [Sojak 2001].

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6 Coface Intercredit Poland is a credit agency existing on the Polish market since 1992. The company mainly deals with the assessment of credibility and trading partners ability to pay, management of receivables and credit risk.

Although at the beginning of this century, the number of applications in both bankruptcy and announced bankruptcy was increasing, in 2004 the number of the latter was 38% lower than in the previous year. Contrary to widespread fears before Poland's accession to the European Union, some companies, particularly large ones employing over 250 people, were able to adapt to new business conditions and to meet strong competition from abroad. In addition, those companies made use of the wider development opportunities, which were created by European integration. The economic recovery was least evident in small companies, that have felt neither positive nor negative effects of accession [Michałków 2005].

Although the European Union has considerable financial resources for business development, especially for small and medium enterprises, complicated procedures, formal requirements and the high costs of properly preparing complete applications sometimes effectively restricts access to EU funds [Michałków 2005]. The downward trend in the number of insolvency remained until 2008, when only 411 cases were reported – the least in the 15 years surveyed. It is worth to note that the number of actual failures of companies was significantly higher than the number of announced bankruptcies. About five times more applications were rejected because of formal errors or due to not ensuring enough assets. Also, since March 2nd 2006 the fee for an application for bankruptcy has been increased to 1000 PLN, which resulted in a significant reduction in the number of applications [www.coface.pl].

After six years of decrease, in 2009 there was a clear increase in bankruptcy - 68% more than in the previous year. The primary cause of chronic insolvency of 691 companies in Poland was more difficult access to sources of financing for their business. Furthermore, the situation in the market was influenced by the downturn arising from the global financial crisis and resulting in lower sales revenues.

Further increase in insolvencies occurred in 2011 (by 10% compared to the previous year). Economic problems of the euro zone countries, fluctuating exchange rates of the Polish zloty (PLN) and rising inflation, adversely affected the profitability of Polish companies and their capacity for managing liabilities on time.

Prognosis on the number of bankruptcies in the Polish economy in 2012 is not optimistic. According to the analysis by credit agency *Dun & Bradstreet Poland*[7], in the first half of this year 416 companies filed for bankruptcy, and by the end of the year this number could increase up to 800 This is the highest number of bankruptcies in recent years [www.dnb.com.pl]. This means a significant increase (20%) compared to the same period in the previous year. The reason for this situation is the increased business risk expressed by the growing number and value of overdue payments.

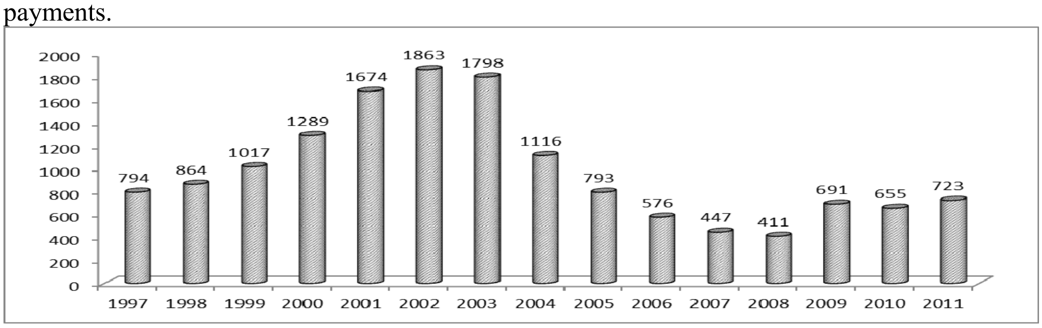


Figure 1. Number of corporate bankruptcies in the years 1997-2011.

Source: own elaboration based on reports from Coface on corporate bankruptcy in Poland; www.coface.pl

[7] *Dun&Bradstreet Poland is a credit agency existing on the Polish market since 1992. The company offers solutions in risk management to enhance profitability of companies and making accurate businesses decisions by management.*

Important information is also provided by the study of the phenomenon of bankruptcy in Poland, including selected voivodeships (Table 1). Analyses carried out by Coface revealed that in the years 2007-2011 most bankruptcies, amounting to 580, were declared in the region of Masovia. This does not mean that companies operating in that area were in a much worse financial situation than companies in other regions. Such a large number of bankruptcies was mainly due to the fact that locational attractiveness and opportunities for economic development encourage most companies to be founded in the Masovian Voivodeship. The data also shows that companies operating in the Voivodeship of Silesia, Lower Silesia, West Pomerania and Greater Poland were at high risk of bankruptcy. The total number of bankruptcies announced in those five voivodeships in each of the periods represented over 55% of all insolvencies. In contrast, the relatively least number of bankruptcies was recorded in the Podlaskie, Świętokrzyskie and Opolskie Voivodeships. This stemmed from the fact that these regions are relatively poorly developed in terms of economy, with a small local market and relatively few companies operating. It is worth noting that in 2009 almost all voivodeships, except the Opole Voivodeship, experienced significant increase in the number of bankruptcies. The regions of Greater Poland, Lesser Poland and Kujawy-Pomerania had the highest dynamic of this phenomenon, which amounted to 200%, 165% and 135%.

Table 1. Number of corporate bankruptcies in 2007-2011 in selected voivodeships.

Voivodeship	2007	2008	2009	2010	2011
Masovian	96	91	118	134	141
Silesian	67	63	104	93	89
Lower Silesian	42	44	86	77	87
West Pomeranian	27	34	59	58	70
Wielkopolska	19	15	45	54	64
Małopolska	21	20	53	52	64
Lublin	32	29	34	17	25
Warmian-Masurian	25	24	23	25	18

Source: own elaboration based on reports from Coface on corporate bankruptcy in Poland; www.coface.pl

THE SCALE OF BANKRUPTCY IN THE WOOD INDUSTRY

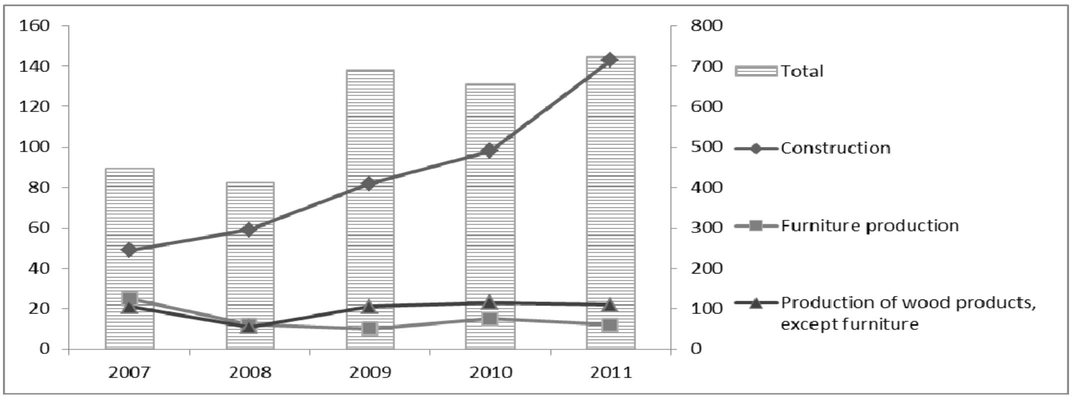
Interesting information about the condition of Polish economy is provided by research on bankruptcy of enterprises in different sectors. According to the *Coface* reports the wood sector comprises of companies producing furniture and other wood products. However, some companies from the wood industry are related to the construction industry. Thus, the analysis also takes into account the phenomenon of bankruptcy among construction companies.

As the *Coface* research shows, the number of bankrupt companies producing furniture and other wood products was highest in 2007 and reached a total of 46 companies, representing 10% of all cases of insolvency (Figure 2). In the next two years the number of bankruptcies in the furniture industry declined to 10 cases, but in 2010 there was an upward trend again. It was mainly caused by higher raw material prices, the slow revival of exports and currency fluctuations.

However, in 2011 wood sector bankruptcy hit a total of 34 companies, including 12 companies from the furniture sector and 22 factories producing other wood products. This represents 5% of all cases of insolvency of companies. According to the CSO (*Central Statistical Office*), the sold production value of furniture in 2011 amounted to 28.9 billion PLN, which is 20.4% more than in the previous year. Therefore the high growth rate observed in the first 3 quarters of 2011maintained. These results set a new record in the history of the Polish furniture industry. Results from the year 2008 have since been corrected, as furniture manufacturers calculated the rest of the production, not classified elsewhere, and accounted for 28.3 billion PLN [www.brstudio.eu].

In the first half of 2012, nine companies of the furniture sector and three companies involved in production of wood products, except furniture, announced bankruptcy. In case of the latter, there was a significant decrease in the number of bankruptcies during the same period of the previous year. If current trends continue, despite the upward trend in bankruptcy of enterprises in Poland, the number of insolvencies in the furniture industry will remain at a similar level as in the previous year. However, there will be significant decrease in the number of bankrupt companies producing other wood products.

Figure 2. Number of corporate bankruptcies in 2007-2011 in selected industries.



Source*: own elaboration based on* reports *from* Coface on corporate bankruptcy in Poland; www.coface.pl

The timber sector is also associated with the construction industry, where the number of insolvencies of enterprises increased from year to year. At the beginning of the analysed period 49 bankrupt companies were recorded, and in 2011 that number had risen to 143 cases, representing 20% of all insolvencies in the Polish economy. In the first half of 2012 the upward trend continued. At that time 66% more bankruptcies were recorded than in the same period of previous year.

According to analysts from Brad & Dunstreet, crisis in the construction industry will get worse. This may be indicated not only by a greater number of bankruptcies, but also by the increasing amount of debt in individual companies. In April 2011 seven thousand debtors were late with payments to their contractors, totalling more than 247 million PLN, which compared to April in the previous year represents a 41% growth in the total amount of indebtedness, as well as a 46% increase in the number of reported debtors [Rzeczpospolita, 27.01.2012].

SUMMARY

Bankruptcy is an inherent part of every business. Apart from the obvious negative consequences, this phenomenon eliminates unprofitable enterprises from the market and thus prevents the economy from suffering a flood of subsequent failures of companies. Due to the limited supply of raw wood materials, companies from the wood industry may be particularly at risk of insolvency. As a result of the global economic crisis, which had its origins in the United States, several thousand companies across the global economy were dropped. This situation is true for Poland since 2009, when a significant increase in the number of bankruptcies was recorded. This article presents the dynamics of that particular phenomenon in the wood sector, as well as in the construction industry, which for the last few years has suffered the highest rate of insolvency, and is closely linked to some of the wood industry companies.

Due to limited access to data on the phenomenon of bankruptcy in the various sectors of the economy and the scarce research available in this field for the timber sector, the presented subject is worth undertaking further studies.

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***Vladislav Kaputa*[8], *Roman Sucháň*[9]**

SLOVAK WOOD BIOMASS MARKET

Abstract: This paper deals with the wood biomass market in the Slovak Republic regarding the main industrial players such as pulp and paper industry, agglomerate wood based panels' producers and energy sector. The demand for wood biomass has undergone significant changes. Behind of rapidly growing consumption are not only traditional industrial sectors as pulp and paper and agglomerate wood based panels' producers, but also subjects of energy sector utilising wood biomass as an input. Production of energy from renewable energy sources is growing significantly due to the higher purchase price of electricity (made from biofuels = biomass fuels) and opportunity to co-finance "bioenergy projects" through the European Union structural funds. Moreover, lack of supply is magnified by export. The characteristics and consequences of recent wood biomass market conditions are analysed in this paper.

Keywords: wood biomass, wood chips, pulpwood, pulp and paper industry, agglomerate wood based panel's production, energy sector.

INTRODUCTION

The forest industry has experienced many important changes during last twenty years. After the year 2000 wood processing capacity in Slovakia increased significantly and improved domestic wood consumption. The highest economic growth was recorded during the years before the economic and financial crisis (driven by the global economic growth, Slovakia's accession to the EU etc.). Different sectors within the industry started to develop variously, reflected by domestic and foreign conditions (Paluš, Parobek, 2011). Šupín (2011) described two major shifts as a result of globalisation of the forest products trade, a process marked by increasing centralisation of the wood processing industry into a smaller group of the large transnational corporations. The second shift has been a replacement of raw logs by wood chips and pulp. Spectacular growth in the wood fibre trade – an increase of more than 300 % since 1960 – has been matched by a surge in pulp processing. In 1960, wood chips amounted to less than 10 % of the fibre trade and more than 60 % in 2000.

The term 'wood biomass' is in public perceptions more or less connected to their energy utilization. Energy sector has wide support to process renewable energy sources (RES) for heating and power. Besides utilization for energy, wood biomass in Slovakia is also chemically as well as mechanically processed in the pulp and paper industry, mainly in agglomerate materials production. Hence, the market meets demand of three major industry consumers (excluding exporters and consumption in the private sector). Regarding recent market conditions the majority of demand is aimed at the same input assortments. This fact causes pressure on the price, insufficient availability of supply and changes in the input assortments in the above mentioned sectors.

Wood biomass is a product that consists of ligneous mass or part of ligneous vegetal mass coming from forestry, agriculture, the wood processing industry or other sources, e.g. municipal activities (Lieskovský et al., 2009). The US Forest Service (2008) defined wood biomass utilization as the harvest, sale, offer, trade, or utilization of wood biomass to produce bioenergy and the full range of bio-based products including lumber, composites, paper and pulp, furniture, housing components, round wood, ethanol and other liquids, chemicals, and energy feedstock.

The US Forest Service (2010) adduced the following principle sources of wood biomass: forest residues from forest management, forest restoration, commercial logging (slash) for forest health and hazardous fuels reduction treatments; sanitation cuttings in the wake of major insect and disease

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outbreaks; coarse woody debris following major wind and ice storms; and residues from clearings along utility corridors and transportation rights-of-way – generally these are unmerchantable materials as compared to sawlogs or pulpwood which can be sold for higher value uses. However, depending upon existing markets and prices, pulpwood sized material (roundwood) can be a source of wood biomass for bioenergy applications. This is a typical market situation in Slovakia – chips from pulpwood became significant input for the bioenergy sector. Moreover, the lack of supply caused that even sawlogs are being processed into chips. Other potential sources and types of wood biomass introduced by the US Forest Service (2010) include wood that has been cleared during land conversion; construction and demolition wood; forest products manufacturing residuals (e.g. bark, sawdust, chips and slabwood, etc.); orchard trimmings, municipal solid waste (MSW), green waste; and wood harvested from short rotation woody crop plantations. MSW includes items such as discarded furniture, pallets, packaging materials, processed lumber, and yard and tree removals and trimmings/green waste.

SLOVAK WOOD BIOMASS MARKET ANALYSIS

Three biggest wood biomass industrial consumers in the Slovak Republic are pulp and paper industry, producers of agglomerate wood based panels and the energy sector. The representatives of each sector are among competitors in the purchase of inputs.

Inputs into the pulp and paper industry are primary pulpwood, but market situation has caused that sawlogs are also used. Basic outputs of the pulp and paper industry are cellulose and paper, but also the energy production from incineration of dissolved organic parts of wood is significant. The biggest paper producer and simultaneously consumer of pulpwood in Slovakia is Mondi SCP, a. s. Paper consumption is relatively high in Slovakia and represents yearly over 85 kg per capita, but domestic consumption is lower than production and producers are export-oriented. All paper mills in Slovakia process non-coniferous wood. Lack of supply is the key problem. Thus, inputs are imported from Ukraine, Hungary and Poland.

Inputs into agglomerate wood based panels' production are (technological) wood chips, sawdust, wood residues and pulpwood. Producers of agglomerate materials use residues from mechanical processing of (dominantly coniferous) wood as scrapwood / slabwood, sawdust and chips as well as the, still minimally used in Slovakia, MSW. The biggest producers in Slovakia are Bučina DDD, s. r. o. and Sweedspan Slovakia, s. r. o.

Inputs (as biofuels) into the energy sector are fuelwood, wood chips and pulpwood. Consumers of chips for energy purposes are electricity and heat producers in heating plants or power plants as well as subjects providing central heating appointed for the communal sector or for the industry.

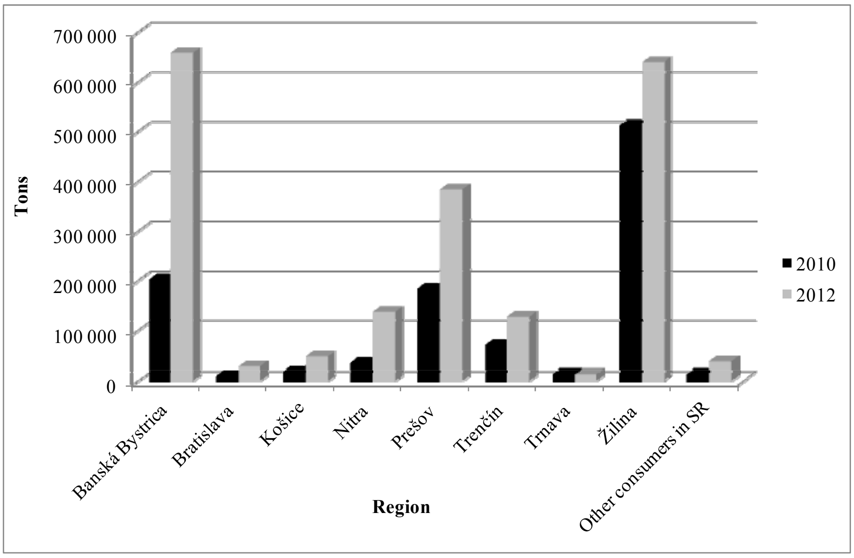
The demand for wood biomass has undergone significant changes, remarkable on the regional level. The plan of consumption in 2012 introduces rapidly growing demand (Table 1).

Table 1 and Graph 1 show relevant regional consumption differences based on geographical location of big market players. In 2010, the biggest consumption of wood biomass was in the Žilina region and respresents almost half of total consumed wood biomass in Slovakia. There is an assumption of significant growth of consumption mainly in Banská Bystrica and Prešov regions in the year 2012 due to the planned investments (Tepláreň Dalkia a. s. and Bukóza Holding a. s.) in bioenergy utilisation.

Table 1. Regional wood biomass consumers in Slovakia

Companies in regions	Consumption in 2010 (tons)	Plan of consumption in 2012 (tons)
BANSKÁ BYSTRICA REGION		
Smrečina Hofatex, a. s., Banská Bystrica	80 000	80 000
Tepláreň Dalkia, a. s., Žiar nad Hronom	-	180 000
Zvolenská teplárenská, a. s., Zvolen	50 000	80 000
Other companies in region	73 000	318 000
Total in Banská Bystrica Region	203 000	658 000
BRATISLAVA REGION		
COMERON SPS, spol. s r. o., Malacky	12 000	12 000
COMERON SPS, spol. s r. o., Vrukuňa	-	18 000
Total in Bratislava Region	12 000	30 000
KOŠICE REGION		
COMERON SPS, spol. s r. o., Moldava n. Bodvou	-	10 000
Enel Slovenské elektrárne, Vojany	20 000	40 000
Total in Košice Region	20 000	50 000
NITRA REGION		
AGRO ENERGY, s.r. o., Želiezovce	13 000	13 000
SES a. s., Tlmače	14 000	14 000
Tepláreň/ elektráreň DAH Biomasa, s.r. o., Topoľčany	-	90 000
Other companies in region	10 000	20 000
Total in Nitra Region	37 000	137 000
PREŠOV REGION		
BUKÓZA HOLDING, a. s., Vranov n. Topľou	-	150 000
Tepláreň/elektráreň DAH Biomasa, s.r. o., Bardejov	90 000	90 000
VIHORLAT s.r. o., Snina	25 000	25 000
Other companies in region	69 000	119 000
Total in Prešov Region	184 000	384 000
TRENČÍN REGION		
Handlovská energetika, a. s., Handlová	15 000	20 000
TERMONOVA, a. s., Nová Dubnica	40 000	60 000
TSM Partizánske	10 000	10 000
Other companies in region	6 000	37 000
Total in Trenčín Region	71 000	127 000
TRNAVA REGION		
COMERON SPS, spol. s r. o., Senica	15 000	15 000
Total in Trnava Region	15 000	15 000
ŽILINA REGION		
Mondi SCP, a. s., Ružomberok	340 000	340 000
Martinská teplárenská, a. s., Martin	60 000	80 000
Rettenmeier Tatra Timber, s.r. o.. Lipt. Hrádok	50 000	50 000
Other companies in region	62 000	168 700
Total in Žilina Region	512 700	638 700
OTHER SMALLER CONSUMERS IN SR	15 000	40 000
TOTAL CONSUMPTION IN SR	1 069 700	2 079 700

Source: Authors' own elaboration



Graph 1. Wood biomass consumption across regions of Slovakia in 2010 and plan for 2012

COMPARISON OF PULPWOOD AND WOOD CHIPS PRICE

Comparison of prices based on recalculation to one "atro ton" (tA) unit explains why the demand for pulpwood is so strong. The prices in euro correspond to the market situation in the first quarter of 2012.

Price of pulpwood:

Market price is 36 €/m³ (price of pulpwood) + 8 €/m³ (transport) + 6 €/m³ (chipping) = 50 €/m³ DAP[10]

Recalculation to atro ton (tA): $\frac{50\ €/m^3}{0{,}630\ kg/m^3} = 79{,}37\ €/tA$

Volume weight of beech: 0,630 kg/m³

Price of (energetic) wood chips:

Market price is 48 €/t DAP with moisture of 45 % (it means that price is divided by 0,55)

Recalculation to atro ton (tA): $\frac{48\ €/t}{0{,}55} = 87{,}27\ €/tA$

Comparison of pulpwood and chips recalculated prices (by given conditions) demonstrate that 7,90 € is saved by purchase of one atro ton of pulpwood instead of the same amount of wood chips. It caused enormous demand for pulpwood from all the major industrial consumers in Slovakia which led into the lack of supply compensated by import and by processing of other raw wood grades, especially sawlogs.

EXPORT AND IMPORT

Table 2 shows decreasing volume of almost the entire exported and imported raw wood grades comparing the years 2009 and 2010, while only the volume of imported non-coniferous pulpwood had grown significantly. Growth of coniferous logs (I.-III. grade) export has a negative indication.

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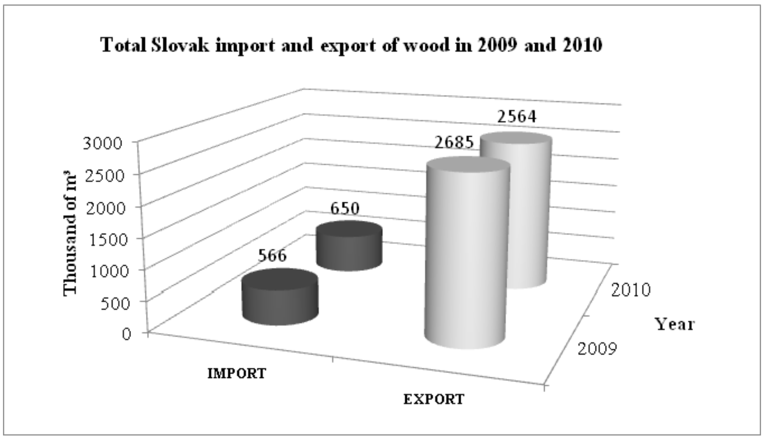
[10] *DAP - Delivered at Place (Incoterms 2010)*

Table 2. Export and import of raw wood grades (thousands of m³)

	Export		Import	
	2009	2010	2009	2010
Coniferous logs (I. - III. grade)	1119	1491	46	44
Coniferous pulpwood and IV. grade logs	997	584	158	58
Non-coniferous logs (I. – III. grade)	187	125	144	26
Non-coniferous pulpwood and IV. grade logs	235	234	159	454
Fuelwood	147	130	59	68
Total	2685	2564	566	650

Source: Green report 2011, p. 27



Graph 2. The Slovak export and import of raw wood [based on Green report 2011]

The amount of exported wood is five (2009), respectively four (2010) times higher comparing to the import amount. Major export destinations are Austria, the Czech Republic, Hungary and Poland. Imported wood comes from Ukraine, Hungary and Poland.

Austrian demand for wood biomass is especially strong because of pulpwood and wood chips price differences between both countries. So, besides of a strong demand by domestic companies there is a significant influence of the (border close) foreign subjects' purchase power, too. It contributes towards a lack of volume and growth of the wood biomass prices on the Slovak market.

WOOD BIOMASS UTILISATION IN THE ENERGY SECTOR

Parobek et al. (2011) described three basic resources of the wood utilised for energy purposes in Slovakia. First is the forest biomass with a share of 30 %. The most significant are wood residues from the wood processing industry (especially sawmills) as an indirect source. Those by-products represent 62% of total resources for energy purposes. The third resource is produced by the pulp and paper industry. Cellulose, as a second generation biofuel, is nearly entirely used for energy purposes directly in paper mills in volume of around 550 thousand m^3 yearly.

The principle economic advantage of wood biomass energy is that wood is usually significantly less expensive than competing fossil fuels. Before building or remodeling a facility to utilize wood biomass for energy, potential users should evaluate the local market for the available supply of wood. Transportation costs may limit the benefits of burning wood fuel. This should be followed by a rigorous life-cycle analysis for the energy system. Initial costs of a wood biomass energy system are generally 50% greater than that of a fossil fuel system due to the fuel handling and storage system requirements (Forest Products Laboratory, 2004).

Subjects of the Slovak energy sector are motivated to produce energy from RES in two major ways. First one is the purchase price of electricity. Price cap set up by The Regulatory Office for Network Industries (URSO) influences decisions to invest in new or existing power and heating plants. Purchase prices of electricity produced from RES are considerably higher compared to those of fossil fuels. For example, recent price of electricity produced from wood biomass is around[11] 126 euro/MWh against approx.[12] 80 euro/MWh produced from coal (based on The Regulation of URSO N. 225/2011). The second strong motivation is that energy sector has had an opportunity to co-finance the projects aimed at investing in technologies utilizing RES through the European Union structural funds. Concerning this fact, it makes investments in bioenergy production cheaper and more profitable. Such conditions caused remarkable interest in utilising wood biomass for energy purposes during the last few years in Slovakia. The energy sector became one of the major wood biomass consumers.

CONCLUSION

The worldwide benefits of using, as opposed to disposing, wood biomass produced by forest management, urban and disaster clean-ups, hazardous fuels treatments and other activities are numerous, but have not been identified comprehensively enough , nor economically quantified. The utilization of wood biomass has numerous direct and indirect benefits. Some of these (Forests and Rangelands, 2012) are:

- improves air quality, visibility, and public health by reducing the smoke created by burning wood biomass;
- provides renewable fuel for clean energy while saving landfill space, reducing waste, and mitigating the need for additional landfill construction. Bioenergy provides enhanced energy independence, security and reliability, rural economic development, and a reduction in greenhouse gases and other pollutants associated with fossil fuels;
- creates economic opportunities in the community;
- reduces the cost of hazardous fuels treatments, which indirectly reduces wildfires;
- reduces the cost of healthy forest and range management by providing a market for insect or disease-infested trees, invasive species, and other wood biomass removed;
- lowers greenhouse gas emissions over fossil fuels, because the carbon dioxide released when wood biomass is burned is balanced out by new, carbon-sequestering biomass growing in its place. Durable wood products from biomass continue to store carbon absorbed by trees when they were growing.

Rapidly growing demand for deficient inputs could be solved by wider utilisation of forest residues from forest management (left on-site from harvesting operations, health and hazardous fuels reduction treatments, forest restoration, sanitation cuttings, salvage felling etc.) as well as from watercourse management, orchard trimmings, forested agriculture land, and municipal solid waste (e. g. furniture, pallets, packaging materials). Further potential is in establishing forest plantations. Bigger supply of wood biomass together with rational utilisation will not only have impact on prices development and the amount of import, but also on more appropriate wood quality utilisation of given raw wood grades (pulpwood and sawlogs especially). Burning of wood does not bring an added value compared to more finalised and sophisticated wood products. So, the last step of wood biomass utilisation should be to burn it for energy since it is usually the lowest value of biomass. Adding value to the products for the end-user brings undoubtedly greater social (employment), economic (added value) and environmental (carbon storage) benefits.

Recalculated prices of pulpwood and wood chips demonstrate that purchase of pulpwood instead of the same amount of wood chips is economically effective for industrial consumers. There

[11] An exact price depends on given conditions
[12] An exact price depends on given conditions

is a strong demand for pulpwood and wood chips as residues from the wood processing industry, while other sources of wood biomass as forest chips[13] are left almost unused. An appropriate suggestion for RES utilization seems to be the change of governmental "subsidy policy" where instead of motivation through higher purchase prices of electricity produced from wood biomass, the purchase of forest chips via price compensation should be motivated. Practically, it means to take subsidies from the output price (electricity from wood biomass) and put locate them into the input price (forest chips). The difference between the purchase price of forest chips and pulpwood could be compensated in this way.

Jussi Heinimö (2011) stated that substantial increase in energy use of biomass requires parallel and positive development in several sectors. Price competitiveness and security of supply are important conditions for the growth of biomass in energy supply. The decisions made by politicians, the strategies of market actors, and the direction of research activities will have a significant influence on the development of the biomass market, and, because of this, several stakeholders and other parties have ambitions to contribute to the development of the market. To support the positive development of the market and for making the most of that development, a more comprehensive understanding of the market is needed.

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[13] The term forest chips has been understood (Heinimö, 2011) as forest/wood fuel in which raw material has not previously had another use – is taken from the forest and processed directly for energy use.

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SOME ECONOMICAL AND TECHNOLOGICAL ASPECTS OF SOLVENT ADHESIVES APPLIED IN PRODUCTION OF UPHOLSTERY FURNITURE

Abstract: The new solutions in the scope of application of solvent adhesives used in production of upholstery furniture was presented. Advantages and disadvantages of these adhesives were characterized. On the basis of data from one producer of furniture (MEBLOMAR Comp.), prices of selected components used in the production of upholstery furniture in the years 2005, 2008 and 2011 in comparison with data from 2000 were given. It was stated that the increasing costs of plant maintenance, purchase of materials and their storage are forcing manufacturers to increase prices of their products, but competition on the market does not allow for their growth. Therefore, the aim is to introduce modern technologies for the production of furniture and to reduce costs while maintaining high-quality products.

Key words: upholstery furniture, solvent adhesive, technology, economic relation

1. INTRODUCTION

The furniture industry is one of the branches in Poland, which has a long tradition and it should be noted that in recent years there has been strong growth in furniture production. Furniture production is an important industrial sector in Poland, in which thousands of people are employed. The main customers are foreign markets, among others in countries such as Belgium, France, Germany and Holland. Only a small portion of which goes to the domestic market. In Table 1, as an example, the amount of furniture produced in Poland was presented.

Table 1. Amount of selected various furniture produced in the years 2000 - 2010 [1]

Kind of furniture	Years						
	2000	2005	2006	2007	2008	2009	2010
	[thousands of pieces]						
Seats convertible into places for sleep (excluding garden or camping)	1 155	1 898	1 964	1 916	1 687	1 906	2 280
To the seat (upholstered, housing)	4 369	7 929	7 992	8 056	9 333	11 422	10 499
Kitchen (wooden, built in)	645	2 454	2 054	2 003	1 604	1 661	1 620
Wooden furniture for kitchen	.	2 024	2 734	3 073	3 973	2 509	1 856
Bedrooms (wooden)	.	3 414	3 613	2 974	3 560	3 380	3 560
Dining and living room furniture	7 749	12 285	19 228	17 164	15 931	17 826	19 615
TOTAL	13 918	30 004	37 585	35 186	36 088	38704	39 430

Upholstered furniture are fit for multi-use, including housing equipment and other facilities. They can also be a decorative element. The aesthetic appearance of the furniture are so very important[13].

Requirements of the potential customers are the determinants of progress in the field of furniture [7]. The development of cheaper products, while maintaining high quality, has a significant impact on the type of binder used. Development of modern adhesives allowed the creation of innovative binders with high environmental standards and glue lines with high strength and resistance, which has been achieved thanks to the introduction of adhesive systems with reduced solvent content known as High Solids (HS) and Super High Solids (SHS) products. Increase the safety requirements. This is especially true of the total fire resistance. [8-9].

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Solvent-based adhesives such as products with a high content of solvents are gradually being replaced by new systems of the SHS solution with a solid content of 80-85% [2-3, 5-6, 11]. In these systems, special importance is the value of the indicator: performance / price. Important is also the ease of waste disposal. For those reasons, the market of upholstered furniture will make constant changes in its final products. Innovative models, fabrics and embellishments, gradually introduced to the market, pose many difficulties in developing mass production of one type of furniture of the same fabric. Also, purchasing more semi-products at attractive prices, such as foam or springs, is not effective as per high cost of storage.

For many years our Department has been conducting research on the properties of multi-dimensional application of adhesives (especially in solvent version) used in the production of upholstered furniture[10, 12]. Furthermore, our Department was twice (1996 and 2000) the organizer of the Novelties in the production of adhesives for upholstery furniture international symposia.

In this context a study was prepared with the aim to present economical and technological aspects of solvent adhesives applied in production of upholstery furniture.

2. CHARACTERISTICS OF SOLVENT ADHESIVES

The evolution of solvent-based binding agents consists primarily of use of adhesives of higher solids content. The reason is the desire to increase efficiency, because less solvent content minimizes the risk of fire and explosions. The adverse effect of solvents on the environment, the cost of finished products, and indirectly the expenses related to packaging and transport also need to be noted [2, 3].

Adhesives based on copolymer butadiene-styrene (BS) or chloroprene (CR) rubber are characterized by simple production technology and applications. They are characterized by very good adhesion to many non-polar materials, and their action (cross-linking) occurs by evaporation of volatile components in the form of solvents and thinners. You can adjust the open time bonding through changes made in the qualitative-quantitative composition of the solvent adhesives. The downside of binding agents, flammable substances with a high fire and explosion hazard rate and toxicity due to the emission of flammable compounds that occur during application and during use of furniture [6].

An important advantage of the solvent in HS and SHS version should be to reduce the intensity of the scent of glue (and emissions) [11]. Other benefits include high adhesion surface, increased thermal resistance and high flexibility of the glue line. SHS adhesives contain no solvents based on chlorinated or aromatic compounds, the individual components are free of chlorine and carcinogenic compounds. In return, these adhesives include renewable natural resources [3, 6]. In Table 2 a comparison of selected properties of SHS adhesives with hardly flammable binding systems was presented.

Table 2. Comparison of SHS adhesives with hardly flammable system [2, 3]

Property	Kind of adhesive	
	SHS product	Hardly flammable systems containing methylene chloride
Solid content [%]	80	48
Unit package-adhesive barrels [kg]	180	200
Adhesive consumption [g] for surface of mattress of 2000 x 1200 mm	ca.65 solid content = ca. 80 adhesive in liquid state	ca.65 solid content = ca.135 adhesive in liquid state
One barrel of adhesive / number of mattresses	ca. 2 250	ca. 1 500

This large consumption is due to very high solid content, resulting in a positive correlation between price and consumption. In Table 3 the main advantages and disadvantages of solvents adhesives were presented.

Table 3. Advantages and disadvantages, and basic information about solvent adhesives [5, 6]

Characteristic	Kind of adhesive			
	On the BS basis			On the CR basis
	High Solids	Conventional	Hardly flammable	
Application	one- or two-sided	one- or two-sided	one-sided	two-sided
Solid content [%]	50-65	30-40	max. 50	15-20
Advantages	- very good adhesion - little waste - easy application - central distribution of the adhesive - hydrodynamic or pneumatic spreading systems -low emissions of solvents - frost resistant - good price	- very good adhesion - little waste (easy to remove) - easy application - central distribution of the adhesive - hydrodynamic or pneumatic spreading systems - average price	- can be used without anti-explosive installation - easy application - central distribution of the adhesive - frost resistant	- flexible joint - possibility of correcting the position of glued formatters - very high thermal resistance of glue lines - high resistance to aging
Disadvantages	- flammable - low resistance to plasticizers	- flammable - low resistance to plasticizers	- not resistant to the plasticizers action - negative impact on the environment - high price - toxic	- flammable - contains aromatic hydrocarbons as solvents - utilization as hazardous waste - a high price

3. RELATION OF MATERIAL COSTS OF SELECTED COMPONENTS

In Figure 1 and 2 the course of prices of selected components used in the production of upholstery furniture in MEBLOMAR Comp. in the years 2005, 2008 and 2011 as compared with data from the year 2000, were presented.

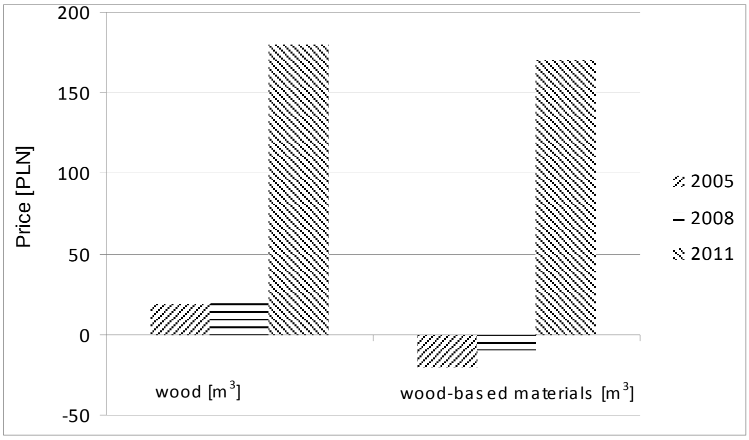

Figure 1. The course of prices of wood and wood-based materials applied in upholstery furniture

[4]

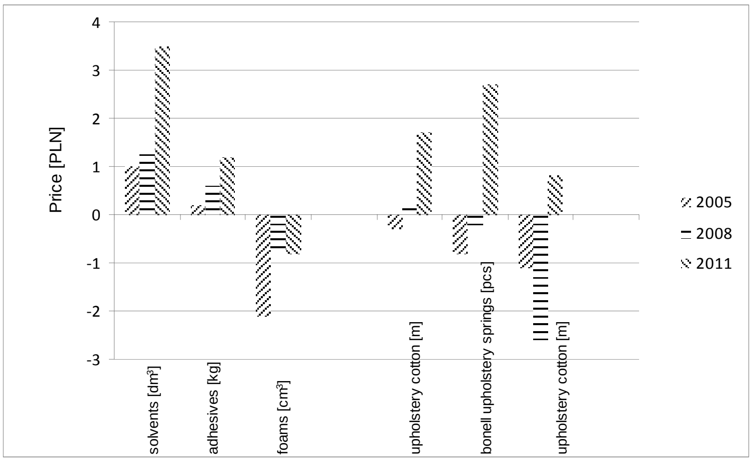

Figure 2. The course of prices of selected components applied for production of upholstery furniture

[4]

Over the years significant changes in pricing of components of upholstered furniture were evident. Due to the rapid development of technology since the year 2000, the prices of products manufactured in 2005 dropped. In the years 2008 - 2010 a steady increase in costs was evident due to rising fuel prices, the minimum wage and other factors directly related to the furniture industry. The year 2011 has caused a significant increase in prices by further increasing cost of fuel, electricity, heating, etc. In addition, the purchase price of wood (total costs) increased during this period by as much as 200%.

The increasing cost of plant maintenance, purchase of materials and their storage are forcing manufacturers to increase prices of their products, but competition on the market does not allow for their growth. The aim is to introduce modern technologies for production of furniture and to reduce costs while maintaining high-quality products.

4. RECAPITULATION

The development of the industry has created innovative furniture manufacturing equipment and new components. Presented to appear development of innovative solutions in this area. The aim is to introduce modern technologies for production of furniture and to reduce costs while maintaining high-quality products. For the current production of adhesives, the requirements set are very strict. Performance index related to a suitably low price, flexibility of applications and the many other demands - result in the elimination of old solutions in this area.

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RECIPIENTS OF ROUNDWOOD FROM THE STATE FORESTS IN POLAND

Abstract: Problem of State Forests clients division on in relation to the level of their demand for roundwood has been presented. Groups of recipients of roundwood assuming division their entire population on 30, 12, 10 and 6 group - depending on the wood processing was isolated. For the 10 groups were also statistical divisions on decile group – by the number of customers and by the demand for roundwood.

Key words: roundwood, recipients, divisions

INTRODUCTION

Economic situation of timber industry in Poland depends on economic situation in the European Union, as well as the state itself, Europe and across the world. Also not to a small degree it is affected by industry factors. The most important factors being influences by forest-timber sector on its own are: timber price and its accessibility on the market. Both closely related to each other – for years cause great controversies. The significant problem of the State Forests (SF), the largest supplier or even natural monopolist on roundwood market - is a huge differences in clients demand for roundwood.

This article is devoted to the problem of SF clients division on in relation to the level of their demand for roundwood.

WOOD RECIPIENTS IN 2008

The most complete and trustworthy data comes from 2008. In 2007 a so called forest website was launched as an IT platform for gathering data on clients demand and the allocation – sales of merchantable wood from forests. List of recipients and their demand from that period are shown in table 1 (Lis 2007a, Lis 2007b, Lis 2008a, Lis 2008b).

The data on the recipients of the State Forests roundwood according to the volume of material processed by them in that table shows that an average SF recipient needed back then 662 m^3 of roundwood annually (middle value of the recipients group or its median). Average arithmetic demand for roundwood – does not even go beyond 4038 m^3 (weighted average - demand applied for by all 7136 clients monitored at the time = 28 814 thousands of m^3 divided by the number of applicants).

Practically, more than a half of all clients in 2008 wanted to buy less than 662 m^3 of roundwood per year (that is around two vans per month), and only 958 clients (that is 13,42% of all clients) wished to purchase an amount that equaled average arithmetic of the demand of all clients that is 4038 m^3 and more roundwood annually (which meant 3 vans per week).

The solution in this situation and an excellent simplification of sales system – distribution of roundwood available, would be undertaking such changes in sales principles as to define a limit beyond which purchase could be realized only on free market in retail. Certainly, one cannot treat as an entrepreneur someone who purchases 100 m^3 of roundwood – 1 van per quarter of a year or less. Organizing clients and determining the minimum volume of purchase will simplify the system based on forest and timber website and the application: e-drewno. Naturally, the amount of roundwood for retail should be adequately increased – even more than it would seem proportional to the loss of clients.

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Table 1. State Forests roundwood recipients according to the size of wood processing

Roundwood processing in m^3 – at least				Number of trucks (25 m^3)				Number of operators in year				Operators in 2012 in the	
daily	weekly	monthly	annually	daily	weekly	monthly	annually	2008	2009	2010	2012	rdLP	nadl
less than 250 m^3 annually				less than 1 truck monthly				1899	1613	1830	2180	128	5
1	6	25	250	-	-	1	10	5237	4667	5070	6020	354	14
2	12	50	500	-	0,5	2	20	4072	3629	3950	4680	275	11
3	18	75	750	-	1	3	30	3357	2991	3250	3860	227	9
4	20	84	1000	-	1	4	40	2860	2549	2770	3290	194	8
5	25	125	1300	-	1	5	55	2404	2142	2330	2760	162	6
6	30	140	1 500	-	1	5	60	2196	1957	2130	2520	148	6
8	40	180	2 000	-	2	7	80	1775	1582	1720	2040	120	5
10	50	230	2 500	0,5	2	8	100	1465	1305	1420	1685	99	4
14	60	270	3 000	1	2,5	10	120	1255	1118	1220	1440	85	3
15	75	300	3 500	1	3	12	140	1107	986	1080	1270	75	3
20	100	450	5 000	1	3,5	17	200	774	690	760	890	52	2
24	120	500	6 000	1	5	20	240	646	576	630	740	44	2
30	155	670	8 000	1,5	5,5	27	320	479	427	470	550	32	1
40	200	830	10 000	2	8	33	400	366	326	360	420	25	1
385	1 925	8 300	100 000	15	77	333	4000	27	27	27	29	2	
4 000	19 200	83 300	1 000 000	154	769	3333	40000	4	4	4	4		
Recipients in total – assumed for calculations								7136	6280	6900 *	8200 *	482	19
Recipients who made offers in the first half of the year									4779	5415			
Recipients authorized to make purchasing offers in the first half of the year									8011	8675			
Demand for roundwood in 2008 – based on offers made in IT system of State Forests (Information System of State Forests - SILP)			the arithmetic mean				m^3	4 037,8363					
			maximum					1 724 572					
			minimum					5					
			median					662					
			dominant					100					

source: own work based on the data of State Forests

* self-esteem

rdLP - Regional Directorate of State Forests

nadl. - superintendence, forest district

The problem of grouping clients in accordance to their demand for roundwood seems to be crucial for the improvement of relations concerning purchases of raw material in forest and wood sector. As the preferences and expectations of a client who buys annually less than 300 m^3 of wood (30,42%) differ from these of a client who wants to purchase 50 thousand m^3 and more (0,46% - table 1 – 3). Therefore the problem of grouping clients receiving wood will be approached mostly in further analysis.

Table 2. Grouping recipients of roundwood from State Forests according to the volume of their demand for roundwood

30 groups of recipients

m^3 from - to	in 2008 year m^3 together	%	average	recipients 2008	recipients %	recipients 2012
below – 25	1151	0,0040	14,02	43	0,60	49
25 – 50	8066	0,0280	35,74	241	3,38	277
50 – 75	14 999	0,0521	61,22	245	3,43	282
75 – 100	19 062	0,0662	85,48	223	3,13	256
100 – 200	119 591	0,4150	144,09	830	11,63	954
200 – 300	145 087	0,5035	246,33	589	8,25	677
300 – 400	176 073	0,6111	347,97	506	7,09	581
400 – 500	171 967	0,5968	444,36	387	5,42	445
500 – 600	189 457	0,6575	545,99	347	4,86	399
600 – 700	158 179	0,5490	648,27	244	3,42	280
700 – 800	170 645	0,5922	745,17	229	3,21	263
800 – 900	176 874	0,6138	846,29	209	2,93	240
900 – 1 000	173 459	0,6020	947,86	183	2,56	210
1 000 – 1 500	807 216	2,8015	1215,69	664	*9.30*	763
1 500 – 2 000	735 001	2,5508	1745,85	421	5,90	484
2 000 – 3 000	1 267 572	4,3992	2437,64	520	7,29	598
3 000 – 4 000	998 871	3,4666	3480,39	287	4,02	330
4 000 – 5 000	864 394	2,9999	4 455,64	194	2,72	223
5 000 – 6 000	698 649	2,4247	5 458,20	128	1,79	147
6 000 – 7 000	616 808	2,1407	6 492,72	95	1,33	109
7 000 – 8 000	535 757	1,8594	7 441,07	72	1,01	83
8 000 – 9 000	466 746	1,6199	8 486,29	55	0,77	63
9 000 – 10 000	551 322	1,9134	9 505,55	58	0,81	67
10 000 – 15 000	1 701 868	5,9064	11 901,17	143	2,00	164
15 000 – 20 000	1 078 996	3,7447	17 403,16	62	0,87	71
20 000 – 30 000	1 566 907	5,4380	24 106,26	65	0,91	75
30 000 – 50 000	1 866 459	6,4776	37 329,18	50	0,70	57
50 000 – 100 000	1 502 231	5,2135	79 064,79	19	0,27	22
100 000 – 1 000 000	6 716 023	23,3082	292 001	23	0,32	26
1 000 000 – above	5 314 570	*18.4444*	1 328 643	4	0,06	5
2008	28814000	100	4037,8363	7136	100	8200
2012				8200		

12 groups of recipients

m^3 from - to	in 2008 year m^3 together	%	average	recipients 2008	recipients %	recipients 2012
below – 300	307 956	1,07	141,85	2171	30,42	2495
300 – 600	537 497	1,87	433,47	1240	*17.38*	1425
600 – 900	505 698	1,76	741,49	682	9,56	784
900 – 1 500	980 675	3,40	1 157,82	847	11,87	973
1 500 – 3 000	2 002 573	6,95	2 128,13	941	13,19	1081
3 000 – 6 000	2 561 914	8,89	4 206,76	609	8,53	700
6 000 – 10 000	2 170 633	7,53	7 752,26	280	3,92	322
10 000 – 20 000	2 780 864	9,65	13 565,19	205	2,87	236
20 000 – 50 000	3 433 366	11,92	29 855,36	115	1,61	132
50 000 – 100 000	1 502 231	5,21	79 064,79	19	0,27	22
100 000 – 1 000 000	6 716 023	23,31	292 001	23	0,32	26
1 000 000 – above	5 314 570	18,44	1 328 643	4	0,06	5
group of recipients	28814000	100	4037,8363	7136	100	8200

10 groups of recipients

m^3 from - to	in 2008 year m^3 together	%	average	recipients 2008	recipients %	recipients 2012
below – 300	307 956	1,07	141,85	2171	30,42	2495
300 – 600	537 497	1,87	433,47	1240	17,38	1425
600 – 900	505 698	1,76	741,49	682	9,56	784
900 – 1 500	980 675	3,40	1 157,82	847	11,87	973
1 500 – 3 000	2 002 573	6,95	2 128,13	941	13,19	1081
3 000 – 6 000	2 561 914	8,89	4 206,76	609	8,53	700
6 000 – 10 000	2 170 633	7,53	7 752,26	280	3,92	322
10 000 – 20 000	2 780 864	9,65	13 565,19	205	2,87	236
20 000 – 50 000	3 433 366	11,92	29 855,36	115	1,61	132
50 000 – above	13 532 824	46,97	294 191,83	46	0,64	53
group of recipients	28814000	100	4037,8363	7136	100	8200

6 groups of recipients

m^3 from - to	in 2008 year m^3 together	%	average	recipients 2008	recipients %	recipients 2012
below – 300	307 956	1,07	141,85	2171	30,42	2495
300 – 900	1 043 195	3,62	542,77	1922	26,93	2209
900 – 3 000	2 983 248	10,35	1 668,48	1788	25,06	2055
3 000 – 10 000	4 732 547	16,42	5 323,45	889	12,46	1022
10 000 – 50 000	6 214 230	21,57	19 419,47	320	4,48	368
50 000 – above	13 532 824	46,97	294 191,83	46	0,64	53
group of recipients	28814000	100	4037,8363	7136	100	8200

Table 3 Demand for roundwood of State Forests recipients depending on their means of aggregating

12 groups of recipients

m³ from - to	recipients 2008	recipients %	recipients 2012	m³ %	m³ average
below – 300	2171	30,42	2495	1,07	142
300 – 600	1240	17,38	1425	1,87	433
600 – 900	682	9,56	784	1,76	741
900 – 1 500	847	11,87	973	3,40	1 158
1 500 – 3 000	941	13,19	1081	6,95	2 128
3 000 – 6 000	609	8,53	700	8,89	4 207
6 000 – 10 000	280	3,92	322	7,53	7 752
10 000 – 20 000	205	2,87	236	9,65	13 565
20 000 – 50 000	115	1,61	132	11,92	29 855
50 000 – 100 000	19	0,27	22	5,21	79 065
100 000 – 1 000 000	23	0,32	26	23,31	292 001
1 000 000 – above	4	0,06	5	18,44	1 328 643
2008 / 2012	7136 / 8200	100	8200	100	4 038

10 groups of recipients

m³ from - to	recipients 2008	recipients %	recipients 2012	m³ %	m³ average
below – 300	2171	30,42	2495	1,07	142
300 – 600	1240	17,38	1425	1,87	433
600 – 900	682	9,56	784	1,76	741
900 – 1 500	847	11,87	973	3,40	1 158
1 500 – 3 000	941	13,19	1081	6,95	2 128
3 000 – 6 000	609	8,53	700	8,89	4 207
6 000 – 10 000	280	3,92	322	7,53	7 752
10 000 – 20 000	205	2,87	236	9,65	13 565
20 000 – 50 000	115	1,61	132	11,92	29 855
50 000 – above	46	0,64	53	46,97	294 192
2008 / 2012	7136	100	8200	100	4 038

Decile groups of recipients

group	recipients 2008	recipients %	m³ %	m³ average
1	714	10	0,14	55
2	713		0,33	132
3	714		0,57	231
4	713		0,90	363
5	714		1,34	541
6	713		2,03	821
7	714		3,08	1 241
8	713		5,00	2 020
9	714		9,21	3 717
10	714		77,41	31 238
2008	7136	100	100	4 038

Decile groups of demand

group	recipients 2008	recipients %	requirement in m³ %	requirement in m³ ~10%	requirement in m³ average
1	5 155	72,239	9,31	2 683 151	520
2	1 069	14,98	10,00	2 880 903	2 695
3	481	6,740	10,00	2 880 469	5 989
4	242	3,391	10,00	2 881 891	11 909
5	117	1,640	9,99	2 879 439	24 611
6	48	0,673	10,06	2 898 872	60 393
7	13	0,182	9,94	2 865 430	220 418
8	6	0,084	9,83	2 832 815	472 136
9	3	0,042	10,29	2 963 853	987 951
10	2	0,028	10,58	3 047 177	1 523 589
2008	7136	100	100	28 814 000	4 038

6 groups of recipients

m³ from - to	recipients 2008	recipients %	recipients 2012	m³ %	m³ average
below – 300	2171	30,42	2495	1,07	142
300 – 900	1922	26,93	2209	3,62	543
900 – 3 000	1788	25,06	2055	10,35	1 668
3 000 – 10 000	889	12,46	1022	16,42	5 323
10 000 – 50 000	320	4,48	368	21,57	19 419
50 000 – above	46	0,64	53	46,97	294 192
2008 / 2012	7136	100	8200	100	4 038

THE NUMBER OF GROUPS OF CLIENTS

Table 2 contains the results of grouping the recipients of the State Forests – in accordance to their demand for roundwood submitted in prognosis for 2008. Subsequently, 30, 12, 10 and 6 groups of consumers were specified. For each of these groups demand for roundwood in two forms was determined – in m^3 and as a percentage of total annual demand.

An average volume of purchase in demand was also determined for each group as well as the number of recipients in each group and percentage share of each group in the overall number of SF clients. For example in the first group in the division into 12, 10 and 6 groups, that is such recipients who in 2008 bought 300 m^3 of roundwood or less there were 2171 clients. They accounted for almost 1/3 – exactly 30,42% of all SF clients. They bought 1,07% of roundwood - in total 307 967 m^3, that is on average 141,85 m^3 of wood per client of that group.

In the division into 30 groups – up to the demand limit of 300 m^3 roundwood per year – 6 groups of recipients were determined, including the largest group with the demand between 100 m^3 and 200 m^3. Such SF clients were relatively the biggest group– and embraced 11,63% of all recipients and their demand amounted to 0,42% of roundwood acquired annually by the leading supplier.

On the basis of 8200 recipients acknowledged in 2012 – the size of individual groups in 2012 was determined in table 1, keeping the percentage share of clients in those groups from 2008.

STATISTICAL DIVISIONS

Table 3 presents groups of recipients, in accordance to their division into 12, 10 and 6 such groups, that is like in table 2. For 10 groups two additional statistical divisions were done – into decile groups: according to the number of recipients and demand for roundwood.

In decile division , where a group includes 713 – 714 SF clients – what draws attention is the fact that until the 9th decile group the demand does not relate to the size of any group, in the 9th decile group the demand for 9,65% of roundwood roughly relates to the number of clients (10%). The first group - the smallest recipients- buys together 0,14% of raw material, on average 55 m^3 of wood per client. 10th group – the largest clients – reports demand for 77,41% of merchantable wood, on average 31 238 m^3 of raw material per recipient. The difference in demand between the 1st and the 10th group is substantial and amounts to 56 093%.

Division into decile groups in accordance with clients demand for wood shows even greater discrepancies. In this category the 2nd decile group embraces 1069 recipients, that is 14,89% of the whole set. The 2nd group buys 10% of raw material – 2 880 903 m^3 of wood. On average a client from that group reports demand for 2695 m^3 of wood. Values for the 2nd group (14,89% of recipients and 10% of wood) are the most alike.

The 1st decile group of demand (9,31%) comprises of 5155 clients – 72,24% of the overall number of clients. On average the client from this group purchased 520 m^3 of raw material. In 10th group with the demand of 3 047 177 m^3, that is 10,58% of total volume of merchantable wood there were only two clients, amounting to 0,028% of the overall number of clients. Average demand in that group reached 1 523 589 m^3 of roundwood. The discrepancy of average demand between the 1st and 10th group is enormous and equals 292 519%.

In the division of recipients into ten groups (table 2 and 3) – group 3 – with the demand of 600 – 900 m^3 roundwood per year and 682 recipients (9,56% of the total number of clients) – corresponds with the decile division best (as 9,56% is the closest to 10%). Recipient from group 3 reported on average demand for 741 m^3 of raw material from forest.

In the same division entrepreneur from group 7 – with demand for 10 - 20 thousand m^3 of wood – reports the intention to buy on average 13 565 m^3 of raw material. In this group in 2008 – there were 205 recipients, and in 2012 – as it is estimated – there may be 236. The share of this group in the total number of SF clients equals 2,87%. Divergence between demand of group 3 and 7 amounts to 1636%, and between group 1 and 10 – 206 978%. Substantial share of small recipients causes significant flattening of series while increasing the number of recipients in groups.

SUMMARY

Growing recession, which end is forecast for 2014 creates an opportunity for organizing the issue of utilizing wood in economy as the problem is becoming ever better perceived and ever more commonly understood. Numerous solutions – require decisions which are beyond national level or UE decisions, many require domestic solutions at governmental level. Certainly, among the solutions which need to be undertaken by forest and wood sector there is a problem of the size of purchase- currently at modernized forest and wood website, and in the future on a new application for electronic sales of wood (ESD), which will be launched in 2013.

Time is limited. With a long-term poor supply and price policy – Polish wood sector may quickly become uncompetitive in the EU in Europe and in the world. There is a chance to avoid this situation!

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THE ANALYSIS OF ROUNDWOOD PRICES IN THE POLISH MARKET

Abstract: This article is devoted to an analysis of roundwood price changes in the Polish market based on various sources of primary data. In the examined period high similarity of data was observed, regardless of the source of information. Most importantly, similar trends in the scope of roundwood price changes were identified.

Key words: prices, roundwood, Polish wood market.

INTRODUCTION

The problem of roundwood price changes in Poland in recent years was the object of the analysis. The aim of the research study was to make an attempt to identify the most important trends in the scope of price changes in the analysed prices. A hypothesis of significant similarity between the verified trends was formulated. The years 2008-2012 were analysed in general. Detailed deliberations were carried out for the following primary data:

- wood prices in State Forests in the years 1998-2011 based on the information published in the Polish Monitor,
- prices of roundwood according to the data of the Polish Economic Chamber of Wood Industry in the period from 2006 until the first quarter of 2012,
- wood prices according to the State Forests IT System (SILP) managed by State Forests.

The above-specified data were used as source material for the analysis of roundwood prices in the period 2008–first half-year of 2012. The "average wood price" parameter was used for the purpose of this publication; it was calculated for comparable conditions based on the above-mentioned sources. Moreover, the analysis included percentage changes of these prices in the examined period and attention was paid to seeking similarities and characteristic trends.

WOOD PRICES ACCORDING TO THE POLISH MONITOR AND THE CENTRAL STATISTICAL OFFICE

At the very beginning, average sale prices of one cubic metre of roundwood, calculated by the Central Statistical Office on the basis of average wood prices set by all monitored forest divisions in the first three quarters of each year, were analysed for the first 14 years (1998–2011). The prices are announced by October, 20th each year by the president of the Central Statistical Office and then published in the Polish Monitor. They serve, among others, to calculate forest tax for successive calendar years [Lis 2011].

The source data on roundwood prices come from the so-called C-01 forms collected each month by the Central Statistical Office (report on prices of manufacturers and service providers). Approximately 300 forest divisions participated in the analysis of roundwood prices.

The fundamental data provided in a C-01 form are average manufacturer's prices, basic prices and sale values of selected products (own production goods and own services) sold domestically and abroad during a reporting month. In other words, in case of roundwood the Central Statistical Office sets average monthly prices and monthly sales values for the so-called "representative products" classified in the 02.01.1 category (raw unprocessed wood) according to the Polish Classification of Goods and Services. The data on the value and price of "representative products" are then used to determine total sales in an examined month and, later, to calculate – as weighted average for the "representative products" – average sale price of wood in a given month in the entire country [Lis 2011b].

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The results of the analysis were presented and summarised in Table 1. Based on this analysis, wood prices in 2003 oscillated below their arithmetic mean from the last 14 years (this average totals 134.91 PLN per 1 cubic metre). Beginning with 2004, the prices were systematically growing, except for 2009 when the price of 136.54 PLN per 1 cubic metre was almost as low as in 2006 (when the value was 133.70 PLN per 1 cubic metre). The prices in 2009 were almost 10.5% lower as compared to 2008.

In the period 1998–2011, the prices ranged from 107.70 PLN (2003) to 186.68 PLN per 1 cubic metre (2011). The prices differed by 73.33% from the lowest value and by 42.31% from the highest value with the price range amounting to 31.03%. The prices in 2006 reaching the level of 133.70 PLN per 1 cubic metre were closest to the 14-year arithmetic mean. They were lower than the long-term arithmetic mean by 1.21 PLN per 1 cubic metre, i.e. 0.89% of its value.

The prices of roundwood in 1998 - which was the first year included in our analysis – and in 2005 where closest to the median (middle value within the price range totalling 130.16 PLN per one cubic metre). The prices were lower than the median in 1998 and higher in 2005 – by 1.19 PLN per 1 cubic metre, i.e. by 0.91% of the median's value.

A detailed analysis of the data from Table 1 leads to certain observations that a significant rise of roundwood prices took place in 2010 and 2011 despite the fact that no exceptional boom in the economic situation was observed then. It is worth noticing that this trend could have been connected with demand for biomass by the energy sector. Hence rational behaviour of the conventional power engineering sector, which attempted to fulfil the international obligations connected with the use of the so-called green energy produced from renewable sources of energy by increased burning of wood, became a paradox of the Polish wood market [Lis 2012a].

Table 1. Average selling price of roundwood, calculated on the basis of average wood prices set by all monitored forest divisions in the first three quarters of the year

Year	Round-wood price PLN/m^3	Polish Monitor	Year = 100%				Difference in PLN/m^3 to the year				Difference in % to the year				Difference to the arithmetic mean	
			previous	1998	2003	2011	previous	1998	2003	2011	previous	1998	2003	2011	PLN/m^3	%
2011	186,68	M.P.11.95.970	120,71	144,75	173,33	100,00	32,03	57,71	78,98	0	20,71	44,75	73,33	0,00	51,78	38,38
2010	154,65	M.P.10.78.970	113,26	119,91	143,59	82,84	18,11	25,68	46,95	-32,03	13,26	19,91	43,59	-17,16	19,75	14,64
2009	136,54	M.P.09.69.896	89,52	105,87	126,78	73,14	-15,99	7,57	28,84	-50,14	-10,48	5,87	26,78	-26,86	1,63	1,21
2008	152,53	M.P.08.81.718	103,56	118,27	141,62	81,71	5,25	23,56	44,83	-34,15	3,56	18,27	41,62	-18,29	17,63	13,06
2007	147,28	M.P.07.79.846	110,16	114,20	136,75	78,89	13,58	18,31	39,58	-39,4	10,16	14,20	36,75	-21,11	12,38	9,17
2006	133,70	M.P.06.74.746	101,79	103,67	124,14	71,62	2,35	4,73	26,00	-52,98	1,79	3,67	24,14	-28,38	-1,21	-0,89
2005	131,35	M.P.05.62.868	109,09	101,85	121,96	70,36	10,95	2,38	23,65	-55,33	9,09	1,85	21,96	-29,64	-3,56	-2,64
2004	120,40	M.P.04.44.781	111,79	93,36	111,79	64,50	12,7	-8,57	12,70	-66,28	11,79	-6,64	11,79	-35,50	-14,51	-10,75
2003	*107,70*	M.P.03.50.787	96,84	83,51	100,00	57,69	-3,51	-21,27	0,00	-78,98	-3,16	-16,49	0,00	-42,31	*-27,21*	*-20,17*
2002	111,21	M.P.02.50.729	88,21	86,23	103,26	59,57	-14,86	-17,76	3,51	-75,47	-11,79	-13,77	3,26	-40,43	-23,70	-17,56
2001	126,07	M.P.01.38.627	98,52	97,75	117,06	67,53	-1,89	-2,9	18,37	-60,61	-1,48	-2,25	17,06	-32,47	-8,84	-6,55
2000	127,96	M.P.00.34.709	103,50	99,22	118,81	68,55	4,33	-1,01	20,26	-58,72	3,50	-0,78	18,81	-31,45	-6,95	-5,15
1999	123,63	M.P.99.34.531	95,86	95,86	114,79	66,23	-5,34	-5,34	15,93	-63,05	-4,14	-4,14	14,79	-33,77	-11,28	-8,36
1998	128,97	M.P.98.36.515		100,00	119,75	69,09		0	21,27	-57,71		0,00	19,75	-30,91	-5,94	-4,40
Roundwood price in the years 1998 - 2010		the aritmethic mean		134,91	PLN/m^3											
		median		130,16												
		maximum		186,68												
		minimum		107,70												
Price ranges				31,03	%											

Source: [Lis 2011b] based on Messages of the President of the Central Statistical Office published in the Polish Monitor

WOOD PRICES ACCORDING TO THE POLISH ECONOMIC CHAMBER OF WOOD INDUSTRY

Each quarter, the Polish Economic Chamber of Wood Industry monitors the prices of four (marked as WC01, WC02, WC03, WA03) most often purchased ranges of coniferous material (pine, spruce) and deciduous material (oak, beech), and publishes data in its quarterly magazine entitled *Rynek Drzewny*.

It needs to be underlined that the price of wood is the most important cost item for the wood industry. In the structure of lumber production costs, wood constitutes more than 60% (almost 66% with costs of logistics) [Lis 2011c].

In the period 2005–2010, it was possible to notice substantial changes in the price of rough lumber. The biggest increase – by more than 22% – was observed from the fourth quarter of 2006 until the first quarter of 2008. The prices of one cubic metre then rose from 181 PLN up to 222 PLN. This increase in the price of the material had a significant influence on the total costs of production, which also went up rapidly. In the said period, the costs of producing one cubic metre of lumber rose by 16%. Sector analyses, including mesoeconomic factors, made it possible to identify the following factors of roundwood price increase in the Polish market:
- a decreased supply of wood from Russia as a result of very high export duties imposed by the authorities of this country,
- an increase in the prices of crude oil purchase, which also caused an increase in the costs of production and transport of logs and saw logs from the woods, as well as
- the situation in the market of coniferous lumber.

It is worth noticing that in 2007 lumber production in Europe went up by 9% in relation to 2005, which was caused to a large extent by Poland. A huge increase in the production of lumber in Poland was the direct cause of increased demand for this raw material (roundwood), which resulted in a substantial rise of its prices [Lis 2012b].

The start of the global economic crisis can also be identified in the wood market when we observe the worldwide fall in the demand for rough lumber together with the drop of its price. This situation had a direct influence on the rapid decrease of production costs in the period from the first quarter of 2008 until the second quarter of 2009. Gradual stabilisation of lumber prices and production costs, which are affected to an extremely large extent by the price of the wood material, occurred in subsequent quarters.

The data presented in Table 2 were used to analyse average purchase prices of selected most popular and most frequently purchased wood products: pine, spruce, beech and oak. The table includes subsequent quarters beginning from 2006 and ending on the first quarter of 2012. The roundwood quality and size classes specified in Table 2, based on the publication entitled "*Klasyfikacja surowca drzewnego w Polsce. Poradnik leśniczego*" [Ślęzak 2006], included the following:

WC01 – multidimensional C class rough lumber of diameter up to 24 cm, debarked,

WC02 – multidimensional C class rough lumber of diameter from 25 to 34 cm, debarked,

WC03 – multidimensional C class rough lumber of diameter exceeding 35 cm, debarked,

WA03 – multidimensional A class rough lumber of diameter exceeding 35 cm, debarked.

Based on the analysis conducted (compare Table 2), the prices of wood ranges selected for the experiment rose beginning from the first quarter of 2006 until the first quarter of 2008. Then, the growing tendency stopped and a gradual and systematic decrease in the price of the raw material began and lasted until 2009. The above tendency is illustrated by the following example: the price of high quality (WA03) pine rough lumber initially rose from 321 PLN per one cubic metre in the first quarter of 2006 to 389 PLN per one cubic metre in the first quarter of 2008, and then went down to 317 PLN per one cubic metre in the third quarter of 2009. What has to be emphasised at this point is that this was the minimum price level for this class of pine rough lumber in the examined period.

In subsequent periods, the prices of WA03 pine wood were systematically going up and in the first quarter of 2012 reached the level of 465 PLN per one cubic metre. This was the highest price of WA03 pine wood in the researched period. The price range of this wood assortment (from 317 PLN to 465 PLN per one cubic metre) amounts to 14.86%. It needs to be added that this is not the highest value among the 24 products analysed in the period from the first quarter of 2006 until the first quarter of 2012 (compare Table 2) either. The biggest price change dynamics was observed in case of WC01 spruce and totalled 28.04%.

Table 2. Average purchase price of selected assortments of softwood (pine, spruce) and hardwood (oak, beech) from 2006-2011 in PLN/m³

Rok	Quarter	Pine				Spruce				Oak				Beech			
		WC01	WC02	WC03	WA03	WC01	WC02	WC03	WA03	WC01	WC02	WC03	WA03	WC01	WC02	WC03	WA03
2006	I	161	190	217	321	162	186	217	313	239	344	445	844	161	194	243	429
	II	163	191	220	325	163	190	216	325	252	347	449	833	157	190	237	423
	III	164	191	218	320	165	195	216	323	239	353	466	855	159	190	239	422
	IV	166	193	218	333	162	190	213	343	243	357	459	923	171	199	242	429
	average	163,50	191,25	218,25	324,75	163,00	190,25	215,50	326,00	243,25	350,25	454,75	863,75	162,00	193,25	240,25	425,75
2007	I	171	199	227	355	171	196	224	328	254	364	472	936	168	198	241	455
	II	175	202	231	346	172	199	229	325	248	362	463	915	179	208	261	432
	III	177	207	240	356	180	208	243	342	256	365	476	939	176	205	259	450
	IV	175	206	241	362	176	208	237	358	265	375	478	921	183	215	268	451
	average	174,50	203,50	234,75	354,75	174,75	202,75	233,25	338,25	255,75	366,50	472,25	927,75	176,50	206,50	257,25	447,00
2008	I	192	224	259	389	197	227	261	369	274	387	519	1050	185	205	269	509
	II	187	218	246	369	185	216	244	356	260	388	518	1053	160	195	263	493
	III	179	210	240	356	179	209	240	345	272	398	526	1031	152	186	255	479
	IV	175	204	233	355	178	207	238	335	268	387	510	1019	155	191	249	453
	average	183,25	214,00	244,50	367,25	184,75	214,75	245,75	351,25	268,50	390,00	518,25	1038,25	163,00	194,25	259,00	483,50
2009	I	165	192	218	327	162	188	213	322	249	358	482	918	130	166	212	412
	II	162	191	217	324	163	190	215	295	262	419	586	1014	140	176	220	450
	III	155	183	208	317	157	185	207	316	257	366	496	910	145	186	231	437
	IV	158	186	212	321	167	195	221	336	254	388	531	1026	140	178	221	475
	average	160,00	188,00	213,75	322,25	162,25	189,50	214,00	317,25	255,50	382,75	523,75	967,00	138,75	176,50	221,00	443,50
2010	I	166	193	221	339	171	198	223	316	239	344	462	876	137	174	220	423
	II	169	198	226	335	179	207	236	332	248	382	523	981	145	184	234	436
	III	177	209	241	350	185	218	250	359	252	362	487	948	137	171	219	419
	IV	186	217	247	355	193	223	248	349	256	369	498	949	140	176	225	419
	average	174,50	204,25	233,75	344,75	182,00	211,50	239,25	339,00	248,75	364,25	492,50	938,50	139,75	176,25	224,50	424,25
2011	I	213	245	283	397	217	253	291	423	266	389	531	1089	194	241	302	594
	II	231	266	300	454	224	260	296	405	268	392	536	1089	199	244	294	650
	III	236	258	292	431	265	289	327	449	255	396	544	1089	215	257	321	659
	IV	236	274	307	461	249	294	331	483	258	391	536	1089	188	234	288	591
	average	229,00	260,75	295,50	435,75	238,75	274,00	311,25	440,00	261,75	392,00	536,75	1089,00	199,00	244,00	301,25	623,50
2012	I	245	275	306	465	230	268	296	440	264	410	556	1111	168	220	261	591
Year	Quarter	WC01	WC02	WC03	WA03	WC01	WC02	WC03	WA03	WC01	WC02	WC03	WA03	WC01	WC02	WC03	WA03
		Pine				Spruce				Oak				Beech			
Quarterly average in the following years	2006-2012	189,96	219,54	249,50	373,50	190,79	221,54	250,71	364,54	256,79	379,39	507,75	990,75	163,86	201,54	252,04	491,21
	2009-2012	202,13	232,00	262,25	391,94	203,25	235,75	265,13	384,06	257,50	387,25	527,25	1026,38	161,38	204,19	251,94	520,56
	2010-2012	216,17	246,67	278,42	415,17	216,92	251,17	282,17	406,33	258,17	388,75	528,42	1046,17	168,92	213,42	262,25	546,25
	2011-2012	237,00	267,88	300,75	450,38	234,38	271,00	303,63	440,00	262,88	401,00	546,38	1100,00	183,50	232,00	281,13	607,25
Prices in 2006 - 2012	the arithmetic mean	183,36	212,88	242,72	362,52	186,08	215,96	245,28	355,48	255,92	375,72	501,96	976,32	163,36	199,32	250,96	479,24
	median	175,00	204,00	233,00	355,00	178,00	207,00	237,00	342,00	256,00	375,00	498,00	949,00	160,00	194,00	243,00	450,00
	maximum	245,00	275,00	307,00	465,00	265,00	294,00	331,00	483,00	274,00	419,00	586,00	1111,00	215,00	257,00	321,00	659,00
	minimum	155,00	183,00	208,00	317,00	157,00	185,00	207,00	295,00	239,00	344,00	445,00	833,00	130,00	166,00	212,00	412,00
Price ranges in %		21,33	16,82	15,35	14,86	28,04	21,84	22,44	24,81	1,87	3,90	7,62	8,35	25,85	19,41	17,46	22,47

Source: own study based on prices published in quarterly magazine "Rynek Drzewny"

A similar trend can be observed for WC0 class of pine wood; the price of this wood in the first quarter of 2006 was similar to the price recorded in the fourth quarter of 2009 with local culmination in the first quarter of 2008. Only beginning with 2010, an increase in the prices of products from the WC0 group was noticed, similarly to the WA03 class products. The prices for WC0 pine wood gradually went up to reach the following levels in the first quarter of 2012:

- 245 PLN per one cubic metre of WC01 wood;
- 275 PLN per one cubic metre of WC02 wood;
- 306 PLN per one cubic metre of WC03 wood.

In the first two cases, the highest level of prices in the period from 2006 to 2012 was noticed for WC01 and WC02 product classes. On the other hand, in case of the best quality WC03 wood, the price was symbolically (by 1 PLN per one cubic metre) lower than in the fourth quarter of 2011. It means price stabilisation of the most popular pine wood and indicates very high probability of the prices going down in successive quarters.

It was also observed (compare Table 2) that the price of WC0 oak wood turned out to be most stable of all four main types of wood included in the analysis. Almost throughout the entire period analysed, the price maintained on a similar level. This mainly concerned WC01 class assortment, which is treated as standard by the State Forests, i.e. the largest supplier of roundwood to the market. In this case, the price range in the analysed period totalled merely 1.87%. WC01 oak wood reached the minimum price level of 239 PLN per one cubic metre three times in the analysed period (Q1 of 2006, Q3 of 2006, Q1 of 2010). The maximum price (274 PLN per one cubic metre) was recorded in the first quarter of 2008.

Periodic yet relatively insignificant price variations were observed for WC02 and WC03 oak wood. The price range for WC02 oak rough lumber over more than 6 years totalled 3.9%. Meanwhile, in case of WC03 assortment, the prices changed by 7.62%.

The biggest changes of oak roundwood prices were recorded for the highest quality rough lumber class, i.e. WA03. The price of this assortment was lowest in the second quarter of 2006 (833 PLN per one cubic metre) and highest in the first quarter of 2012 (1111 PLN per one cubic metre). The 8.35% price range over the period of 6 years (equal to 24 quarters) was recorded by the top class of oak wood. This was the longest period between the maximum value and the minimum value among all 24 products included in the analysis. In case of WA03 oak relatively frequent price changes were recorded in the analysed time, yet their amplitude was not significant.

Table 2 presents prices of coniferous and deciduous round rough lumber for the following quality and size classes: WC01, WC02, WC03, WA03, in the successive quarters of 2006–2012. Average prices were also determined every year for each assortment and type of wood: among coniferous species – pine and spruce, among deciduous species – oak and beech. An arithmetic mean of all prices, their median (medial value) and price ranges were determined for all 24 product assortments divided in the manner specified above.

An analysis of data made it possible to claim that oak prices were most stable, in particular of the standard WC01 class (the price range was only 1.87%). Prices of spruce varied most intensely, in particular in case of the standard WC01 class – the 28.04% price range was recorded in the period of two years (minimum in the third quarter of 2009, maximum in the third quarter of 2011), and in case of the standard WC01 class of beech – the 25.85% price range was observed in a period longer by two quarters (minimum in the first quarter of 2009, maximum in the third quarter of 2011) as compared to WC01 spruce.

WOOD PRICES ACCORDING TO THE STATE FORESTS

The prices of basic wood products announced by the State forests for the years 2000–2011, collected in the State Forests IT System (SILP), were compared in the analysis.

A detailed analysis of wood prices in total and prices of large lumber set by the State Forests in the years 2000–2011 is presented in Table 3.

Table 3. Analysis of the average wood prices in total and prices of large lumber set by the State Forests.

Year	Current prices		Previous year = 100		Year 2000 = 100		XAV = 100		D/XAV		Year 2009 = 100		Year 2011 = 100	
	wood	large lumber	wood	large lumber	wood	large lumber	wood	large lumber	wood	large lumber	wood	large lumber	wood	large lumber
2000	123,9	130,1			100	100	91,66	91,72	-8,34	-8,28	90,44	89,11	65,90	65,71
2001	119,9	126,2	96,77	97,00	96,77	97,00	88,70	88,97	-11,30	-11,03	87,52	86,44	63,78	63,74
2002	107,9	113,2	89,99	89,70	87,09	87,01	79,82	79,80	-20,18	-20,20	78,76	77,53	57,39	57,17
2003	107,0	113,0	99,17	99,82	86,36	86,86	79,16	79,66	-20,84	-20,34	78,10	77,40	56,91	57,07
2004	120,1	126,8	112,24	112,21	96,93	97,46	88,85	89,39	-11,15	-10,61	87,66	86,85	63,88	64,04
2005	131,4	138,2	109,41	108,99	106,05	106,23	97,21	97,43	-2,79	-2,57	95,91	94,66	69,89	69,80
2006	133,3	139,7	101,45	101,09	107,59	107,38	98,61	98,48	-1,39	-1,52	97,30	95,68	70,90	70,56
2007	147,6	153,0	110,73	109,52	119,13	117,60	109,19	107,86	9,19	7,86	107,74	104,79	78,51	77,27
2008	149,0	155,0	100,95	101,31	120,26	119,14	110,23	109,27	10,23	9,27	108,76	106,16	79,26	78,28
2009	137,0	146,0	91,95	94,19	110,57	112,22	101,35	102,93	1,35	2,93	100	100	72,87	73,74
2010	157,0	163,0	114,60	111,64	126,72	125,29	116,15	114,91	16,15	14,91	114,60	111,64	83,51	82,32
2011	188,0	198,0	119,75	121,47	151,74	152,19	139,08	139,58	39,08	39,58	137,23	135,62	100	100

	Price analysis		
PLN	135,18	141,85	the aritmethic mean
	132	139	median
	107	113	minimum
	188	198	maximum
%	32,62	32,29	price ranges

Notation:
X_{AV} The aritmethic mean (XAV)
D/XAV Difference compared to the arithmetic mean

Source: own study based on prices set by the State Forests.

Table 4, on the other hand, presents evaluation results of offers for basic wood products in the State Forests in the years 2008–2011. The following products were subject to a detailed analysis:

- coniferous rough lumber [CRL] = WA0+WB0+WC0+WD coniferous wood;
- pine pulpwood [PP] = S2a, S2b So/Mo wood;
- spruce pulpwood [SP] = S2a, S2b Św/Jd wood;
- deciduous rough lumber [DRL] = WA0+WB0+WC0+WD deciduous wood;
- deciduous pulp [DP] = S2a, S2b deciduous wood.

Table 4. The evaluation results of offers for basic wood products in the State Forests in the years 2008–2011.

Year	Wood (total)	Roundwood					
		Softwood			Hardwood		
		CRL	Pulpwood [PP] So/Mo	Pulpwood [SP] Św/Jd	DRL	Pulpwood [DP]	
Current prices							
2008	149	208	116	113	241	107	
2009	137	183	113	109	211	112	
2010	157	202	143	134	214	128	
2011	188	255	171	165	253	152	
Price changes - previous year = 100%							
2008							
2009	91,95	87,98	97,41	96,46	87,55	104,67	
2010	114,60	110,38	126,55	122,94	101,42	114,29	
2011	119,74522	126,24	119,58	123,13	118,22	118,75	
Price increases - for the year 2009 = 100%							
2009	100,00	100,00	100,00	100,00	100,00	100,00	
2010	114,60	110,38	126,55	122,94	101,42	114,29	
2011	137,22628	139,34	151,33	151,38	119,91	135,71	
Price analysis - the years 2008 - 2011							
XAV	157,75	212,00	135,75	130,25	229,75	124,75	PLN
Median	153	205	130	124	228	120	
Minimum	137	183	113	109	211	107	
Maximum	188	255	171	165	253	152	
Price ranges	10,10	11,11	17,41	17,44	3,30	12,45	%
Difference compared to the arithmetic mean - PLN							
2008	-8,75	-4,00	-19,75	-17,25	11,25	-17,75	
2009	-20,75	-29,00	-22,75	-21,25	-18,75	-12,75	
2010	-0,75	-10,00	7,25	3,75	-15,75	3,25	
2011	30,25	43,00	35,25	34,75	23,25	27,25	
Difference compared to the arithmetic mean - %							
2008	-5,55	-1,89	-14,55	-13,24	4,90	-14,23	
2009	-13,15	-13,68	-16,76	-16,31	-8,16	-10,22	
2010	-0,48	-4,72	5,34	2,88	-6,86	2,61	
2011	19,18	20,28	25,97	26,68	10,12	21,84	

Source: own study based on prices set by the State Forests [Lis 2012b].

Notation:
CRL [coniferous rough lumber] = WA0+WB0+WC0+WD coniferous wood;
PP [pine pulpwood] = S2a, S2b So/Mo wood;
SP [spruce pulpwood] = S2a, S2b Św/Jd wood;
DRL [deciduous rough lumber] = WA0+WB0+WC0+WD deciduous wood;
DP [deciduous pulp] = S2a, S2b deciduous wood;
XAV - The aritmethic mean.

AVERAGE WOOD PRICES FROM THE DISCUSSED SOURCES IN COMPARABLE CONDITIONS

In conclusion of the detailed analysis of prices based on different sources of primary data, prices of roundwood were summarised and compared. Table 5 includes:

- prices of wood published each year in the Polish Monitor – based on Table 1,
- prices of wood according to the Polish Economic Chamber of Wood Industry published successively in quarterly magazine "*Rynek Drzewny*" – based on Table 2,
- prices of wood in the State Forests IT System – based on Tables 3 and 4.

Table 5 Pooled analysis of roundwood prices from different sources in the years 2008 - 2011 [in PLN/m3]

Year	Wood (based on Polish Monitor)	Roundwood - set by the State Forests							Average annual prices published in quarterly "Rynek Drzewny"															
		Total	Large lumber [LL]	Softwood			Hardwood		Pine				Oak				Spruce				Beech			
				CRL	Pulpwood [PP] So/Mo	Pulpwood [SP] Św/Jd	DRL	Pulpwood [DP]	WC01	WC02	WC03	WA03	WC01	WC02	WC03	WA03	WC01	WC02	WC03	WA03	WC01	WC02	WC03	WA03
Current prices																								
2008	152,53	149	155	208	116	113	241	107	183,25	214,00	244,50	367,25	268,50	390,00	518,25	1038,25	184,75	214,75	245,75	351,25	163,00	194,25	259,00	483,50
2009	136,54	137	146	183	113	109	211	112	160,00	188,00	213,75	322,25	255,50	382,75	523,75	967,00	162,25	189,50	214,00	317,25	138,75	176,50	221,00	443,50
2010	154,65	157	163	202	143	134	214	128	174,50	204,25	233,75	344,75	248,75	364,25	492,50	938,50	182,00	211,50	239,25	339,00	139,75	176,25	224,50	424,25
2011	186,68	188	198	255	171	165	253	152	226,67	256,33	291,67	427,33	263,00	392,33	537,00	1089,00	235,33	267,33	304,67	425,67	202,67	247,33	305,67	634,33
Price changes - previous year = 100%																								
2008																								
2009	89,52	91,95	94,19	87,98	97,41	96,46	87,55	104,67	87,31	87,85	87,42	87,75	95,16	98,14	101,06	93,14	87,82	88,24	87,08	90,32	85,12	90,86	85,33	91,73
2010	113,26	114,60	111,64	110,38	126,55	122,94	101,42	114,29	109,06	108,64	109,36	106,98	97,36	95,17	94,03	97,05	112,17	111,61	111,80	106,86	100,72	99,86	101,58	95,66
2011	120,71	119,745	121,472	126,24	119,58	123,13	118,22	118,75	129,89	125,50	124,78	123,95	105,73	107,71	109,04	116,04	129,30	126,40	127,34	125,57	145,02	140,33	136,16	149,52
Price increases - for the year 2009 = 100%																								
2009	99,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	101,00	102,00	103,00	104,00	105,00	106,00	107,00	108,00
2010	113,26	114,60	111,64	110,38	126,55	122,94	101,42	114,29	109,06	108,64	109,36	106,98	97,36	95,17	94,03	97,05	112,17	111,61	111,80	106,86	100,72	99,86	101,58	95,66
2011	**136,72**	**137,226**	**135,616**	**139,34**	**151,33**	**151,38**	**119,91**	**135,71**	**141,67**	**136,35**	**136,45**	**132,61**	**102,94**	**102,50**	**102,53**	**112,62**	**145,04**	**141,07**	**142,37**	**134,17**	**146,07**	**140,13**	**138,31**	**143,03**
Price analysis - the years 2008 - 2011																								
XAV	157,60	157,75	165,50	212,00	135,75	130,25	229,75	124,75	186,10	215,65	245,92	365,40	258,94	382,33	517,88	1008,19	191,08	220,77	250,92	358,29	161,04	198,58	252,54	496,40
Median	154	153	159	205	130	124	228	120	179	209	239	356	259	386	521	1003	183	213	243	345	151	185	242	464
Minimum	136,54	137	146	183	113	109	211	107	160,00	188,00	213,75	322,25	248,75	364,25	492,5	938,5	162,25	189,5	214	317,25	138,75	176,25	221	424,25
Maximum	186,68	188	198	255	171	165	253	152	226,67	256,33	291,67	427,33	268,50	392,33	537,00	1089,00	235,33	267,33	304,67	425,67	202,67	247,33	305,67	634,33
PR	9,86	10,10	9,35	11,11	17,41	17,44	3,30	12,45	12,25	9,69	9,74	8,02	0,58	0,55	0,75	2,22	13,99	11,96	12,61	8,70	14,53	11,59	10,61	16,40
Difference compared to the arithmetic mean - PLN																								
2008	-5,07	-8,75	-10,50	-4,00	-19,75	-17,25	11,25	-17,75	-2,85	-1,65	-1,42	1,85	9,56	7,67	0,38	30,06	-6,33	-6,02	-5,17	-7,04	1,96	-4,33	6,46	-12,90
2009	-21,06	-20,75	-19,50	-29,00	-22,75	-21,25	-18,75	-12,75	-26,10	-27,65	-32,17	-43,15	-3,44	0,42	5,88	-41,19	-28,83	-31,27	-36,92	-41,04	-22,29	-22,08	-31,54	-52,90
2010	-2,95	-0,75	-2,50	-10,00	7,25	3,75	-15,75	3,25	-11,60	-11,40	-12,17	-20,65	-10,19	-18,08	-25,38	-69,69	-9,08	-9,27	-11,67	-19,29	-21,29	-22,33	-28,04	-72,15
2011	29,08	30,25	32,50	43,00	35,25	34,75	23,25	27,25	40,56	40,69	45,75	61,94	4,06	10,00	19,13	80,81	44,25	46,56	53,75	67,38	41,63	48,75	53,13	137,94
Difference compared to the arithmetic mean - %																								
2008	-3,22	-5,55	-6,34	-1,89	-14,55	-13,24	4,90	-14,23	-1,53	-0,76	-0,58	0,51	3,69	2,01	0,07	2,98	-3,31	-2,73	-2,06	-1,97	1,22	-2,18	2,56	-2,60
2009	-13,36	-13,15	-11,78	-13,68	-16,76	-16,31	-8,16	-10,22	-14,03	-12,82	-13,08	-11,81	-1,33	0,11	1,13	-4,09	-15,09	-14,16	-14,71	-11,46	-13,84	-11,12	-12,49	-10,66
2010	-1,87	-0,48	-1,51	-4,72	5,34	2,88	-6,86	2,61	-6,24	-5,28	-4,95	-5,65	-3,93	-4,73	-4,90	-6,91	-4,75	-4,20	-4,65	-5,38	-13,22	-11,25	-11,10	-14,53
2011	18,45	19,18	19,64	20,28	25,97	26,68	10,12	21,84	21,80	18,87	18,60	16,95	1,57	2,62	3,69	8,02	23,16	21,09	21,42	18,81	25,85	24,55	21,04	27,79

Source: own study based on prices set by the State Forests [Lis 2012b].

Notation:
CRL [coniferous rough lumber] = WA0+WB0+WC0+WD coniferous wood;
PP [pine pulpwood] = S2a, S2b So/Mo wood;
SP [spruce pulpwood] = S2a, S2b Św/Jd wood;
DRL [deciduous rough lumber] = WA0+WB0+WC0+WD deciduous wood;
DP [deciduous pulp] = S2a, S2b deciduous wood;
XAV - The aritmethic mean;
PR [Price ranges] in%

High similarities of prices of medium class pine rough lumber (WC02) in the period 2008–2011 are worth mentioning; the prices announced by the State Forests (in the State Forests IT System) are very similar to the prices announced by the Polish Economic Chamber of Wood Industry in quarterly reports published in subsequent editions of quarterly magazine *Rynek Drzewny*.

CONCLUSIONS

An analysis of wood prices in the examined period would have been incomplete if the situation of the Polish currency had not been included. It needs to be pointed out that in the third and fourth quarter of 2011 the zloty (PLN) was the most undervalued currency in the entire region of Central and Eastern Europe. A reaction to this and a strong increase in the exchange rate of the Polish zloty was observed in mid-January 2012. Nevertheless, the Polish currency is still treated and considered currency of a developing country, hence involving a certain amount of risk. Such a situation brings about frequent changes in the exchange rate both in relation to the dollar (USD) and, especially in the last months of 2012, to the euro (EUR) – the most important currency used in the Polish foreign trade.

However, there are also positive aspects to this situation. Weaker Polish zloty positively affects Polish export and relieves the influence of the slowdown in the global economy, especially in the Euro Zone, which is the most important area of trade for Poland. Weak Polish zloty improves profitability of export, which beneficially affects the industrial sector, including to a certain extent the wood industry and the furniture market as well.

As compared to 2011, State Forests' raw material offer for 2012 rose by 0.97%, i.e. by 272,000 cubic metres in case of wood for entrepreneurs, and by 1.21%, i.e. nearly 415,000 cubic meters, in case of wood in general. The above figures are very small. This has been the smallest offer since 2010 when the State Forests were forced to significantly reduce their initial proposal as a result of the global recession, whose end in Poland was conventionally set for the year 2009. Such enormous limitation of roundwood supply for industrial customers by the natural monopolist has led to a situation which directly causes an increase of prices.

We may expect that prices of deciduous wood will continue growing in the months to come. By the end of 2011 it was possible to buy some types of wood, like oak or ash, whose prices in recent years were substantially higher than the prices of pine wood, for only slightly more money than pine. Generally speaking, in recent years, the increase in prices of deciduous wood was slower than in case of prices of coniferous wood. Therefore, we may expect that in the following two years the price proportions will come back to the tendencies observed on a permanent basis in previous years.

In the first quarter of 2012, both average prices of pine wood as well as top quality WA03 oak wood reached their highest levels in history. On the other hand, prices of other types of wood and products dropped. Since the second quarter of 2012 almost all prices have been successively going down. The prices of WC01 pine wood in contracts for the second half-year of 2012 have decreased by approximately 24%. In the present macroeconomic conditions and a very unstable international economic situation, especially in the Euro Zone, the prices of pine rough lumber have most probably already reached their maximum level. They should not change rapidly, especially be subject to a sudden increase.

To sum up, the prices of coniferous roundwood increased in average by 21% per annum in 2010 and 2011. In the first quarter of 2012, the rising tendency was less intense and amounted to 15% on average annually. In the second half-year of 2012 we are expecting a visible drop in the prices of roundwood, especially coniferous. Hence, it is recommended to observe whether the wood industry uses this signal increase and improve competitiveness among companies.

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RATIO ANALYSIS OF PROCESSING WOODEN BY-PRODUCTS INTO ENERGY

Abstract: The article is a presentation of a method of pricing sawmill by-products converted into energy. This method embraces a number of indicators enabling an entrepreneur, the owner of wood waste, to evaluate profitability of converting it into energy. Among these indicators are: maximum margin, maximum cost of processing, maximum price of purchasing by-products assigned for conversion, maximum distance from which raw material may be transported and the minimum sales price of the final product possible to accept by the producer. The method accounts for both using generated energy for producer's own purposes as well as its sale to external clients. It also helps to determine price competitiveness of energy generated from purchased wood waste with an intention of further sale in comparison with other energy carriers.

Key words: Wooden by-products, profitability of converting into energy, ratio analysis.

INTRODUCTION

The obligation to fulfill EU commitments concerning the share of renewable energy in the overall national energy balance causes a dramatic increase in the usage of biomass as the most easily accessible source of that type of energy in Poland. According to experts' estimates [Polityka ekologiczna/ Ecolgical Policy 2010] keeping the trend will lead in 2020 to a five-fold (20 M tonnes) increase in energy plants' demand for biomass. The most easily accessible type of biomass is forest biomass. Its main share is generated by the wood sector in the form of various types of post-production material. According to research by Szostak, Ratajczak, Bidzińska and Gałecka [2004] more than a half of it is dedicated to generating energy, mainly for its producers' own purposes. This way of using wood by-products is favoured by the changeable relations on the market of energy carriers. Companies mechanically processing wood being in possession of a certain amount of wood waste aim at the most efficient way of utilising it. Taking the right decision requires a profitability analysis, which within the scope of energy usage of wooden by-products may be facilitated by the use of the presented method.

RATIOS OF PROFITABILITY ANALYSIS OF CONVERTING WOODEN BY-PRODUCTS INTO ENERGY

Assuming as the starting point the below formula [Mikołajczak 2008], the valuation of converting wooden by- products into energy is calculated as follows:

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

where:

- W_{ei} – value of a given type of by-product of „i" number converted into energy [PLN/m^3],
- i – number of types of by-products being converted, i ϵ <1, n>,
- c_{je} – unit price of selling energy generated from burning by-products [PLN/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
- m_j – assumed net profit margin level, satisfactory for the producer, m_j: {0,01; 0,05; ... 0,15},
- p – income tax level (CIT), for 2011 = 0,19,
- k_{pi} – unit cost of converting a given type of by-product of „i" number into energy along with the remaining unit operating costs into energy [PLN/m^3],
- k_{ti} – unit cost of transporting a given type of by-product of „i" number to the place of its conversion into energy [PLN/m^3],

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As the result of adequate conversions and with the assumption that: m_j=0, one may determine the lowest possible to accept by the producer sales price of generated energy (4):

$$W_{ei} = c_{je} g \frac{19{,}5 - 2{,}5w_o}{1 + w_o} - k_{pi} - k_{ti} \qquad [\mathrm{PLN/m^3}] \qquad (2)$$

$$c_{je} = \frac{(W_{ei} + k_{pi} + k_{ti})(1 + w_0)}{g(19{,}5 - 2{,}5w_0)} \qquad [\mathrm{PLN/GJ}] \qquad (3)$$

Consequently assuming further that the profitability of conversion is conditioned by the equation: $W_{ei} = c_{pub}$ (the value of by-products being processed into energy cannot be lower than the price of purchasing or selling them unprocessed), the relation (3) will be as follows:

$$c_{e\min} = \frac{(c_{pub} + k_{pi} + k_{ti})(1 + w_0)}{g(19{,}5 - 2{,}5w_0)} \qquad [\mathrm{PLN/GJ}] \qquad (4)$$

where:

c_{emin} – minimum energy price, possible to be accepted by the producer, [PLN/GJ],

c_{pub} – unit sales/purchase price of a given type of by-product [PLN/m^3],

When energy production constitutes company side-production, based only on its own raw material in equation (4) the cost of transport is to be ignored k_{ti}:

$$c_{e\min} = \frac{(c_{pub} + k_{pi})(1 + w_0)}{g(19{,}5 - 2{,}5w_0)} \qquad [\mathrm{PLN/GJ}] \qquad (5)$$

With analogy to the case of converting wooden by-products into pellets and briquettes [Mikołajczak 2007a, 2007b], one may determine the maximum margin (m_{gr}) (9), facilitating the profitability evaluation of converting those materials into energy. Then one uses the relation (6) [Mikołajczak 2008], at the same time assuming that the value of by-products converted into energy equals the price which can be reached when selling them unprocessed ($W_{ei} = c_{pub}$).

$$\frac{c_{je} m_j}{1 - p} = c_{je} - \frac{k_{pi} + k_{ti} + W_{ei}}{gQ_{wi}} \times (1 - p) \qquad (6)$$

$$c_{je} m_{gr} = (1 - p)\left(c_{je} - \frac{k_{pi} + k_{ti} + c_{pub}}{gQ_{wi}}\right) \qquad (7)$$

where:

m_{gr} – maximum margin – maximum level of margin to be reached at given remaining variables,

Q_{wi} – fuel value i-that type of by-product of a certain moisture content w_o [GJ/t],

Since the fuel value of dump wood Q_{wi} of an absolute moisture of w_o may be expressed by the equation [Mikołajczak 2008]:

$$Q_{wi} = \frac{19{,}5 - 2{,}5w_0}{1 + w_0} \qquad (8)$$

hence the following adequate conversions, the level of maximum margin will amount to:

$$m_{gr} = \frac{1}{c_{je}}(1 - p)\left(c_{je} - \frac{(k_{pi} + k_{ti} + c_{pub})(1 + w_o)}{g(19{,}5 - 0{,}25w_o)}\right) \qquad (9)$$

Assuming the maximum margin level at $m_{gr} = 0$, allows us to determine the maximum price of wooden by-products (14), beyond which an entrepreneur who is not their administrator is not able to purchase them and convert into energy with a profit.

$$\frac{1}{c_{je}}(1 - p)\left(c_{je} - \frac{(k_{pi} + k_{ti} + c_{pub})(1 + w_o)}{g(19{,}5 - 0{,}25w_o)}\right) = 0 \qquad (10)$$

For the equation (10) to be true the following conditions have to be fulfilled:

$c_{je} \neq 0$ and $1 - p = 0$ or $c_{je} - \frac{(k_{pi} + k_{ti} + c_{pub})(1 + w_o)}{g(19{,}5 - 0{,}25w_o)} = 0$

Since p is a fixed number and equals 0,19, the equation (10) will be true when:

$$c_{je} - \frac{(k_{pi} + k_{ti} + c_{pub})(1 + w_o)}{g(19{,}5 - 0{,}25w_o)} = 0 \tag{11}$$

$$\frac{(k_{pi} + k_{ti} + c_{pub})(1 + w_o)}{g(19{,}5 - 0{,}25w_o)} = c_{je} \; : \; g\frac{19{,}5 - 2{,}5w_0}{1 + w_0} \tag{12}$$

$$k_{pi} + k_{ti} + c_{pub} = c_{je} g \frac{19{,}5 - 2{,}5w_0}{1 + w_0} \tag{13}$$

hence the price level of wooden by-products, up to which it is still profitable for the producer to buy them and convert into energy, sold at a price of c_{je} equals

$$c_{ub\max} = c_{je} g \frac{19{,}5 - 2{,}5w_0}{1 + w_0} - k_{pi} - k_{ti} \quad \text{[PLN/m}^3\text{]} \tag{14}$$

where:

$c_{ub\,max}$ – maximum purchase price of the raw material to be converted [PLN/m^3],

Equation (13) also allows us to determine the maximum unit costs of processing wooden by-products directly into energy, including cost of transport, assuming margin at $m_{gr} = 0$ and at a given price of selling an energy unit c_{je}:

$$k_{p\max} + k_{t\max} = c_{je} g \frac{19{,}5 - 2{,}5w_0}{1 + w_0} - c_{pub} \quad \text{[PLN/m}^3\text{]} \tag{15}$$

Presentation of indicators facilitating a versatile profitability analysis of using all types of sawmill by-products to generate environment-friendly fuels and energy is shown in Table 1.

Table 1. Elements of ratio analysis of profitability of converting sawmill by-products into energy

Value of by-product in conversion [PLN /m^3]	$W_{ei} = c_{je} g \frac{19{,}5 - 2{,}5w_o}{1 + w_o}\left(1 - \frac{m_j}{1 - p}\right) - k_{pi} - k_{ti}$
Maximum margin	$m_{egr} = \frac{1}{c_{je}}(1 - p)\left[c_{je} - \frac{(k_{pi} + k_{ti} + c_{pub})(1 + w_0)}{g(19{,}5 - 0{,}25w_0)}\right]$
Maximum unit costs of conversion including transport [PLN/m^3]	$k_{p\max} + k_{t\max} = c_{je} g \frac{19{,}5 - 2{,}5w_0}{1 + w_0} - c_{pub}$
Maximum costs of transport per unit [PLN/m^3]	$k_{t\max} = c_{je} g \frac{19{,}5 - 2{,}5w_0}{1 + w_0} - c_{pub} - k_{pi}$
Maximum distance from which raw materials can be transported [km]	$l_e = \frac{k_{t\max} v}{2 s_{km}}$
Minimum selling price of finished goods, which can be accepted by producer [PLN/GJ]	$c_{e\min} = \frac{(c_{pub} + k_{pi} + k_{ti})(1 + w_0)}{g(19{,}5 - 2{,}5w_0)}$
Maximum purchase price of raw materials for conversion [PLN/m^3]	$c_{ub\max} = c_{je} g \frac{19{,}5 - 2{,}5w_0}{1 + w_0} - k_{pi} - k_{ti}$

v – unique density of by-products being transported by car at distance l [m^3],

s_{km} – unit cost of transport service of by-products to the place of their conversion [PLN/km]

CONCLUSION

The presented method of pricing of sawmill by-products being converted into energy allows one to carry out a versatile profitability analysis of this form of utilisation. It constitutes a useful tool for producers to take up an economically sound decision concerning the means of using post-production waste from mechanical wood processing. It allows us to compare the profitability of using generated energy for a producer's own purposes with the profitability level of its sale to external clients, taking into account different margin levels.

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THE NEW PRODUCT DEVELOPMENT MODELS IN THE FURNITURE INDUSTRY – A LITERATURE REVIEW

Abstract: The new product development models in the furniture industry – a literature review Very little has been published concerning the product development process in the furniture industry regardless of knowledge that furniture is a product with a big potential, caused by many possible feature combinations, serving both functional and aesthetic considerations. Nevertheless, this paper explores the new product development models in the furniture industry through a deep literature analysis which was an introduction to research into the new product development process in the Polish furniture industry. This study sought to expand knowledge of the activities involved in furniture product development and revealed the gaps in previous researches.

Key words: new product, a new product development model, furniture industry,

INTRODUCTION

The design processes consists of various activities depending on the company's resources, its competitive strategy and the industry specificity. Often these individual actions are carried out as sequential or parallel activities, repeating themselves in all projects but in infinite configurations with infinite results. This is why it's important to look at the order in which they are done and how they relate to each other in the process [7]. It will become clear below that each company has its specific rules for the design process, which can be written down in a procedure or just maintained as a routine in the company. The design processes differ between radical and new products, satisfying needs in new ways and the latter marginal improvements and 'styling'. The context also differs depending on the industry. In the case of new products, the process is comprehensive, it takes time and often concerns huge resources in the company [5]. The complexity of the topic of a new product development process and its diversified courses impact on the fact: industry type, characteristics, capabilities and resources of a company, is hard to fit to the models presented in the literature from the Product Management domain, because most of them are too general. This is also a negative association with attempts to reduce the next stages of the development process to specific tools and techniques which could assist this process.

There is a need to research for narrow models of development processes, not only for each sector of economy, but also for individual industries, taking into account the size of the company.

THE PRODUCT DEVELOPMENT IN THE FURNITURE INDUSTRY

Furniture, seen through the prism of the new product development processes are products on one hand simple from the constructional and technological aspect, on the other hand, products with big esthetic and functional potential which can be achieved at relatively low cost of effort to prepare and carry out the development process.

The conditions of a process of new products development in the furniture industry are presented in Table 1. The significant difference in the development processes in the furniture industry – resulting from the adopted strategy and the available resources, indirectly connected with the size of a company – is characterized by the number of new products or new product groups (collections) implemented simultaneously or introduced annually by enterprises. Individual products are the focus of rather small, medium-sized and design-oriented companies (also large-sized), where the emphasis is put on uniqueness of each of the proposed items, thus the development of a new product (furniture) may take up to 2-3 years [5, 7]. Large companies annually implement from a few

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to several (or even several dozen) collections of furniture. However, this depends on the degree of newness of the developed products as well as on their level of design and technological advancement.

Due to the nature of the new product in the furniture industry, a definition was proposed. “The new product” is a term describing a single product (one piece of furniture) or a collection of furniture (i.e. a set of products related by style and bearing a common name) which fulfills the criterion of novelty for 24 months of continous sales booking by the manufacturer. “The newness” factor can be expressed in a modified or improved design or construction, use of a new material, a new process, a new method of customer service, satisfying new customer needs or meeting current needs in a better way.

Table 1. Conditions for a new product development process in the furniture industry [9];

No.	Features of the new product development process	Furniture industry
1.	The nature of the industry	The industry: traditional, mature, sensitive to fashion, natural and recycled resources dependent, with a relatively low level of technology;
2.	Market attitude	Conservative, binding of a discouragement to promote innovation;
3.	The potential of innovations introduction	Low potential for the implementation of critical product innovations, but rather to make some changes (incremental innovation); a high degree of division of the industry significantly impedes the penetration of new market segments through the development of new products;
4.	The product	The furniture is distinguished from other products by: the use of raw material resulting in the need for woodworking and a technology process; product function; aesthetic and utility values of wood;;
5.	The degree of new product failures	The industry is resistant to failure of product innovations due to the low degree of changes introduced to new products;
6.	The new product development process	The industry does not require a long period of time for new products development because of doing only modifications in existing designs or following up the company's range of products (e.g. the furniture collection). Rapidly growing product development opportunities require the involvement of many employees of various departments and the efficient coordination of activities carried out at the same time;
7.	The product life cycle before modification	Products are likely to remain unchanged for a longer time than they should;
8.	Duration of the new product development process	Circa 2-6 months (in plants not highly focused on design and innovation) - a relatively shorter period of the new product development process in relation to the duration of this process in other industries, such as food, electronics (circa 1 - 1,5 years); circa 1-3 years in companies highly focused on design and innovation.

THE MODELS OF THE NEW FURNITURE DEVELOPMENT

Most of the new product development models presented in previous studies are based on the belief that new product development process should be formalized in companies (recognized and considered as a separate process), guided through by taking into account the risks, carried out as soon as possible, absorbing resources in an efficient manner and ensuring profit from the new product.

Table 2. The usefulness of new product development models in relation to the criterion of company size [6]

Company size	Technological level	
	low	high
Large – above 250 employees	Decision – stage model Cross – functional team model	Network model Response model Decision – stage model
Medium – from 50 to 250 employees	Decision – stage model Cross – functional team model	Response model Decision – stage model Cross – functional team model
Small – from 10 to 49 employees	Cross – functional team model Activity – stage model	Decision – stage model Cross – functional team model Activity – stage model
Micro – below 10 employees		Cross – functional team model

Due to the ideas dominating in the new product development models, they have been divided into seven groups. Classification, based on Saren's work (1984), is presented in Table 3. However, the division of new product development models (highlighted by Saren) in terms of suitability of various models for companies varying of sizes and technological advancement levels, is found in table 2.

Table 3. New product development models

No.	The new product development model	The model description
1.	*Departmental – stage model*	One of the first forms which formulates a new product development process. Each department within the company has specific tasks assigned concerning product development. Individual parts of the process are worked out in turn and by each department separately [10];
2.	*Activity – stage model and concurrent engineering*	This model is based on activity and concurrent design. The main idea of this approach is the emphasis on actions ensuring better representation of reality largely through project teams and computer-aided process planning systems such as CAD, CAM [7], as well as carrying out the largest possible number of elements of the new product development process at the same time [10];
3.	*Cross – functional team model*	This model solves the problem of lack of communication between the various departments during the process. It is based on simultaneous operation of secondment employees from all engaged departments (divisions: marketing, finance, R&D, manufacturing, legal, logistical and sales) and overlapping process steps. However, it requires a complete modification of company structures and implementation of project management procedures [9, 10];
4.	*Decision – stage model*	This model is based on decisions, i.e., the new product development process determines a series of decisions that must be taken in order to allow the project to proceed [10];
5.	*Conversion – process model*	Views the process as a „black box" and is a collection of unspecified tasks which may or may not be carried out, depending on the nature of the innovation. Over time, depending on a multiplicity of factors, including human, organization and resource-related, this input is converted into an output [4, 8];
6.	*Response model*	This model focuses on individual or organization response to change, such as a new product idea, or R&D project proposals in terms of acceptance or rejection of the idea or project [4, 8];
7.	*Network model*	It emphasises the external linkages coupled with the internal activities that have been shown to contribute to successful product development. That model suggests that the new product development process should be viewed as a knowledge-accumulation process that requires inputs from a wide variety of sources [10].

Now, we have merely a few studies about the structure of a new product development process in the furniture industry. Bennington (1985) offers one of the only published models, a step-wise cycle containing nine steps and created for large furniture companies. The Bennington model provides a framework for a review of what is known about the broad stages of the product development process for furniture manufacturers, as presented below in Figure 1. This model, after 16 years, was verified and the following 14 new product development stages were identified [1]:

1) identification of opportunity/need for new products;
2) generation of new product ideas;
3) new product information given to designers;
4) designer activities;
5) initial new product review;
6) additional designer activities (e.g. specs for approved designs);
7) first intermediate new product review (based on designer specs);
8) mock-up construction/manufacturing issues;
9) second intermediate new product review (based on mock-ups);
10) remaining group pieces sketched by designers;
11) final new product review (i.e., premarket);
12) prepare for market (using feedback from premarket);
13) introduction to the market;
14) product manufactured/orders filled.

An interesting observation resulting from the mentioned models is the supposition that the role of marketing in new furniture development processes may have been overemphasized. Clearly, manufacturing considerations have a significant role in the development process and this was evident in the models. They also suggest the importance of early involvement of the manufacturing stage [1].

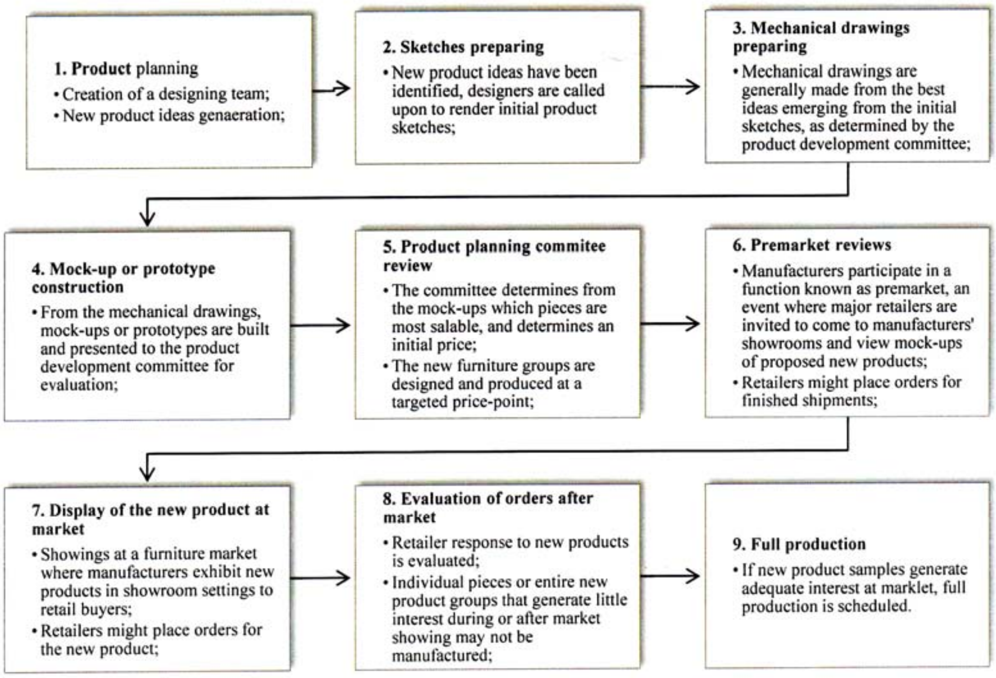

Figure 1. The Bennington's new product development model for the large case goods companies, 1985 [based on 1]

Non-standard elements of models of preparing a new furniture line were visible, pre-market reviews and cooperation with potential clients at early development phases. It is a very valuable remark because retailers place about 6% of their yearly orders during premarket activities. Whereas, approximately 51% of retailers' yearly orders are placed during and within six weeks after showings at a furniture market (but before the final launching of the new product on the market).

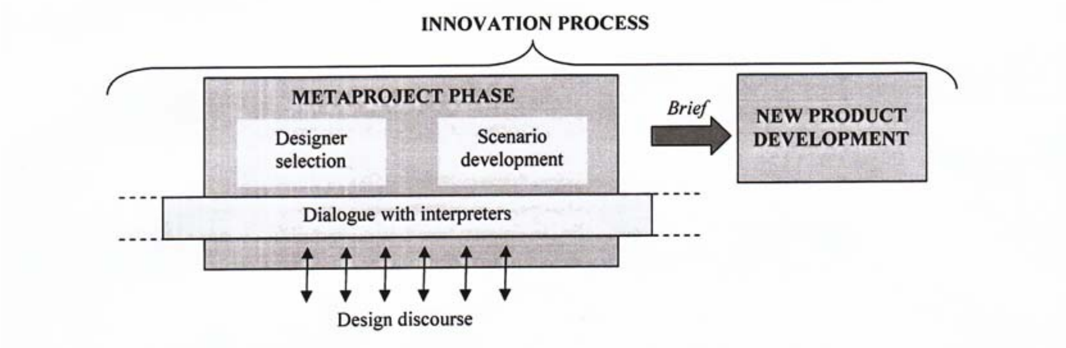

Figure 2. Metaproject phase preceding the new product development process in design-driven companies of the furniture industry [2]

Analyzing professional literature, it should be noted that the major factor affecting the new product development process is the company's strategic focus on design [2, 5, 7]. Then, the new product development model differs considerably from those described above, because the main player in the process becomes the designer (usually a professional from outside the company) and the duration of the process extends repeatedly (from 2-6 months to 1-3 years). It is also noticed that design-driven companies have an extra "pre" phase in their development processes, which enterprises call the metaproject. Usually the metaproject phase, depending on the company, remains unique in terms of content and how it is managed, but what is fascinating, each metaproject phase contains a similar set of activities showed in Figure 2 [2].

Continuing the discussion about the available models for the development of new products for the furniture industry in relation to the size of the manufacturer, it is clear that new product development in medium-sized enterprises has not been investigated yet. The process analysis in micro and small enterprises investigated by Ekberg (Sweden, 2005) revealed the absence of a formalized development process. The formation of a new product was also carried out without a plan of conduct or any defined schedules. Therefore the authors propose their own model of implementation of activities related to the new product development for entrepreneurs [3]. Figure 3 describes it.

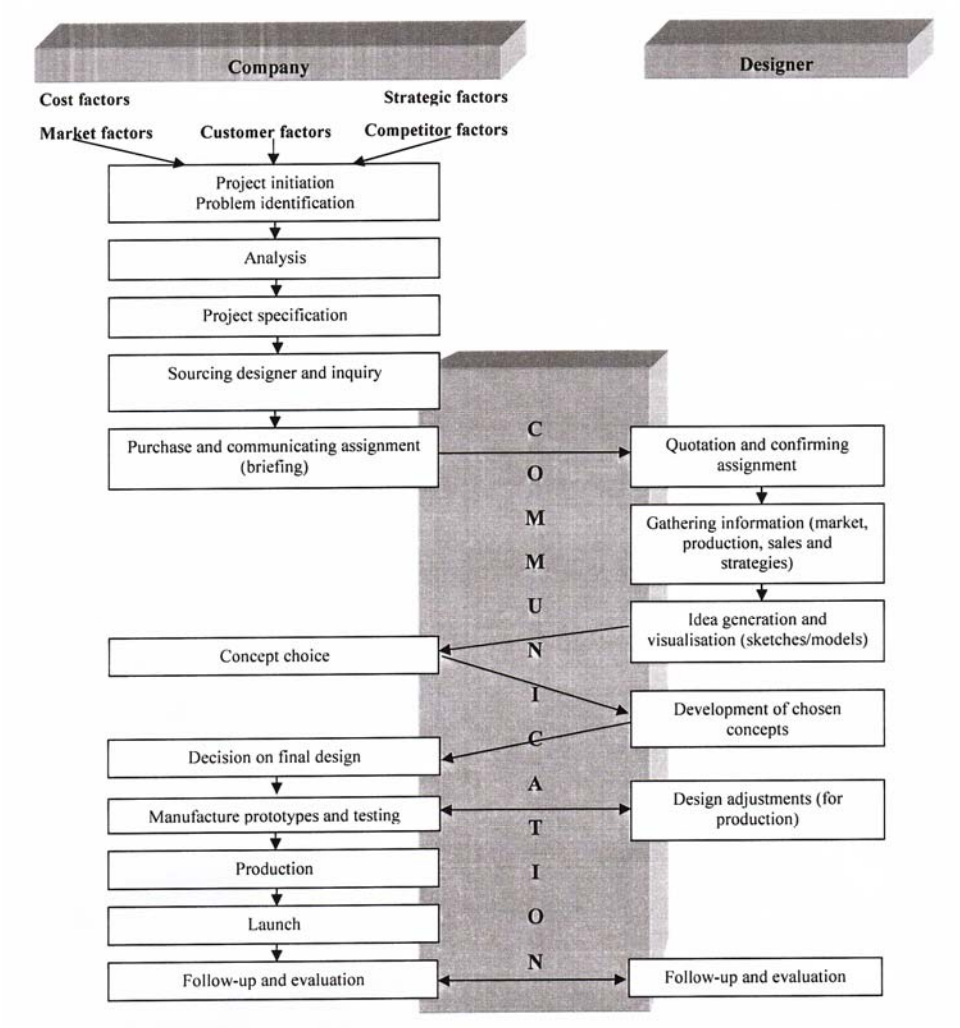

Figure 3. Suggested model of the design project process for micro and small-sized furniture manufacturers [3]

SUMMARY

The furniture industry seems to be undergoing profound changes, where the focus on systems and networks is becoming more urgent. With increasing use of high technology in the processes that must be adapted to the existing skill base, there is a lack of understanding of how the high and low technology can be brought to function well together. The issue is much concerned with how to absorb contextual information, in particular, understanding the clients/users and their needs, and channel that information flows into the development processes at determined time and with the established new product costs. That is why, further research on design processes should focus on the varieties found within single industries. There seems to be a deep concern for better understanding of how the specific constraints and opportunities are accommodated, especially in industries that are either new (such as e-businesses) or mature industries (as the furniture industry is), that are subject to major technological and other changes **[5]**.

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FAILURE MODE AND EFFECT ANALYSIS (FMEA) OF THE QUALITY MANAGEMENT SYSTEM IMPLEMENTATION PROCESS

Abstract: Quality Management Systems (QMS) compliant with ISO 9001 are currently very popular standard. One of the reasons of this state of affairs was a quick development of the science, which determined the functioning of enterprises. Better ones were these, based on the knowledge and public information. Growing diversity and amount of products, decreasing amount of necessary machinery and devices, as well as shortened production time and the product's life cycle guaranteed the development only to these organizations, which were able to meet its clients' expectations. Therefore, the organizations begun to compete between themselves for the markets and, above all, for the clients.

Key words: quality management system, effect analysis, product life cycle, ISO 9001

INTRODUCTION

More importance was attached to the quality, and consequently, to the possession of the certificates confirming the fulfillment of some standards. One of such standards in the scope of quality, understood as meeting the client's expectations, are the ISO norms of the 9000 series. With the time being it turned out, that in order to exist on the European market, the organization should possess a quality management certificate. Up to now, the ISO 9001 norm is the most frequently chosen standard for the quality management systems. The certificate of the compliance with ISO 9001 norm is possessed by over 1000000 organizations in 170 countries, and the average yearly growth rate throughout the world is around 15%.

The norms are subjected to the periodical revisions and amendments, so as to remain up-to-date and to meet the expectations of the parties concerned, as well as because of the fact, that the quality management is a process, which undergoes dynamical development. Therefore, the norms ISO 9000 series are subjected to the constant review and amendments, which is performed by the Technical Committee TC 176. The first publication of these norms had place in 1987, the second in 1994, the third in 2000, and the forth, the up-to-date one, on the 15th of November 2008.

The abovementioned amendments, besides a large amount of implementations, cause still problems with the appropriate preparation of the company for meeting the requirements of the norm, and for the system configuration in order to meet the organization needs. This fact becomes a basis for formulating the FMEA sheet for untypical process, which is the implementation of the quality management system compliant with ISO 9001. Because of the large amount of possible variants of factors determining the implementation, the attention was paid at the small production organizations, which do not include design (see 7.3. ISO 9001). Also, the product life cycle affect the selection of parameters. [2] The analysis may illustrate to the potential users the problems appearing during the implementation process and which among them may be more difficult to overcome. On this basis, it would be possible to develop rationally the project of implementation the quality management system, to create the schedule of the implementation or to appoint appropriately large teams.

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FMEA

The Failure Mode and Effect Analysis (FMEA) method is mainly used in preventing and mitigating the impact of the drawbacks, which might appear in the constructive and productive processes. However, there is nothing that prevents this method to be used for developing the internal audit process. While deciding to carry out the FMEA analysis, the aim and scope it would embrace should be précised. The best result may be achieved if the FMEA would be applied before launching the process. In this particular case, it should be initiated before realization of the program or audit schedules in the organization, but after the trainings for the auditors end. However, because of the specifics of the internal audit, it is necessary to gain experience while carrying out the audits. Hence, exceptionally in the case of the internal audit process, it would appear that advisable is to execute the FMEA when the auditors will be experienced, for example after, at least two internal audits.

The essence of the FMEA method comes down to the following steps:

1) identification of all the elements of the process.
2) creation of the list of the possible mistakes.
3) creation of the list of probable effects of these mistakes.
4) creation of the list of the causes of the possible mistakes.
5) allocation to the possible mistakes the risk value O (occurrence rating – informs what is the probability of the defect occurrence), S (severity rating – informs how harmful for the client this defect may be), D (detection rating – informs what is the probability, that the failure of the process would be detected already in the process duration). These numbers are selected from the tables available in the literature on the subject [4, 5] or from these, created for the needs of the particular organization.
6) calculation of the risk priority number according to the formula:

$$RPN = O*S*D \qquad [4]$$

7) ordering of possible mistakes according to its importance.
8) recommendation of the remedial actions.

The risk priority number may be changeable in the range of 1–1000. If it is significantly higher than 1, the recommendation (proposition) of the precautionary actions, for example the modernization of the construction or the modification of the process, is being published.

ANALYSIS

The FMEA analysis for improving the implementation process of the quality management system compliant with ISO 9001 was carried out experimentally based on the experience of the representatives of the highest rank management from the production companies located in the Subcarpathian Voivodeship (Podkarpackie Voivodeship).

Besides the author, four representatives of the quality management system from the small companies, which for the relatively short period of time possess the system compliant with ISO 9001, took part in the task. The first step was the preparation of the tables for the selection of the priority numbers and the creation of the assessment form of the implementation of the quality management system with the FMEA method. The table 1, 2, 3 present the results of the works on the valuation of the priority numbers: S, D for the FMEA of the implementation process of the quality management system compliant with ISO 9001.

Table 1. Determination of the O number (occurrence)

O	Description
1	Improbable The occurrence of the quality management system imperfection is almost impossible..
2-3	Rare The quality management system imperfection occurs occasionally.
4-6	Average In comparison to similar actions, the quality management system imperfections are not more frequent.
7-8	High The quality management system imperfection generates problems, as it occurs more often than in similar actions.
9-10	Very high It is sure, that the quality management system imperfection will occur.

Table 2. Determination of the S number (severity)

S	Description
1	None One should not expect that the quality management system imperfection will have any impact on the organization or product. The imperfection will not influence the organization functionality.
2-3	Low The quality management system imperfection will invoke small repercussions in the organization and possibly the client's dissatisfaction.
4-6	Average The quality management system imperfection will cause noticeable restrictions on the organization functionality and its consequence may be the client's dissatisfaction.
7-8	Significant The quality management system imperfection will cause significant restrictions on the organization functionality and it may result in the client's outrage.
9	High The quality management system imperfection will cause important restrictions on the organization functionality and may cause a serious damage. There is no danger for the client's safety.
10	Extremely high The quality management system imperfection will cause essential restrictions on the organization functionality and will cause a serious damage. The client's safety may be endangered.

Table 3. Determination of the D number (detection)

D	Description
1-2	Very high The applied tools almost certainly will detect a potential imperfection of the quality management system.
3-4	High The applied tools are highly probable to detect the potential imperfection of the quality management system.
5-6	Average The applied tools may detect the potential imperfection of the quality management system.
7-8	Low It is unlikely that the applied tools will detect the potential imperfection of the quality management system.
9	Very low The applied tools probably will not detect the potential imperfection of the quality management system.
10	None The applied tools certainly will not detect the potential imperfection of the quality management system, or any means are not used.

The next step was to fill in the prepared form in the table 4.

Table 4. The FMEA form for the implementation process of the quality management system compliant with ISO 9001.

FMEA		Concerns: The Implementation process of the Quality Management System (QMS)						No.: 01
No	Potential problem	Effect of the defect	Cause of the defect	O	S	D	RPN	Remedial action
1.	Lack of the management staff engagement	Lack of the resources, poor model for the employees	Lack of the management staff awareness in the scope of the QMS implementation	5	7	3	105	Trainings for the management staff
2.	Willingness of the status quo maintenance	Resistance during the implementation, challenging the need of the implementation, poor example for other employees	Lack of the appropriate incentive scheme	3	4	5	60	Rewarding the most engaged employees
3.	Lack of the appropriate and reliable knowledge of the QMS	Wrongly elaborated system, which disturbs and does not assure any benefits	Lack of the trainings, chats, etc.	8	4	2	64	To plan adequate trainings for the employees
			Trainings existing only on paper	4	4	2	32	To verify the knowledge from the trainings
4.	Insufficient resources	Savings limiting the system efficiency, lack of the consultant	Financial unreadiness for the QMS implementation	3	6	2	36	To consider the system implementation in later time
5.	Wrong planning or too frequent modifications resulting from the QMS implementation	Organizational chaos	Unprofessional preparation for the changes in the organization through the system implementation	2	2	2	8	Training on the QMS implementation for the leader of the implementing team in a respected training unit
6.	Lack of the team members engagement	Even a well-prepared system is difficult to introduce and maintain	Incorrect rewarding rules for the achievements in the QMS implementation	7	9	4	252	Rewarding the engaged employees by ex. notice board, appeal, etc.
7.	Too high expectations of the management	Criticizing the system. Resource limitations for the system. Too high expectations. Pressure for the representative of the highest management.	Lack of the trainings on the benefits of the QMS	2	3	3	18	To reserve particular amount of money for the trainings. To introduce the system effectiveness indicators.
		Excessive specificity or over generality, various forms.	Wrong system documentation	2	3	2	12	To realize extra documentation review.
8.	Misunderstandings with the representatives of the highest management / with the implementation team supervisor.	Wrongly designed and implemented system, which is being inappropriately amended.	Inappropriate approach in the selection of the highest management representative / the implementation team supervisor	4	6	1	24	Consultations in the similar organizations possessing the correctly functioning QMS
9.	Overinterpretations made by the consultants.	Too detailed documentation in the system, often not adjusted to the organization.	Wrong selection of the consultant or wrong contract with the consultant.	6	6	3	108	To get acquainted with the opinions on the consultants.
10.	Excessive system inflexibility	The employees' resistance	Belief that it is enough to describe the procedure in order to have everything working.	4	3	2	24	Rephrase the documentation.
Created by:			Signature:	Date:		Remarks:		

CONCLUSION

The introductory failure mode and effect analysis (FMEA) that was carried out, proved that the FMEA analysis may be applied for the improvement of the implementation process of the quality management system compliant with ISO 9001. In order to be successful, one should prepare the tables for the selection of the priority numbers. Such prototypical tables were prepared before commencing the experimental application of the FMEA. These tables may be developed in the future on the basis of the data from the FMEA process. The failure mode and effect analysis of the implementation process of the quality management system proved, that the major problem in the implementation is caused by the lack of engagement of the management staff and the team members, as well as the system overinterpretations made by the selected consultant. The origins of these problems may arise from the lack of the incentive scheme within the implementation process and from the lack of the quality awareness, triggered by the absence in different kinds of trainings. Another origin of the issues may be an unconsidered selection of the consultant. For these and other sources of the implementation problems the remedial actions were provided, as for example the introduction of the financial motivation. What is more, the trainings and collection of the information about potential candidates for the external consultants were offered. One should believe that the FMEA analysis or similar, will help the organizations to prepare better for the implementation of the quality management system, and therefore to contribute to the appearance of the benefits of this implementation.

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ANALYSIS OF THE USE OF RAW WOOD MATERIAL IN THE PULP AND PAPER INDUSTRY IN SLOVAKIA

Abstract: This paper deals with the analysis of material inputs and production in the pulp and paper industry in Slovakia. It provides insight into the structure of raw material inputs for pulp production as well as the structure of industry production. The analysis is based on data from 2009. Using the principles of material flow analysis, the main relations between the consumption, production and trade are highlighted. The Slovak pulp and paper industry is principally based on the use of domestic raw wood material as well as resources of domestic recovered paper, however, the increasing production capacities source inputs in imports. Even if the domestic consumption of paper is relatively high at 90 kg per capita, the majority of paper produced in Slovakia is exported.

Keywords: raw wood, pulpwood, recovered paper, pulp and paper industry

INTRODUCTION

Taylor et al. (2012) states that wood is a versatile and beautiful material with a very favourable environmental profile. It has been used for thousands of years as a building material for homes, bridges, fences, barns, and furniture. Presently, wood, a renewable and recyclable raw material, is used worldwide for a broad range of end products as well as for renewable energy generation. In the last decades, there has been an increasing role of raw wood material and fibres used in chemical processing. The development of pulp and paper industry is based on the sufficient volume of available raw wood material of low quality grades, which are not suitable for mechanical processing, and on recycled material – recovered paper. During the last two decades, there has been a visible increase in the impact of globalisation on the pulp and paper products industry. Globalisation in this sector is characterised by a degree of openness of the economy, an increased share of imports and exports in GDP, as well as by the rapid growth of imports and exports of the Slovak pulp and paper products in comparison with the growth of total exports and imports (Šupín 2011). Pulp and paper industry offers possible ways to utilise wood as a renewable resource, however this sector is affected by many issues. At the present time, wood resources availability, innovations, wood trade and information technologies as well as other competitive products are the key factors, which influence markets for pulp and paper. Production and foreign trade as well as pulp and paper products consumption are increasing. Consequently, the consumption of recovered paper for pulp and paper production is increasing (Parobek 2010).

ANALYSIS OF MATERIAL INPUTS FOR THE PULP AND PAPER INDUSTRY

The total volume of 9.1 mil. m^3 of timber was supplied to domestic and foreign markets in 2009. Out of this volume, domestic deliveries accounted for 8.4 mil. m^3. The pulp and paper industry consumed more than 27% of this volume. In 2009, Slovakia imported 0.57 mil. m^3 of roundwood, out of which 36.1% was coniferous and 53.5% non-coniferous timber and the remaining 10.4% was represented by fuelwood (MPaRV 2010). Pulpwood, chips, wood residues and recovered paper are the basic material inputs for the pulp and paper industry. In 2009, the industry consumed 2.6 mil. m^3 of raw wood material, out of which 0.35 mil. m^3 had been imported to Slovakia. As for the commodity structure, pulpwood represented 2.56 mil. m^3 and non-coniferous chips 13.5 thousand m^3. A detail composition of raw material inputs is illustrated in Figure 1.

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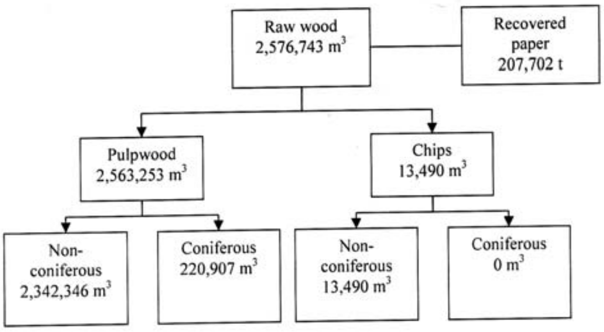

Figure 1. Composition of inputs materials in pulp and paper industry

Recovered paper accounts for a significant volume of production inputs in a number of pulp and paper companies. In 2009, companies consumed 207,702 tons of recovered paper, out of which 4.8 thousand tons of mixed grades, 68.7 thousand tons of other fibres, 56.2 thousand tons of newspaper and magazines and 77.9 thousand tons of quality grades. Though the majority of volumes of recovered paper was imported to Slovakia in the past in order to fulfil domestic demand requirements, nowadays a share of domestic sources in the total volume of recovered paper has increased. Out of the total volume of recovered paper (208,000 tons) import accounted for 26,000 tons only. Since 1995, the volume of recovered paper from domestic sources reached its historical maximum. During the last 10 years the rate of return has increased by 17% and is more than 50.1%. Domestic market with recovered paper profited from the activities of the Recycling Fund, which supported separated waste collection in municipalities as well as contributed to the entrepreneurial activities of companies oriented on waste collection.

ANALYSIS OF PRODUCTION IN PULP AND PAPER INDUSTRY

In 2009, almost 689 thousand tons of fibres for paper and paperboard production were produced in Slovakia. Out of this volume, production of semi-chemical pulp accounted for 112 thousand tons and production of chemical pulp for 576 thousand tons. As in the past, bleached sulphate pulp was mainly produced, out of which 539 thousand tons were non-coniferous and 34 thousand tons were coniferous (Figure 2). Consumption of fibres was nearly 698 thousand tons with the import of 134.5 thousand tons and export of 130 thousand tons.

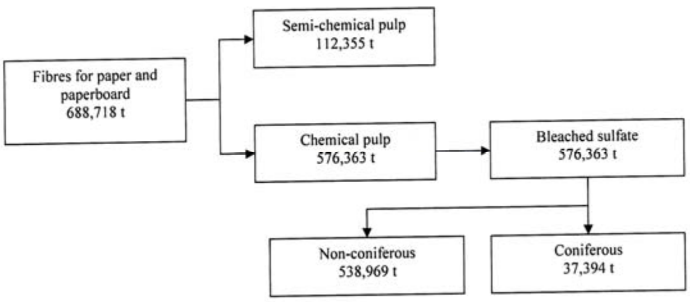

Figure 2. Production of fibres for paper and paperboard

Slovakia is a developed country in terms of paper production and it produces most of commonly used paper grades. However, a significant share (almost 80%) of production is being exported. Recently, the domestic consumption was restrained by the economic situation of Slovak inhabitants, and in the past, partially by their hygienic habits.

In 2009, the companies associated in the Pulp and Paper Industry Federation produced 921 thousand tons of paper and paperboard (ZCPP 2010). The total production consisted of 539.4 thousand tons of graphic paper, 139.2 thousand tons of household paper and 242.4 thousand tons of packaging papers and boards. The economic crisis and regulated supply of gas in January 2009 caused a decrease in the production of household paper by 3.9 % and packaging papers by 4.6 % on an annual basis. Moreover, the production of paper products included 121.2 thousand tons of hygienic products and 11 thousand tons of other products (Figure 3).

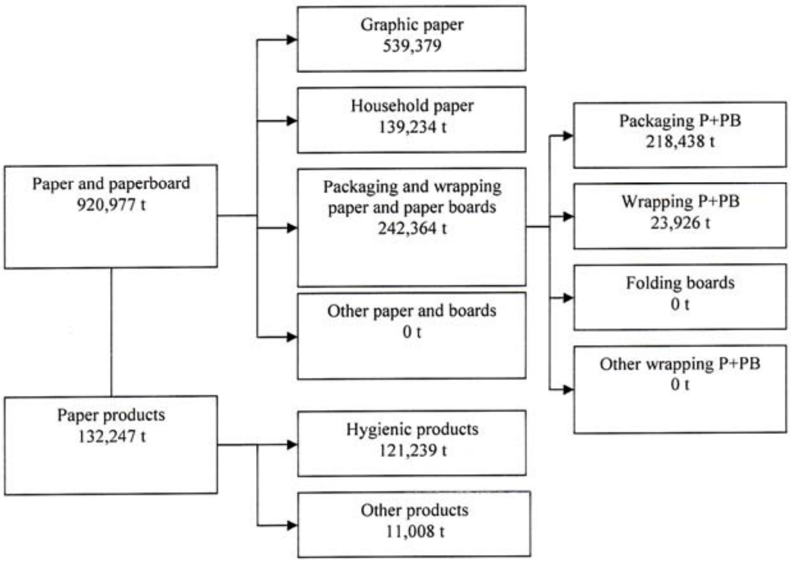

Figure 3. Production of paper, paperboards and paper products

CONCLUSION

Processing raw wood into pulp adds 4 times the initial value and turning it into paper - 8 times. The pulp and paper industry represents a sector enjoying permanent interest from foreign investors in Slovakia. This fact is of particular importance for the future development and restructuralisation of the sector in connection to the trend of the European concentration of the pulp and paper industry that started more than 15 years ago. Paper consumption in Slovakia is relatively high reaching more than 90 kg per capita; however, the domestic consumption is significantly lower than the production. The key problem of pulp and paper producers is the unavailability of domestic raw wood material, which is widely supplied through imports from Ukraine, Hungary and Belarus. Transport costs, however, influence the final price of timber. Other problems include, for example, the increasing energy prices. On the other hand, increasing consumption in general positively influences producers of packaging materials. Slovak paper companies are mostly export-oriented. A couple of years of lasting recession in the European paper market, causing a drop in prices of paper and paper products, ended in 2006. This recession severely affected mainly paper mills as they have significantly higher input costs. On the other hand, their profits had been increasing quicker after the crisis has ended. The global economic crisis, which started in 2008, has fully affected this sector. The multinational companies operating in Slovakia responded to this situation. For example, Mondi Business Paper, the biggest paper producer in Slovakia decreased its production by 14% and sold several companies abroad. Due to the decreasing market demand and surplus of production capacities, Smurfit Kappa, seated in Sturovo, even finished its operations and closed the production site in Slovakia (Sario 2009).

The pulp and paper industry is an important domestic consumer of pulpwood, annually processing 2.5-2.6 million m^3. This volume represents about 30% of the domestic roundwood supply. Even before the global economic crisis this sector experienced economic recession, followed by an attempt to solve the problem by increasing pulp and paper mill's production capacities. This resulted in the total growth of stock of selected pulp, paper and paperboard products and consequently in significant pressure on product prices as well as prices of input raw material. The pulp and paper industry is one of the main industrial sectors in Slovakia. It employs thousands of workers; it is stable and based on processing of domestic renewable raw material with many relations to other sectors of the economy.

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Rastislav Rajnoha[23]*, Dana Slivková*[24]

BUSINESS PERFORMANCE MEASUREMENT – TRANSFER PRICING METHODS ANALYSIS AND MODEL

Abstract: Tax policy and tax planning is one factor that influences Multinational Corporations' strategic and operative decisions. In order to secure business and financial relations between associated enterprises, it was necessary to determine measures for pricing transactions between associated enterprises in compliance with the arm's length principle. Such a measure is transfer pricing. This study's target is focused on selection of the appropriate transfer pricing methods for particular transactions and determining their strengths and weaknesses. The object of the research were transfer pricing methods and the subject of the research were multinational corporations or their parts. According to the theoretical analysis of the primary sources for the research, we have identified and obtained the strengths and weaknesses of individual methods and suggested their use for selected dependent transactions. The final outcome of that primary research is the model for the use of transfer pricing methods.

Keywords: transfer pricing methods, dependant transaction, independent transaction, multinational corporations.

INTRODUCTION

Perhaps the most vexing concern is the need for multinationals to solve the "corporate transfer pricing problem" by establishing transfer pricing policies and practices that satisfy the needs of the business with respect to strategy and internal incentives, result in an efficient use of resources, and provide an appropriate transfer pricing answer from a tax-focused perspective (Urquidi 2008).

One of the definitions of transfer pricing is: "Intra-firm trade involves the sale or transfer of tangible and intangible goods between related companies in two or more countries. Multinational transfer pricing is concerned with the pricing of intra-firm trade" (Tang, 1997).

The relation between parties in a joint entrepreneurial activity can most significantly be defined according to their respective roles and responsibilities. What a company carries out as a function is one thing, what it assumes as risks is another, but who counts at the end of the day is how successful it has been in managing this combination. It can only be held responsible however for elements that it can reasonably take responsibility for, for what it is equipped to manage (Pim 2008).

Many countries determine members of Multinational Corporations as separate tax payers (associated enterprises). If associated enterprises' profit is different from the profit of an independent enterprise in comparable conditions, the state tries to adjust such a profit. This procedure is in accordance with the arm's length principle, the basic principle for transfer pricing (Feinschreiber, Kent 2004).

The authoritative statement of the arm's length principle is found in paragraph 1 of Article 9 of the OECD Model Tax Convention, which forms the basis of bilateral tax treaties involving OECD member countries and an increasing number of non-member countries (OECD Guidelines).

1. TRANSFER PRICING THEORY AND METHODOLOGY – LITERATURE REVIEW

The transfer pricing method task is to verify, whether conditions that are agreed in relations between associated enterprises are in accordance with the arm's length principle (Kutišová, Luknárová 2009).

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The internationally accepted methods for verification of transactions between associated enterprises are as follows:

(1) transactional transaction method:
- comparable uncontrolled price method;
- resale price method;
- cost plus method and

(2) Transactional profit method:
- transactional profit split method;
- transactional net margin method (OECD Guidelines).

In special cases it is suitable to use a combination of methods or more than one method (Brem, Tucha 2006). It is recommended to take into account the substance of a particular transaction for selecting a transfer pricing method (Jacobs, 2004).

1.1. Traditional Transaction Methods

[A] Characterization of the Comparable Uncontrolled Price Method

Comparable uncontrolled price method compares the price charged for property or services transferred in a dependent transaction with the price charged for property or services transferred in a comparable independent transaction in comparable circumstances. If there is any difference between the two prices, this may indicate that the conditions of the commercial and financial relations of the associated enterprise are not at arm's length, and that the price in the independent transaction may need to be substituted with the price in the dependent transaction (OECD Guidelines). All comparable factors must be evaluated, but the most important are comparabilities with regard to the comparability of products, terms of contract, economic and market condition (Feinschreiber, 2004).

[B] Characterization of the Resale Price Method

The resale price method begins with the price at which a product that has been purchased from an associated enterprise is resold to an independent enterprise. This price (the resale price) is then reduced by an appropriate gross margin on this price (the "resale price margin") representing the amount out of which the reseller would seek to cover its selling and other operating expenses and, in the light of the functions performed (taking into account assets used and risks assumed), make an appropriate profit. What is left after subtracting the gross margin can be regarded, after adjustment for other costs associated with the purchase of the product (e.g. customs duties), as an arm's length price for the original transfer of property between the associated enterprises. This method is probably most useful when applied to marketing operations (OECD Guidelines). If transactions are comparable in all facts other than products, this method determines better independent conditions than the comparable uncontrolled price method. Determination of the gross margin in short period is more precise (Jacobs, 2004).

[C] Characterization of the Cost Plus Method

The cost plus method begins with the costs incurred by the supplier of property (or services) in a dependent transaction for property transferred or services provided to an associated purchaser. An appropriate cost plus mark up is then added to this cost, to make an appropriate profit in light of the functions performed and the market conditions. What is arrived at after adding the cost plus mark up to the above costs may be regarded as an arm's length price of the original dependent transaction (OECD Guidelines).

1.2. Transactional Profit Methods

Multinational corporations undertake activities such as technology research and development, distribution, marketing with regard to intangible property. These corporations are connected horizontally and vertically, have unique structure. These business models have difficulties to find comparable data (Brem, 2006; Tucha, 2006). Type of profit method depends on the circumstances of each individual case (Nelson 2003). For the application of the profit method it is suitable to merge transactions (Verlinden 2009).

[D] Characterization of the Profit Split Method.

The transactional profit split method seeks to eliminate the effect on profits of special conditions made or imposed in an dependent transaction by determining the division of profits that independent enterprises would have expected to realize from engaging in the transaction or transactions. The transactional profit split method first identifies the profits to be split for the associated enterprise form the dependent transactions in which the associated enterprises are engaged. References to "profits" should be taken as applying equally to losses (OECD Guidelines).

[E] Characterization of the Transactional Net Margin Method.

The transactional net margin method examines the net profit related to an appropriate base (e.g. costs, sales, assets) that an associated enterprise realizes from a dependent transaction. Thus, a transactional net margin method operates in a manner similar to the cost plus and resale price methods. This similarity means that in order to be applied reliably, the transactional net margin method must be applied in a manner consistent with the manner in which the resale price or cost plus method is applied. This means in particular that the net profit indicator of the associated enterprise from the dependent transaction should ideally be established in reference to the net profit indicator that the same associated enterprise earns in comparable independent transactions (OECD Guidelines). The transactional net margin is possible to apply only after application of functional analyses. It is recommended to use only profit that is attributable to particular transactions (Kolembus 2006). It is necessary to know that net profit is connected with cross-border transactions with foreign associated enterprises (Jacobs 2004).

2. GOALS, SUBJECT AND METHODOLOGY OF RESEARCH

Tax policy and tax planning is one factor that influences Multinational Corporations' strategic and operative decisions. In order to secure business and financial relations between associated enterprises, it was necessary to determine measures for pricing transactions between associated enterprises in compliance with the arm's length principle. Such a measure is transfer pricing.

This study's target is focused on selection of the appropriate transfer pricing methods for particular transactions and determining their strengths and weaknesses. For the purposes of achieving the objective set, the authors will use primary sources of data, which have been obtained during their own primary research. The object of this research are transfer pricing methods. The subject of this research are Multinational Corporations. The authors obtained primary sources for this research directly from Multinational Corporations or through advisory companies. Questionnaires have been used as the research method.

Primary sources for the research were obtained directly from the multinational corporations, or through the advisory companies of KPMG Slovak Republic Advisory, k.s., Deloitte Tax, k.s. and from Mr. Jiří Teichmann who is registered as a tax advisor for the Czech Republic. Questionnaires used as the research method comprised of 10 closed questions, as follows:

- identification of the foreign associated enterprises' line of business who make dependent transactions;
- determination of the type of distributor in case of distribution activities (fully fledged distributors, routine distributors, commissionaire, other distributor);
- determination of the type of manufacturer in case of manufacturing activities (fully fledged manufacturer, contract manufacturer, "toll" manufacturer, other type of manufacturer);
- determination of the type of transaction (providing enterprises' line providing rights for royalties, providing services, providing credit, alienating intangible property, alienating tangible property, alienating financial property, alienating stock, other type of transactions);
- description of the foreign associated enterprises' functions that make dependent transactions;
- evaluation of comparable independent transactions;

- estabilishing which transfer pricing method was used (comparable uncontrolled price method; resale price method; cost plus method; transactional profit split method; transactional net margin method).

The primary research questionnaire was sent to 40 respondents. 34 responses were obtained, ie the result of 85%. Structure of the respondents is as follows (Figure 1):

- 7 through the Advisory Company KPMG Slovak Republic Advisory, k.s.;
- 18 through the Advisory Company Deloitte Tax, k.s.;
- 8 through Mr. Jiří Teichmann who is registered as a tax advisor for the Czech Republic;
- 1 Multinational Corporation (MNC).

3. THE RESEARCH RESULTS - MODEL FOR THE USE OF TRANSFER PRICING METHODS

From the results obtained and the theoretical and empirical analysis, we propose the most appropriate method for individual types of dependent transactions model of application, and point to their strengths and weaknesses (Table 1).

Table 1. The model for the use of transfer pricing methods

Transfer Pricing Method		Focus	The Criterion	The starting point (the starting point of calculation)	The best applied to
Comparable Uncontrolled Price Method		Tangible/intan-gible assets (the product), service	Comparable prices	The direct application of the comparable prices	All transfers, especially commodities and interest rates
Cost Plus Method		Function	Comparable gross margin to the cost	The production cost / services cost rendered by the test party	Contract Manufacturer/service provider
Resale Price Method		Function	Comparable gross margin (rabat)	Independent sales price of the independent customer test party	Routine distributor
Transactional net margin method	Model Cost plus	Function	Comparable net margin	The production cost / services cost rendered by the test party	Contract Manufacturer/service provider who does not add significant intangible assets
	Model Resale price	Function	Comparable net margin (rabat)	Independent sales price of the independent customer test party	Routine distributor
Transactional profit split method	Divide the remaining profit (residual analysis)	Function	Comparable basic profits "routine" functions ---------------------------- The residual profit allocation comparable	Independent production costs/independent sales price of the test party ---------------------------------- Operating profit (EBIT) (essentially the gross profit)	Transfers, which are present on both sides of the transfer of significant intangible assets
	Divide the total profit (contribution analysis)	Function	The comparable allocation of total profit	Operating profit (EBIT) (essentially the gross profit)	Transfers, which are present on both sides of the transfer of significant intangible assets

Source: custom processing

CONCLUSION

For the purpose of meeting the objective set, the authors presented their results obtained during primary research. The primary research was focused on the review of the methodology for the selection of the appropriate transfer of relevant transactions with the application of the arm's length principle. The object of the research were transfer pricing methods and the subject of the research were Multinational Corporations or their parts. According to the theoretical analysis of the primary sources for the research, the authors have identified the strengths and weaknesses of individual methods and suggested their use of transfer pricing methods[25].

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WOOD MANAGEMENT VERSUS ENERGY GENERATION IN THE SAWMILLING INDUSTRY IN POLAND – IN THE LIGHT OF A SURVEY

Abstract: This article presents the results of research concerning the sawmilling industry as the main consumer of wood raw material and at the same time a source of the largest amounts of wood by-products, which are both raw material and energy carrier. The research was conducted in the form of a survey, the aim of which was to broaden knowledge of the sources and the type structure of wood by-products created in the sawmilling industry, as well as of various aspects of their use for energy purposes in economic practice.

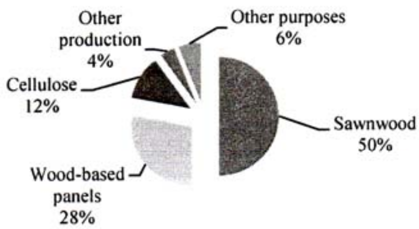
Keywords: sawmilling industry, wood by-products, wood biomass, survey.

INTRODUCTION

Wood is a raw material that is basic for the wood sector operation. At the same time it is one of the oldest energy carriers and currently it also shapes, more and more, the energy market. This is the background for dilemmas connected with the rationale behind the use of wood for production purposes or for energy purposes. The latter becomes more and more important at a global scale. In both these areas the development potential of the wood sector, including the sawmilling industry which is the main consumer of wood, should be examined as an important link in the Polish economy and a player in the international market.

THE SAWMILLING INDUSTRY AS THE MAIN CONSUMER OF WOOD RAW MATERIAL

The sawmilling industry is of special importance for the wood sector, due to it is place between forestry with its wood resources and the industries producing finished wood goods (high value-added products). Sawmills are the first link in the conversion of roundwood to sawnwood, which after further processing has various applications in other wood industries or economic areas. At the same time, sawmills consume half of the harvested wood raw material suitable for industrial processing (Figure 1).



Source: E. Ratajczak, W. Cichy, Wood versus energy generation, a paper presented at the session of PAN Wood Technology Committee, Warsaw April 2012

Figure 1. An approximate structure of wood consumption in Poland in 2010

The sawmilling industry is also a place where the largest amount of wood by-products in the wood sector is created. It is estimated that more than 60% of total amount of wood by-products created in the whole wood sector comes from the sawmilling industry[27]. These by-products include

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27 *A. Szostak, E. Ratajczak, The market in industrial wood waste in Poland, Wood. Research papers. Reports. Announcements, Wood Technology Institute Publication, Poznan 2004, no. 172, p. 78-79.*

pieces of wood of different sizes, sawdust and chips, as well as bark which may be used for both production and energy purposes. Hence, in wood management the sawmilling industry plays the role of both an industrial wood source and a source of energy carrier. The own research of the authors shows that wood by-products created in this industry are utilised to a great extent. It is estimated that 60% of these by-products is used for industrial purposes, 37% for energy purposes (while 40% is used to satisfy the company's own needs), and approximately 3% is used for other purposes, including use in „non-wood" processing industries (e.g. tannin industry, metal industry, food industry) or in economic areas such as agriculture and horticulture.

GREEN ENERGY VERSUS WOOD BIOMASS

Due to civilizational development of virtually every economy and an increase in demand for energy which is connected with this, and also due to the necessity of protecting the environment, wood biomass is considered an important source of renewable energy. However, the economic policy of Poland assumes that consumption of wood for energy purposes should not cause its shortages for industrial purposes[28.] In the Polish conditions biomass accounts for more than 85%[29] of total production of renewable energy, and most of this biomass comes from wood[30.] The sources of wood biomass are the following economic areas: forestry, industries of the wood sector (wood industry – PKD 16, furniture industry – PKD 31, pulp and paper industry – PKD 17), municipal utility management, and agriculture. The volumes of wood biomass supply and consumption are difficult to determine and generally information from this area is approximate/estimated.

The latest research carried out in the Wood Technology Institute in Poznan[31] indicates that forestry and the wood sector are the areas which may deliver the largest amounts of wood biomass for energy purposes. In total 75% of this energy carrier may come from these areas. It is estimated that wood biomass for energy purposes originating from these two economic sectors accounts for over 32% of harvested roundwood. In the wood sector the sawmilling industry delivers the highest amounts of wood biomass in the form of wood by-products, which may be used for energy purposes. It is estimated that it is more than 44% of their total supply for energy purposes from the wood sector.

It is worth adding that, according to estimates, in the European Union states in 2010 approximately 350 M m3 of available wood biomass was used for energy purposes, which equalled 43% of total amount of wood raw material consumed for various purposes[32].

Generalising, it should be said that the wood sector plays an important role in the process of increasing the share of solid biomass within different renewable energy sources. However, in the future in order to use wood biomass more effectively than as an energy carrier and also to protect forests, it should be superseded by other renewable energy carriers such as sun, wind and water (and this concerns especially biomass originating from forests).

28Directive of the European Parliament and the Council 2009/28/EC of 23rd April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC was taken into consideration in the Polish legislation: Act of 8th January 2010 on the amendment of the Energy Act and amendment of some other acts (JoL 2010, No. 21, item 104); A strategy of renewable power industry development, Ministry of the Environment, Warsaw 2000 (adopted by the Sejm on 23.08.2001); The energy policy of Poland by 2030, Ministry of Economy, Warsaw 2009 (a document adopted by the Council of Ministers on 10.11.2009).

29Data of 2010. Environment 2011, GUS, Warsaw 2011, p. 224.

30R. Gajewski, Biomass – the basis of green energy, Polish Energy 2010, no. 7.

31E. Ratajczak, A. Szostak, G. Bidzińska, M. Herbeć, "An analysis of the market in wood biomass for energy purposes in Poland. Phase 2. Potential supply of wood biomass for energy purposes and forecasted demand for energy carriers from wood biomass in Poland by 2015", Wood Technology Institute, Poznan 2011; A. Szostak, E. Ratajczak, M. Herbeć, G. Bidzińska, Potential supply of wood biomass for energy purposes in Poland by 2015, Biomass & Bioenergy 2012 (publication pending).

[32]The amount of available wood biomass means that it includes round fuelwood, wood by-products, and post-consumer wood. U. Mantau, Wood Resource Balance results – is there enough wood for Europe?. W: Final report. Real potential for changes in growth and use of EU forests, EUwood, Hamburg/Germany 2010, June, http;//ec.europe.eu.

CONSUMPTION OF WOOD BY-PRODUCTS FROM THE SAWMILLING INDUSTRY FOR ENERGY PURPOSES – A SURVEY

Research method

As mentioned, currently wood as a renewable energy carrier is, to a greater and greater extent, shaping the energy market. Although wood has been used as fuel for a long time, the market in wood biomass for energy purposes is only emerging as a mature economic category. All analyses of this market are very difficult, mainly due to large diversification and dispersion of producers and consumers of wood biomass and lack of information on this market. The third reason is lack of methodological studies which would enable determination of supply of and demand for wood biomass as an energy carrier. Sporadic and fragmentary information most often concerns only some types of biomass, and moreover, this information is different in volumes and hard to verify.

Taking this into consideration, since April till mid May 2011 in the Wood Technology Institute research on selected aspects of the market in wood biomass for energy purposes was carried out. An important element of this research was a survey[33]. The research encompassed creators of the market in wood biomass for energy purposes in Poland, including one of its major players – the sawmilling industry.

The aim of the survey, which also encompassed the sawmilling industry, was to broaden knowledge of the sources and the structure of wood biomass created in the form of wood by-products, as well as of various aspects of its use for energy purposes in economic practice. The obtained results were to become a basis for verification of information on the type structure of by-products (waste) created in the sawmilling industry and on indices of raw material and material productivity in subsequent phases of wood processing, as well as to enable possibility of assessment of accessibility of this type of wood biomass (delivery radius) and purchase/sale conditions.

The survey was targeted at sawmilling companies which operate across Poland. The main criterion of sample selection was the causal nexus between business entities and utilisation of wood biomass for energy purposes. The respondents were not chosen randomly, but purposefully and proportionally, where the criterion was significance of the respondents for the survey's goal.

The survey based on a specially prepared, anonymous questionnaire, which was sent out to 152 sawmilling companies. The final number of responses was 30, meaning that the return rate was 20%.

Research results

The surveyed sawmilling companies consumed approximately 51 thou. m^3 of wood raw material on average, of which 96% was coniferous wood raw material. The dominant type of sawn raw material was large-size wood for general purposes, which accounted for 84% of the production structure, the other 16% consisted of medium-size long poles (10%) and raw material for industrial processing (6%). Most companies anticipated an increase, on average by more than half as much, in consumption of large-size raw material by 2015. Interestingly, the respondents from small sawmills planned for higher dynamics of wood raw material consumption. In some cases the increase is to be even six times as much. Much discrepancy between opinions was observed in the case of medium-size raw material. The respondents indicated that its consumption may decrease by 6% as well as increase almost three times.

The structure of production of the surveyed companies was dominated by sawnwood (55%). Wooden garden products and structural and glued elements had a considerable share within other products (10%, approx. 4%, and approx. 4%, respectively). At the same time, the respondents declared that in 2010 productivity index for both coniferous and deciduous raw material was at a similar level of 60%.

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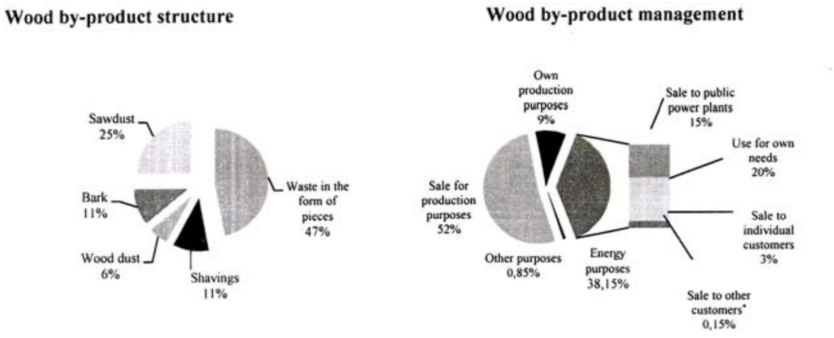
33 E. Ratajczak, A. Szostak, G. Bidzińska, M. Herbeć, An analysis…, op. cit.; E. Ratajczak, A. Szostak, G. Bidzińska, M. Herbeć, Demand for wood biomass for energy purposes in Poland by 2015, Wood. Research papers. Reports. Announcements, 2012, no. 187, p. 51-63; A. Szostak, E. Ratajczak, M. Herbeć, G. Bidzińska, Potential supply, op.cit.

In the production process the surveyed sawmilling companies created from 27% to 70% of wood by-products from sawn wood raw material. Waste in the form of pieces (47%) and sawdust (25%) made up the greatest share, while bark (11%), shavings (11%) and wood dust (6%) accounted for smaller amounts – figure 2.

The analysed companies use most of wood by-products (i.e. 61%) for production purposes (approximately 52% was sold for production purposes, and 9% was intended for the company's own production purposes). The other 38% of wood by-products was used for energy purposes, of which 20% was used to satisfy the company's own needs, and 15% was sold to public power plants (Figure 2).



* municipal utility management units and public units

Source: E. Ratajczak, A. Szostak, G. Bidzińska, M. Herbeć, *An analysis of the market in wood biomass for energy purposes in Poland. Phase 2. Potential supply of wood biomass for energy purposes and forecasted demand for energy carriers from wood biomass in Poland by 2015*, typescript, Wood Technology Institute, Poznan 2011.

Figure 2. The structure and management of wood by-products in the surveyed entities of the sawmilling industry in 2010

Almost all the respondents declared consumption of energy from wood by-products within their own heat systems, other companies pointed to their own electric systems. Most of the respondents (85%) thought that energy generated from wood by-products satisfies the company's own needs.

Almost 70% of the surveyed companies sold wood by-products on the basis of medium-term contracts (i.e. from 1 year to 3 years) which accounted for 37%, but also based on short-term contracts (i.e. shorter than 1 year) which accounted for 17%. Although the sawmilling industry is characterised by much dispersion of producers, the research reveals that the distance between purchasers of wood by-products and sawmills had no significant bearing on purchase decisions. This fact was confirmed by the structure of wood by-product consumers according to the criterion of distance between their seats and sawmills:

- 37% of the respondents declared that wood by-products from sawmills were purchased by business entities located within 100 km to 250 km from sawmills,
- 20% of the respondents declared that the distance was from 50 km to 100 km,
- 17% of the respondents declared that the distance was up to 50 km from sawmills,
- 6% of the respondents declared that the distance was up to 25 km.

CONCLUSIONS

The sawmilling industry supplies many areas of economy with necessary wood materials and products and, at the same time, it creates considerable amounts of wood by-products, which may be both a whole raw material for other industries within the wood sector and energy carrier. The management of wood by-products is an important area of sawmilling companies' operation. It is characteristic of this industry that wood by-products are created systematically and at a mass scale. Their type and basic properties are determined by the kind of conversion process in which they are created. On the other hand, degree of their diversity is defined by used techniques and technologies and the organization of the production process. The volume of wood by-product supply by the sawmilling industry depends mainly on the scale of raw material processing, while demand is determined by specific conditions in particular economic areas. The carried out research shows that the whole volume of wood by-products created in the surveyed sawmilling companies is utilised. The priority is to use these by-products for production purposes, especially outside the company in which they are created. As to energy use of wood by-products – the dominant model here is their use for the company's own energy needs.

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The article is based on a research project entitled "An analysis of the market in wood biomass for energy purposes in Poland. Phase 2. Potential supply of wood biomass for energy purposes and forecasted demand for energy carriers from wood biomass in Poland by 2015" carried out in the Wood Industry Economics Department of the Wood technology Institute in Poznań in 2011.

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FACTORY PRODUCTION CONTROL (PROCESS, INTERPROCESS, POSTPROCESS CONTROL) OF WOOD-BASED PANELS ACCORDING TO STANDARD EN 326-2

Abstract: Quality is becoming a critical factor for business success. To ensure quality, companies introduced the so-called factory production control, which allows for deciding whether products meet the required quality parameters. In the manufacturing of large-scale wood-based materials quality control is regulated by the European standard EN 326-2: 2010, wood-based panels, sampling, cutting and inspection. The objective of the paper is to present recommended procedures for identifying the characteristics of the sample, the determination of confidence limits and defining the way of deciding whether the products conform with the requirements and how to proceed if the products do not meet the requirements. Factory production control allows for continuous analysis of the production process and evaluation of the effectiveness of changes introduced to the manufacturing thereof.

Key words: statistical quality control, wood-based materials, characteristics of a sample, confidence limits

INTRODUCTION

Statistical methods for quality control are one of the most important assumptions of productive quality management and effective product and technology innovations (Šatanová, 2007).

Product quality has become for manufacturers a critical factor in establishing a good position among international competition. For that reason, enterprises are ever more and more focused on the properties of their production. To achieve the required quality parameters of wood-based panels in the European Union, the Standard EN 326-2: 2010, Wood-based panels, sampling, cutting and inspection was published by the European Committee for Standardization. The monitored parameters may include different qualitative and quantitative properties (Holíková, Sedliačiková, 2005).

Wood-based panels are defined as materials which consist of combined small particles of wood, bonded together with an adhesive. A specific place within the wood-based materials range is that of plywood: consisting of an assembly of plies, joined together with a direction of the grain in alternate plies usually at particular angles (Sedliačiková 2007).

The mentioned standard deals with the initial type of testing and factory production control in enterprises focused on production of wood-based panels.

The article deals with proceedings in determining of the number of testing pieces, statistical parameters, confidence limits in the application of factory production control and, finally, deciding about the compliance of the whole batch.

MATERIALS AND METHODS

Factory production control can be executed by the use of two types of tests. The first is the factory production control by variables, when the subjects of assessment are measured values of key characteristics of product quality. The second category of test is factory production control by attributes, which refers to the conformity of products in a given sample. Given the number of non-conforming units is decided whether the quality meets the requirements or not. For brevity, we will focus only on the factory production control by variables.

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SAMPLING AND CUTTING OF TEST PIECES

The minimum number of test specimens m shall be cut from each panel as given either in EN 326-1 Wood-based panels, sampling, cutting and inspection, or in other standards with relevant test methods. The fact which test methods will be used has been determined in advance.

Table 1. Size of the sample n in relation to the inspection lot N_{attr}

Size of the inspection lot N_{attr}	Sample size n		
	Single sampling	Double sampling	
	$n_{attr,si}$	${}_1n_{attr,si}$	${}_2n_{attr,si}$
<500	20	13	13
from 501 to 1 200	32	20	20
from 1 201 to 3 200	50	32	32
from 3 201 to 10 000	80	50	50
NOTE: These sample sizes for the inspection by attributes correspond to a normal inspection of level I according to ISO 2859-1:1989			

STATISTICAL CHARACTERISTICS FOR THE SAMPLE

For each property of product the panel mean $\bar{x}_j$ of the m test values x_{ij} obtained from each individual panel shall be calculated and recorded according to the equation:

$$\bar{x}_j = \frac{\sum_{i=1}^{i=m} x_{ij}}{m} \quad [1]$$

and the standard deviation within a panel $s_{w,j}$ according to the equation:

$$s_{w,j} = \sqrt{\frac{\sum_{i=1}^{i=m}(x_{ij} - \bar{x}_j)^2}{m-1}} \quad [2]$$

In factory production control it is necessary to calculate and record, for each type of product, these characteristics:

a) the rolling grand mean $\bar{\bar{x}}_{30}$ of the last 30 panel means according to:

$$\bar{\bar{x}}_{30} = \frac{\sum_{j=1}^{j=30} \bar{x}_j}{30} \quad [3]$$

b) the rolling standard deviation $s_{\bar{x},30}$ between the last 30 panel means according to equation:

$$\bar{s}_{w,30} = \sqrt{\frac{\sum_{j=1}^{j=30}(\bar{x}_j - \bar{\bar{x}}_{30})^2}{29}} \quad [4]$$

c) the rolling standard deviation $\bar{s}_{w,30}$ within the last 30 panels according to equation:

$$\bar{s}_{w,30} = \sqrt{\frac{\sum_{j=1}^{j=30} s_{w,j}^2}{30}} \quad [5]$$

$s_{w,j}$ - Estimate of the standard deviation of a characteristic within a panel j of the sample

For assessing compliance of a product by variables the following methods shall be used:

- factory production control by variables,
- internal records of an established product.

FACTORY PRODUCTION CONTROL BY VARIABLES

To establish the conformity of the panels with the requirements estimates shall be calculated of the lower ${}_1L_x$ or upper ${}_1U_x$ confidence limit respectively, for the last production period for which the last panel sampled is considered to be representative, according to the following equations:

$$ {}_1L_x = \bar{x}_1 - \frac{t_m \times \bar{s}_w}{\sqrt{m}} \qquad [6]$$

$$ {}_1U_x = \bar{x}_1 + \frac{t_m \times \bar{s}_w}{\sqrt{m}} \qquad [7]$$

Table 2. Single sided t – values for different sample sizes m a n

Number of test pieces m or of panels n, respectively	4	5	6	8	10	12	16	18	30
t_m or t_n respectively	2,35	2,13	2,02	1,89	1,83	1,80	1,75	1,74	1,70
NOTE: The table values correspond to a 95 % confidence limit, single-sided case, in accordance with ISO 2602:1980.									

The standard deviation within panels $\bar{s}_w$ shall be taken from either the rolling mean standard deviation within panels $\bar{s}_{w,30}$ or the mean standard deviation within panels of the initial type testing $\bar{s}_{w,ITT}$:

$$\bar{s}_{w,ITT} = \sqrt{\frac{\sum_{j=1}^{j=n_{ITT}} s^2_{w,ITT,j}}{n_{ITT}}} \qquad [8]$$

n - Sample size (number of panels)

ITT - Test results related to initial type testing

- or the mean standard deviation within the last n representative panels tested according to

$$\bar{s}_{w,n} = \sqrt{\frac{\sum_{j=1}^{j=n} s^2_{w,j}}{n}} \qquad [9]$$

Only if none of these mean standard deviation within panels s_w are available, the standard deviation within the last panel sampled (panel 1) $s_{w,1}$ shall be used in equations [6] and [7] respectively, by calculating according to the equation:

$$\bar{s}_{w,1} = \sqrt{\frac{\sum_{i=1}^{i=m} (x_{i1} - \bar{x}_1)^2}{m}} \qquad [10]$$

The t-values in relation to the number of test pieces m are given in Table 2.

If ${}_1L_x$ is equal to or greater than the lower specification limit L, or if ${}_1U_x$ is equal to or less than the upper specification limit U respectively, the panel characteristics shall be considered to be in conformity with the requirements.

If the single panel sampled does not meet the requirements, one or two more panels shall be tested. In this case the grand mean values $x_{1,2}$ or $x_{1,2,3}$ respectively, shall be calculated according to equations [11] and [12]:

$$\bar{\bar{x}}_{1,2} = \frac{\bar{x}_1 + \bar{x}_2}{2} \qquad [11]$$

$$\bar{\bar{x}}_{1,2,3} = \frac{\bar{x}_1 + \bar{x}_2 + \bar{x}_3}{3} \qquad [12]$$

Estimates of the lower (${}_{1,2}L_x$ and ${}_{1,2,3}L_x$) and upper (${}_{1,2}U_x$ and ${}_{1,2,3}U_x$) confidence limit respectively, shall be calculated according to equations [13] to [16], respectively:

$$ {}_{1,2}L_x = \bar{\bar{x}}_{1,2} - \frac{t_m \times \bar{s}_w}{\sqrt{m}} \qquad [13] $$

$$ {}_{1,2}U_x = \bar{\bar{x}}_{1,2} + \frac{t_m \times \bar{s}_w}{\sqrt{m}} \qquad [14] $$

$$ {}_{1,2,3}L_x = \bar{\bar{x}}_{1,2,3} - \frac{t_m \times \bar{s}_w}{\sqrt{m}} \qquad [15] $$

$$ {}_{1,2,3}U_x = \bar{\bar{x}}_{1,2,3} - \frac{t_m \times \bar{s}_w}{\sqrt{m}} \qquad [16] $$

In case where only the standard deviation within panel $\bar{s}_{w,j}$ of the three panels sampled is available, the mean standard deviation within panels $\bar{s}_w$ shall be calculated according to the equations:

$$ \bar{s}_{w,1,2} = \sqrt{\frac{s_{w,1}^2 + s_{w,2}^2}{2}} \qquad [17] $$

$$ \bar{s}_{w,1,2,3} = \sqrt{\frac{s_{w,1}^2 + s_{w,2}^2 + s_{w,3}^2}{3}} \qquad [18] $$

If the requirements are not met, the panels of the respective production period shall be down-graded.

INTERNAL RECORDS OF AN ESTABLISHED PRODUCT

The history of an established product type under inspection shall be given by recording the test results of factory production control on a continuous basis by using control charts, e.g. Shewhart control charts as given in ISO 8258.

For an established product the compliance of the panels of the last 30 production periods shall be considered confirmed for each characteristic listed in the EN specification if:

- the lower 5 percentile limit L5% of the control charts is equal to or greater than the lower specification limit according to:

  $$ L_{5\%} = \bar{\bar{x}}_{30} - 1.70 \times s_{\bar{x}_{j,30}} \qquad [19] \text{ or} $$

- the higher 95-percentile limit U95% of the control charts is equal to or smaller than the upper specification limit according to equation:

  $$ U_{95\%} = \bar{\bar{x}}_{30} + 1.70 \times s_{\bar{x}_{j,30}} \qquad [20] $$

The specification requirement of the lower 5 % value or the upper 95 % value respectively, shall be considered also fulfilled, if all single 30 mean values j x are greater than the lower specification limit L or less than the upper specification limit U respectively.

RESULTS AND DISCUSSION

Factory production control is an analytical decision making tool which allows for establishing when a process is working correctly and when it is not. Variation is present in any process, deciding when the variation is natural and when it needs correction is the key to quality control. The mentioned methods show if a process is in control or out of control. They show the variance of the output of a process over time, such as measurement of width, length or temperature. They compare this variance against upper and lower limits to see if it fits within the expected, specific, predictable and normal variation levels. If so, the process is considered in control and the variance between measurements is considered normal random variation that is inherent in the process. If, however, the variance falls outside the limits, or has a run of non-natural points, the process is considered out of control. If a process is out of control, the next step is to look for the causes behind the process output and to look for the out-of-control factor (Hart, 2007).

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TARGET COSTING APPLIED IN COSTING OF FURNITURE PRODUCTS

Abstract: The paper presents potential application of target costing in furniture manufacturing enterprises. Market and production conditions found in the furniture industry have been discussed. An example has been presented for the application of the target costing method in production costing for a set of office furniture. Advantages of applying target costing were indicated for companies.

Keys words: target costing, target price, the profit target, furniture industry, furniture

INTRODUTCION

In the period of predominance of mass-scale production in the 1950's - 1960's prices for consumer goods were most frequently established on the basis of the sum of incurred costs and calculated profit as a particular percentage of these costs (the costs-plus formula). In the course of time market conditions changed. These changes were manifested in the increasing competition and growing requirements concerning the degree of product adaptation to customer preferences. These factors resulted in the need to reduce manufacturing costs of products already at the stage of their design. In the 1960's at Toyota Motor Corporation, a Japanese car manufacturer, a novel costing method was developed, referred to as target costing or target cost management (Japanese genka kikaku) [Masztalerz 2006]. In the 1990's the new calculation method gained considerable acclaim and found numerous applications in American and German enterprises. Companies which implemented target costing proved economically successful [Monden i Hamada 1991, Horvath et al. 1993, Robinson 2000, Ansari and Bell 2009, Rains 2010].

The aim of this article is to present application potential for target costing in costing and calculation of prices for new furniture products, launched on the market or modified (redesigned). At present small-batch and medium-batch production predominate in enterprises manufacturing furniture. The offered range of products is characterised by considerable diversity and is provided in different finish variants. In terms of their design such furniture is manufactured in different colour variants, using different finishing materials and equipped with various hardware variants.

In most cases furniture is manufactured in many functional variants, which means that it may be classified as MIX type products. Strong competition between producers makes it necessary to frequently change the offered range of products and enforces the need to become customer-oriented. Such production and market conditions are factors justifying the application of costing based on target costs.

1. PRINCIPLES OF TARGET COSTING

The paper presents principles of target costing, in which target costs refer to the 'into' and 'out of' company versions, also referred to as the total costs method. Within this method four basic stages are distinguished in the realization of the target costing procedure [Jaruga et al. 2001, Świderska 2003]:

1. Determination of the target price – based on marketing analyses the most advantageous price is searched for, which will be possible to attain in the selected segment of the market for a product with a specific set of functions.
2. Adoption of the expected (target) profit/margin for a product – margin is a unit profit obtained from the sale of a product. It may be expressed as an amount or as a percentage. Margin in the amount form is the difference between sale price and manufacturing costs of the product. The percentage margin is a quotient of the amount margin and the sale price or manufacturing cost of

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the product. If the sale price was used in the denominator of the percentage margin , then the quotient is called the return on sales index (ROS). Most frequently margin is assumed to be the mean value, obtained in an enterprise or in a given sector, to which the product belongs.

3. Determination of target costs – the difference between target price and target amount margin constitutes allowable cost. The maximum allowable level of manufacturing costs for the analysed product is established. Allowable cost is equal to the target cost, which needs to be reached, reducing planned or current costs.
4. Reduction of planned (or current) manufacturing costs - if the predicted (planned) manufacturing costs of the designed product are greater than the established target costs, a manufacturing cost analysis is performed in order to reduce them to the level of target costs. In case such a reduction of costs does not provide the expected effect, the product is not introduced on the market.

Figure 1 presents the structure of the planned price (initial status) and target price (final status). The planned (initial, current) price may be determined according to the classical costing principles, e.g. using the costs-plus formula. It constitutes a reference point in further stages of the process.

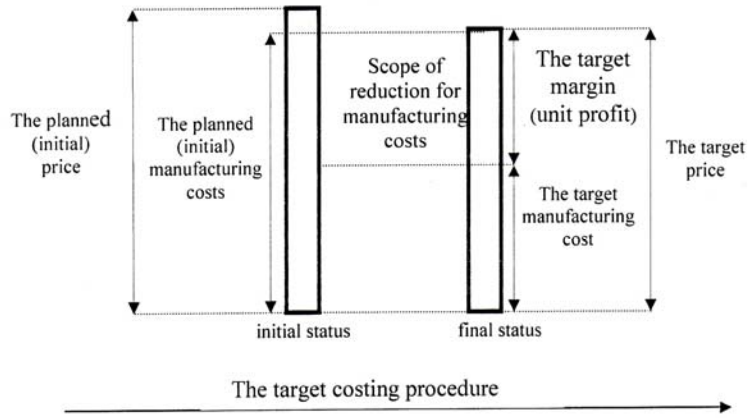

Fig. 1. Structure of planned (initial) and target price according to target costing
Source: own study.

In the target costing procedure the planned price is replaced by the target price. Typically the planned price is greater than the target price. A key stage in target costing is to reduce manufacturing costs of a product. A positive result of the procedure in this respect leads to the generation of the assumed profit (margin) for the product. The price of the product is accepted by consumers and is competitive in relation to those of similar products offered by other manufacturers. Such a product may be successful on the market.

The established level of target costs should be maintained throughout the entire life cycle of the product. For certain categories of unit costs of the product actions are undertaken aiming at a reduction of other types of costs. Higher costs may not be compensated for by a higher price or a reduction of unit profit. An increase in price is justified only in case of an enhanced utility of the product, found acceptable by consumers [Nowak et al. 2004].

On the basis of analyses conducted using the Quality Function Deployment method we may distinguish functions and weights of customer expectations. The method makes it possible to transfer the degree of significance of needs and expectations (conscious and unconscious) of potential buyers onto quality and technical parameters of the product and on the technological possibilities of its manufacture in the enterprise. Next a list is compiled including the most important components (subassemblies, assemblies) of the product. For selected components the degree of function realisation is determined and respective portions of target costs are allocated. The division of target costs is most frequently performed using the function method [Wierzbiński 2001].

In the function method types of functions performed by the product are specified. Functions are characteristics or actions of the product, which meet the needs of its buyers. The importance of a function is expressed in the percentages of the benefits, which a product provides for the customer in the form of utility value. Information on the above is obtained from customers based on survey studies. Functions are connected with components, which are their carriers. Each component is allocated a portion of the target cost of the product. Established target costs are compared with planned (current) costs in order to determine the range of their reduction to the level of target costs.

2. EXAMPLE OF TARGET COSTING APPLICATION

The manner of target costing calculations is presented based on the example of a set of office furniture. As a result of market analyses it was established that there is a demand for a set of multi-function office furniture. A set of furniture called "Manager" was designed. The set is composed of a large conference table, a small conference table, a double desk and a computer desk. All desktops were made from a board of 28 mm in thickness and have rounded edges. The narrow surfaces were finished with a 0.5mm PCV margin identical in colour as the desktops. Tabletops and desktops have cable grommets of 60 mm in diameter. Table frames were made from steel closed sections rectangular in cross-section with height-adjusting flanges. Furniture items were finished with artificial imitation wood wear-resistant veneer. The set may be manufactured in one of four wood colours. Furniture is prepared for self-assembly.

On the basis of expectations of potential buyers the marketing department established that the target price for the Manager set should be PLN 2 500 and will be considered acceptable. The analysis was performed by comparing two designs of sets with similar functions and differing in price. The financial department in cooperation with the manufacturing department established that the planned (current) unit manufacturing cost under current production conditions will be PLN 2 200. It was estimated that the potential annual volume of sales may be five thousand designed sets on the foreign and domestic markets. The enterprise expects 15% return on investment (ROI). The target costs for the analysed set of office furniture were estimated on the basis of data collected by the marketing department. Results of calculations are presented in Table 1.

Based on market analyses four key functions of the set of office furniture significant for potential customers were identified, i.e. utility characteristics (F1), esthetic value (F2), user-friendly operation (F3) and safety (F4). Functions are values of the product from the point of view of the customer, i.e. benefits, which are provided for the customer and for which the customer is willing to pay.

Table 1. Determination of target cost of a set of office furniture

Type size	The results of calculation
Target price set [zł]	2 500
Annual volume of sales for the set [pc]	5 000
Estimated annual revenue from the sale set [zł]	12 500 000
Target (expected annual profit margin [zł]	1 875 000
The annual cost of production target set [zł]	10 625 000
The unit cost of the target set [zł]	2 125
The target unit profitmargin [zł]	375
Planned (current) unit production costs [zł]	2 200
Required reduction of planned cost to the target valuej [zł]	75

Source: own study.

Table 2 presents weights of importance for each function, determined on the basis of evaluations made by potential customers. Using weights of importance the unit target cost (PLN 2 125) was divided for individual functions.

Table 2. Weights of importance for the functions of the set of office furniture

Type of function	F1	F2	F3	F4
Weight of importance of function [%]	40	30	20	10
Target cost function [zł]	850	637,5	425	212,5

Source: own study.

The most important function for the set of office furniture, according to the declarations made by potential customers, is the function forming a set of utility characteristics. Its importance was evaluated at 40% in comparison to the other functions of the product. On this basis this function was allocated a cost of PLN 850. The product safety function was evaluated the lowest and it was ascribed the weight of 10% and allocated the target cost function at PLN 212.5.

The design department identified four basic components of the analysed set of office furniture Manager. They are single furniture items comprising the set: a large conference table (S1), a small conference table (S2), a computer desk (S3) and a double desk (S4). On the basis of a questionnaire survey the degree, to which individual functions are realised, was determined for each indicated component. The degree of function realisation by a given component of the set is presented in Table 3.

Table 3. Degrees of function realisation by components of the office furniture set [%]

Component of the kit	Functions of office furniture set			
	F1	F2	F3	F4
S1	20	40	10	10
S2	15	30	10	10
S3	30	10	40	40
S4	35	20	40	40
Total	100	100	100	100

Source: own study.

Esthetic function (F2) is associated the strongest (40%) with the large conference table (S1) and it is associated the least (10%) with the computer desk (S3). In turn, the user-friendly operation function (F3) is predominant for the computer desk (S3) and desks (S4), with 40% each.

Unit target costs of individual components of the analysed set of office furniture are determined on the basis of the quotient of the degree of function realisation by a given component (tab. 3) and the target cost of the function (tab. 2). Mathematically it is a product of the matrix by a column vector. Data contained in Tables 3 and 2, written in the form of a matrix and a vector, respectively, take the following form:#

$$\begin{bmatrix} 0{,}20 & 0{,}40 & 0{,}10 & 0{,}10 \\ 0{,}15 & 0{,}30 & 0{,}10 & 0{,}10 \\ 0{,}30 & 0{,}10 & 0{,}40 & 0{,}40 \\ 0{,}35 & 0{,}20 & 0{,}40 & 0{,}40 \end{bmatrix} \times \begin{bmatrix} 850{,}0 \\ 637{,}5 \\ 425{,}0 \\ 212{,}5 \end{bmatrix}.$$

Results of calculations made following the principles of a matrix calculus, are presented in Table 4.

Table 4. Unit target costs of components of the office furniture set

Component set	S1	S2	S3	S4
The unit cost of the component target	488,75	382,50	573,75	680,00

Source: own study.

For the first row of the matrix and the column vector, containing function costs, calculations take the form: 0.20*850 = 170; 0.40*637.5 = 255; 0.1*425 = 42.5; 0.1*212.5 = 21.25. After summing the products we receive the target cost of 488.75 złotys/item for component S1, i.e. the large conference table. An analogous procedure is applied in relation to the other components of the office furniture set.

Reaching target costs established in Table 4 for individual components of the product requires the application of methods assisting target costing. Value engineering is used most frequently for this purpose. This method consists in the search for new, more advantageous structural, material, technological, technical and organisational solutions, which would reduce manufacturing costs to the target level, while maintaining assumed functional and quality requirements [Value management Guidelines 2005]. Value engineering originates from value analysis and it was developed in the 1960's. It is a systematised approach, which key stage is connected with the indication and analysis of cheaper, alternative methods to meet the functions of the product, expected by customers.

CONCLUSIONS

Furniture manufacturing companies operate within a strongly competitive environment. Their products are frequently altered and modified, and they have relatively short life cycles. Under such conditions launching new furniture products on the market is burdened with considerable risk. Such a risk may be reduced as a result of the application of target costing. Its application will provide furniture found acceptable by customers and bringing expected profit to their manufacturers. The use of target costing increases the probability of market success for the launched range of products. The key advantages of target costing include customer orientation of the enterprise and minimization of these actions, which do not increase added value.

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MAPPING AND MODELING OF INTERNAL BUSINESS PROCESSES

Abstract: Business process mapping refers to activities involved in defining exactly what a business entity does, who is responsible, to what standard a process should be completed and how the success of a business process can be determined. Once this is done, there can be no uncertainty as to the requirements of every internal business process. A business process illustration is produced. The first step in gaining control over an organization is to know and understand the basic processes.

Keywords: business process, modeling, mapping, methods.

INTRODUCTION

Business process is a logically and sequentially ordered set of transformations, which have a common goal (technical operations management activities, process steps, other activities) where the output of the previous transformation is entered into the next transformation. The input signal is a customer need, it triggers a sequence of activities, which according to given rules use or consume business resources and finally create a product or service - which in turn satisfies the initial output of customer needs. Simply we can say that any business process consists of inputs, outputs and activities. It has a defined beginning and end and can be decomposed into sub-processes and activities.

Figure 1. Scheme of production process

Action is the smallest unit of work within the process used in the analysis. The boundary between process and activity is either not defined or defined [4].

Basically the following correspondences can be drawn [2]:

- the management process: planning, controlling, human resources management
- the key processes: creating the product
- and the support processes: creating the conditions for running core processes.

THE CATEGORIZATION OF BUSINESS PROCESSES

Business process can be understood as a set of activities that require one or more input and output forms, and one which represents great value for the customer. The processes are of well understood purpose, always in connection to the customer. Business processes are processed from input to output, regardless of the operation [3].

During their implementation is continuously analyzed. The result of an analysis of business processes is a business process map (Figure 2).

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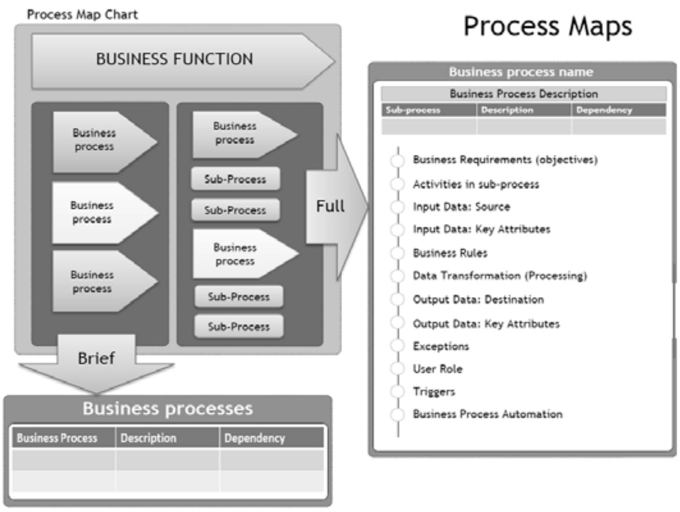

Figure 2. Map of business processes

The company, which operates in a business environment, integratess business processes, adapting them to the following requirements:

- for business owners,
- for customers,
- and for the environment,

Business activities are divided into [1]:

- main (direct) processes, described as main business activities, directly traceable to meet customer needs. They constitute an important and significant part of the "value" of the final product or service and therefore the quality and performance of the enterprise,
- support (house) processes that support the basic processes occurring within the company. The processes involved in management activities within the company, whether as personnel management, recruitment, coordination of material flows, production supplies, inventory, invoicing, issuing orders, but also coordinating the transition process itself and all its business activities and ensuring its smooth running,
- demarcation and valuation processes at this stage of the processing resources required to implement the process, and then run the following resources for further business processes.

Production process is a process into which inputs are entered in a form of direct physical character, such as material, machines, people, or in an indirect form of non-physical inputs, such as software and know-how. This way outputs are created - products that meet the needs of end users, i.e. consumers.

The production process, in terms of technology, can be used to distinguish the following phases [8]:

- phase before production - which includes the production and preparation of intermediates
- production phase - includes the production in mechanical workshops
- after production phase - includes offering fitting advice, testing and surface treatment.

MODELING OF A PRODUCTION (TRANSFORMATION) PROCESS

The basic elements of every modeling of a business process are: process, activity, initiative and linkages - continuity. The process is always modeled as a follow-up structure. The principle that applies here is that each action can be described as a separate process. Traceability is described by means of links. Ties are defined by different types of organization of activities in the process of succession, and combinations thereof [2].

The modeling process and its tools fall into three main categories [1]:

- tools for representation of flow - this is a drawing tool, which is the lowest level of the process and helps to describe the devolution process of verbal descriptions to graphic symbols,
- CASE tools - provide a conceptual framework for modeling the process hierarchy and their description; usually applied for linear, deterministic and statistical analysis,
- simulation tools - provide a deeper dynamic analysis of continuous or discrete data; simulation tools are usually a part of effective CASE tools application.

Production systems can be divided into separate groups:

- FMS (Flexible Manufacturing Systems) - are part of the unattended human operator's work. Their flexibility is evaluated as per technology and structural capacity. FMS also represent the ability to easily adapt the system to the production and implementation to further programs. This production system is now universally applicable and analyzed.
- APS (Automated Production System) - works in real time. Offers information on the status of the manufacturing process. APS automatically directs and controls the production process and each executive task in the current and the next batch.

TIMING ANALYSIS OF PRODUCTION DURATION

Its aim is to encourage the use of the process at the same time to allow for better insight into its structure. It is a tool for identifying gaps and improving the organization of the production system. The system not only allows for status identification, but also for current analysis [4]. It is characterized by two partial indicators [2]:

1. pre-production cycle - the time of the preparatory work to be performed before starting actual production,
2. the length and structure of the production cycle - the time duration of the operations and products' manufacturing throughout the production process, understood as a complex indicator. It consists of a basic time manufacturing operations factor, as well as including time needed for transport, control and other ancillary operations.

In view of the growing complexity and difficulty of the preparation phase of production, one should seek appropriate methods of management. Most typical exact method of organizing production preparation methods include network analysis [1].

Network analysis is based on the graph theory. It provides time, source and cost analysis. It has applications in planning, implementation and design [3].

A network graph is any of several possible views that link project activities and events in order to show their interdependencies. Each activity or event has linkages with both the previous= and following concurrent activities [2].

In network analysis, the following concepts and terms may occur[4]:

- The network: a finite, oriented, coherent and acyclic graph.
- Finality of the network is given a limited number of nodes and edges. Such a network can represent only the final processes, which are then expressed in each follow-up activity.
- Orientation means that every action has its initial node i and ending node j, which should not be confused. Similarly, a process graph has only one start and end node.
- Orientation means that every action has its initial node i and ending node j, which should not be confused. Similarly, a process graph has only one start and end node.
- Relatedness means that all possible routes in the project are always linked with the start and end nodes of the project.
- Non-cyclicity is characterized by $i < j$. Initial node number is smaller than the number of end nodes. Checking for non-cyclic networks is one of the most important phases of designing a model for the follow-up process.

- The node (top graph) represents the state reached by a certain activity, the moment of commencement or cessation of activities, presented in circles and numbers.
- The edge means the activity may be real or fictional. Edges in the graph are valued. Basic assessment of time - reflects the duration of an action. Valuation can apply to both the source (the amount of resources spent) and cost (implementation costs).
- Real activity is shown in the graph by the solid line. Dubbed the pair of numbers (i, j). The first number indicates the node from which the action stems, the second indicates the node in which the action ends. Orientation during operation is shown in the graph as 'an arrow'. Each real activity is associated with the consumption of time and incurring costs.
- The fictitious business factor is shown in the chart by the dashed line. It shows the relationship between certain activities or their concurrency. Dummy activities in fact do not exist.
- The Token - when marking the place "p" assigned non-negative integer "k", we say that "p" is marked with the name - token.

PERT method pertains to the duration of each activity as a random variable that has a certain probability distribution. Due to the absence of duplication of activities, we have statistical material that allows for the use of conventional methods of mathematical statistics. We must therefore rely on the experience and judgment of those who are responsible for carrying out the work. These workers must also assess the conditions and risks of the implementation of these activities. In particular, the interval in which the random variable will move has to be determined by its maximum and minimum values. It is a non-deterministic (stochastic) method, where manufacturing operations are defined by the time evaluated in case of normal probability distribution and where their edge-oriented models are known[3].

These estimates can be called [3]:

- an optimistic estimate: the planned shortest duration (and is referred to),
- the most likely estimate: it is a mode (referred to m)
- pessimistic estimate: indicates the considered longest duration (referred to b).

CPM method, is otherwise known as the critical path method.

Modeling by CPM analysis starts with the manufacturing process. Every element that we call operation, activities, processes, must be clearly defined and determined as a sequence of steps. It is suitable to model deterministic processes into line graphs [3].

Calculation of critical activities and critical path. After creating a chart, critical path timing analysis is carried out and consists of the following [3]:

- the earliest time for the node,
- the latest time for the node,
- the temporal characteristics of an activity,
- reserves,
- identification of critical activities and critical path.

Other methods of network analysis:

- MPM - for deterministic production processes, with parallel course of both process and feedback [3].
- GERT - this kind of production processes that are modeled as a general type of network graphs GAN [3].
- RAMPS - method of allocation of resources and planning of multiple projects, serves as a rich analysis of current network resources. Allows for operation of multiple projects simultaneously to ensure they use the same resources [1].

CONCLUSION

Today, every company is searching for an answer to the question of how to improve its business. This means that every company wants to produce its products or services more efficiently, so as to increase business competitiveness. One of the key areas for improvement in corporate performance is the reengineering of existing, but in many cases, outdated processes, scattered over different departments of an organization. Companies should therefore constantly analyze their needs in relation to the restructuring of business processes and the management of trade and economic order.

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