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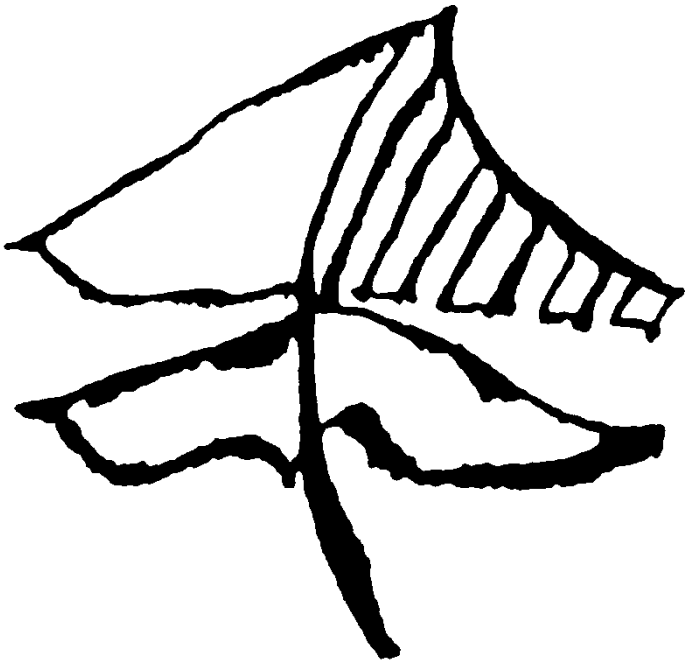

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No 32/3 contains articles ordered by the Editorial Board in the 2016 year - approved for printing following reviewers' positive opinions and necessary amendments. A overwhelming majority of published articles was presented and discussed in scientific conference: SECURITY. Economy – Society – Environment (BEZPIECZEŃSTWO. Gospodarka - Społeczeństwo – Środowisko).

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Wojciech Lis

Zbigniew Gołaś[1]

THE LEVEL AND CONDITIONS OF PROFITABILITY OF FURNITURE MANUFACTURING ENTERPRISES IN POLAND BETWEEN 2005 AND 2014

Abstract: The main aim of the study was a multidimensional analysis of profitability of the furniture manufacturing sector in Poland. The analysis was based on aggregated financial statements provided by enterprises between 2005 and 2014 and published by the European Central Bank in the database of the Bank for Accounts of Companies Harmonised (BACH). As results from the data, the return on sales and assets in the furniture manufacturing sector in Poland was relatively stable and exhibited a slight rising tendency. However, the return on equity in this sector exhibited a negative trend. The results of a factor analysis revealed that the decrease in the return on equity was mostly caused by the decrease in capital leverage and efficient use of assets, measured with the assets turnover.

Key words: profitability, furniture industry, Poland

INTRODUCTION

The profitability of an enterprise is influenced by different financial assets and macroeconomic factors, structural conditions in the sector as well as individual technical and economic characteristics of individual enterprises. It is important to study the factors affecting profitability for many reasons. It is the basis for ex-post assessment of the rationality of owners' decisions and a significant indication to improve tools of the economic policy in business financing. It is significant to maintain the continuity of business activity. Profit accumulation is a basic and the most important source of capital growth. Profitability is a synthetic determinant of the financial situation, which has significant influence on the assessment of the competitive capacity of enterprises, on the possibility to continue business activity and on development perspectives [1997 Bednarski, Bieniasz et al. 2010, Bieniasz & Gołaś 2013, Dudycz 2011].

The aim of this article is a multidimensional analysis of profitability of furniture manufacturing enterprises in Poland. The study is also an attempt to identify the strength and trend of the influence of selected financial factors on the most important measure of profitability – return on equity. In this article return on equity is seen through the prism of concepts developed by the financial management theory, i.e. the cause and effect analysis using the DuPont decomposition model (*DuPont System of Financial Control*).

MATERIAL AND METHODS

The assessment of the profitability of the furniture manufacturing sector in Poland was based on aggregated financial statements provided by enterprises between 2005 and 2014 and published by the European Central Bank in the database of the Bank for Accounts of Companies Harmonised (BACH) [Bank, 2016]. These statements enable multidimensional economic and financial analyses of different sectors of the economy in the EU member states according to NACE Rev. 2, i.e. the Statistical Classification of Economic Activities, which is applicable in the EU [NACE, 2016]. The BACH database includes aggregated accounting data of non-financial enterprises in 11 EU countries, which were harmonised according to European directives on accountancy to make them comparable [The Bank, 2015].

The statistics from the BACH (the Bank for Accounts of Companies Harmonised) database were used to analyse and assess the essential determinants of profitability of furniture

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manufacturing enterprises in Poland according to the size of these enterprises. The following three classes of enterprise sizes were distinguished: small enterprises (income < 10 million euros), medium enterprises (income 10-50 million euros) and large enterprises (income > 50 million euros).

Profitability ratios are widely used to evaluate enterprises and benefits for their owners. However, their usefulness is considerably narrowed down due to their synthetic character and the resulting limited range of economic content. Therefore, in analytical practice they are often disaggregated and included into indicator systems in order to enable a multidimensional cause-and-effect analysis of different aspects related to profitability [Bednarski 1997, Bieniasz & Gołaś 2013, Dudycz 2011, Skoczylas 2007, Hawawini & Viallet 2007, Zaleska 2002]. The analyses presented in this article were based on the decomposition of the return on equity ratio. The starting point was a modified DuPont model, where return on equity (ROE) is expressed with the following five-factor equation (Hawawini & Viallet 2006):

$$ROE = \frac{EAT}{EQ} = \frac{EBIT}{S} \times \frac{S}{A} \times \frac{EBT}{EBIT} \times \frac{EAT}{EBT} \times \frac{A}{EQ}$$

where:

ROE – return on equity,

$\frac{EBIT}{S}$ – operating margin sales (EBIT - earnings before interest and taxes),

S – net revenues from sales,

$\frac{S}{A}$ – assets turnover (A – total assets),

$\frac{EBT}{EBIT}$ – ratio of financial costs (EBT – profit before tax),

$\frac{EAT}{EBT}$ – tax effect (EAT – profit after tax),

$\frac{A}{EQ}$ – capital leverage (EQ – equity capital).

As results from the equation, return on equity (ROE) is analysed in the context of the following determinants: sales operating profitability measured with earnings before interest and taxes (EBIT), assets efficiency measured with assets turnover (S/A), financial costs measured with the ratio between earnings before taxes (EBT) and earnings before interest and taxes (EBIT), effective tax rate measured with the ratio between net profit (EAT) and gross profit (EBT) and capital leverage measured with the ratio between total assets (A) and equity (EQ).

RESULTS AND DISCUSSION

CHANGES IN PROFITABILITY IN THE FURNITURE INDUSTRY BETWEEN 2005 AND 2014

Profitability as a synthetic measure of the capacity to generate profit and financial success can be expressed in the form of various indicators showing different aspects of profitability. Table 1 shows the values of six profitability indicators, which can be used to assess the capacity to generate

profit from sales (return on sales ratio), assets (return on assets ratio) and equity (return on equity ratio).

The first measure of assessment of the profitability of furniture enterprises is the relation between gross value added and net income from sales, which is relatively rarely used in analytical practice (Table 1). This relation carries important information. First of all, it indicates the capacity to bring new values in relation to hard costs borne. Second of all, it is regarded as an essential determinant of technical and technological advancement of enterprises. Third of all, it is an indicator of the quality and quantity of human capital [Skoczylas & Niemiec 2005, Wędzki 2006]. The average value of this measure of profitability was not very variable in the furniture manufacturing sector in Poland. It ranged from 23.8% in 2006 to 27.9% in 2010. However, it exhibited a slight rising tendency. Between 2005 and 2014 on average the share of value added in income increased by 0.9% per year. This shows that there was a small but significant increase in the capacity to bring new values in relation to hard costs borne.

Another measure of return on sales is EBIT, i.e. earnings before interest and taxes. It shows the results of enterprises' activity regardless of the cost and scale of using financial leverage, tax burden or extraordinary gains and losses. During the period under study this measure of profitability varied with similar dynamics (Δ=0.9%) to the share of value added in income and it indicates slight improvement in the capacity to generate profit from the operating activity. Apart from that, the data justify approaching changes in this profitability category by taking two subperiods into consideration. The first subperiod encompasses the years 2005-2008, when a global economic crisis was increasing and reached its maximum. The other subperiod refers to the years 2006-2014, i.e. the period of slow recovery from the crisis. As results from the data in Table 1, during the first period the return on sales dropped noticeably from 6.3% to 4.3%, but it increased considerably during the other period and stabilised at 6-7%.

Table 1. Corporate profitability ratios in furniture industry in Poland in the years 2005-2014 (in %)

Profitability ratios	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Δ[1]
Gross value added/ net sales	24,0	23,8	24,3	25,3	27,6	27,9	24,9	25,3	26,7	25,9	0,9
EBIT[2]/net sales	6,3	5,9	5,7	4,3	7,1	7,0	5,6	5,7	7,1	6,8	0,9
EBT[3]/ net sales	5,4	5,0	4,9	3,1	6,1	6,1	4,7	4,8	6,4	6,2	1,5
EAT[4]/ net sales	4,6	4,2	4,3	2,5	5,3	5,1	4,1	4,2	5,7	5,7	1,1
EAT/total assets	7,8	6,8	7,3	3,7	7,9	7,2	6,2	6,3	8,5	8,5	1,0
EAT/equity	17,5	15,4	15,9	8,8	16,7	13,5	12,4	11,7	15,4	16,5	-0,7

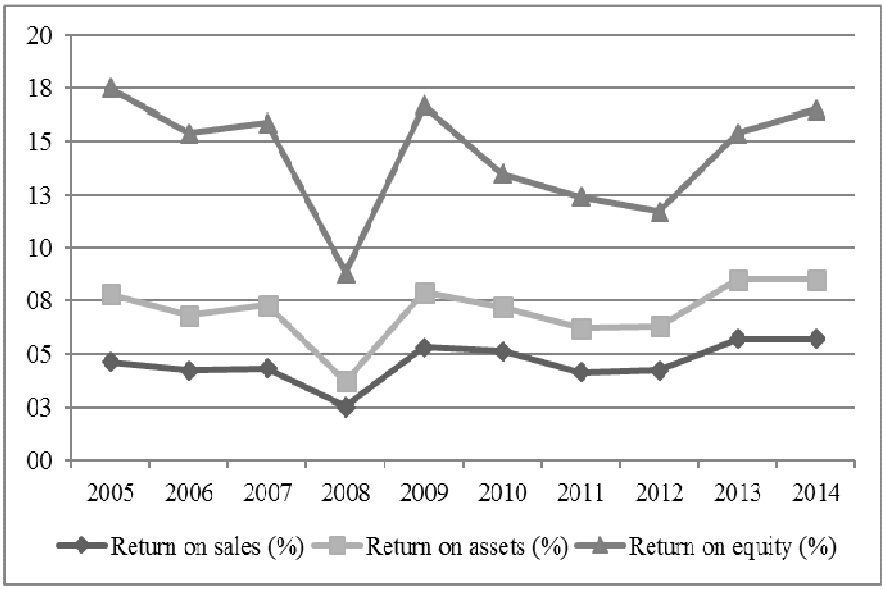
[1]Δ – Average annual change in% (geometric mean), [2]EBIT - operating profit before taxes and interest, [3]EBT - pre-tax profit (gross profit), [4]EAT - profit after tax (net profit).

Source: own calculations based on Bank for the Accounts of Companies Harmonised [Bank, 2016].

The third measure of return on sales is EBT, i.e. earnings before taxes. It provides information about the profitability of an enterprise, including the income and costs from all types of activity, i.e.

operational, financing and investment activities and extraordinary occurrences. It shows total achievements of an enterprise and indicates the difference in percentage between total income and total costs. Despite a considerable decrease in the furniture manufacturing sector in Poland in 2008, this category of return on sales exhibited a slight but favourable increasing tendency (Δ = 1.5%) between 2005 and 2014. The tendency resulted in a significant change in gross return on sales. As results from the data in Table 1, between 2005 and 2007 1 zloty of income gave 4.9-5.4% gross profit, whereas between 2013 and 2014 this relation increased to 6.2-6.4%.

Fig. 1 Changes in net profitability of sales, assets and equity in the furniture manufacturing sector in Poland in the years 2005-2014



Source: own study based on the table 1.

There were similar tendencies observed when return on sales was measured with EAT, i.e. net profit, which included all costs and income as well as the income tax paid. Despite the decrease in the furniture manufacturing sector in Poland in 2008, this category of return on sales exhibited a favourable increasing tendency between 2005 and 2014. On average it increased by 1.1% per year. The tendency resulted in a slight but noticeable increase in net return on sales. As results from the data in Table 1, between 2005 and 2007 1 zloty of income gave 4.2-4.6% net profit, whereas between 2013 and 2014 this relation increased to 5.7%.

Another measure of profitability is the return on assets ratio, which provides information about the capacity of enterprises to generate profit and manage assets efficiently. This measure of profitability also exhibited a favourable tendency in the furniture industry in Poland, although it dropped considerably in 2008. On average, the return on assets, measured with EAT, i.e. net profit, increased by 1% per year. At the end of the period under study it reached 8.5%. This means that 1 zloty of assets gave 8.5% net profit, which was the highest during the whole period under study.

The last measure of profitability in the furniture manufacturing sector in Poland was the return on equity ratio. It provides information about owners gaining profit from equity. Of all the measures

of profitability in the analysis, only the return on equity ratio did not exhibit a favourable tendency, because there was a negative average yearly dynamics of variation (Δ = -0.7%). Apart from that, as results from the data in Table 1, there were relatively high fluctuations in the return on equity ratio. In 2014 (16.5%) it was still lower than in 2005 (17.5%). However, despite the negative average yearly dynamics of variation, in the last two years of the period under study (2013-2014) there were some symptoms of increase in this category of profitability. If this tendency is maintained, furniture manufacturing enterprises may achieve much higher return on equity ratios in the years to come.

FACTOR ANALYSIS OF VARIATION IN RETURN ON EQUITY IN THE FURNITURE INDUSTRY BETWEEN 2005 AND 2014

As was emphasised above, the return on equity ratio (ROE) was the only measure of profitability of furniture manufacturing enterprises which did not exhibit a favourable tendency between 2005 and 2014. Therefore, it is recommended to extend the analysis with a study of causes and effects in order to recognise the mechanism of ROE variation in detail.

Table 2 shows the parameters of a five-factor model of decomposition of return on equity (ROE) and the results of a factor analysis[2] of variation in this category of profitability in the furniture manufacturing sector in Poland between 2005 and 2014. As results from the data in the table, during the period under study the highest variation was observed in return on equity (V=18%) and return on sales measured with EBIT (V=13.8%). There was much lesser variation in the other factors of the model, especially the effective tax rate (EAT/EBT). However, in order to identify the causes of variation in the return on equity ratio it is absolutely important to analyse deviations of individual factors of the model as well as their structure, because they show the tendency of their influence on ROE variation and their share in total variation. The 2.1% decrease in the ROE between 2005 and 2006 was caused by a decrease in the return on sales (EBIT/S), a drop in the assets turnover (S/A), an increase in financial costs (EAT/EBT) and a decrease in the capital leverage (A/EQ). The increase in the EAT/EBT ratio was the only factor which had positive influence on the ROE variation and reduced the scale of its decrease during that period. It indicates that the tax effect had positive influence on the profitability of furniture manufacturing enterprises. However, if we take the structure of deviations into consideration, the favourable influence of that the tax effect was of marginal importance during that period (2.4%). The negative trend in the ROE variation was mostly caused by a decrease in the assets turnover (more than 59%) and a decrease in the capital leverage (30.2%).

During the next period, between 2007 and 2008 the return on equity increased slightly (by 0.05%) in the furniture manufacturing sector. The increase was mostly caused by the increase in the assets turnover (S/A) and, though to a much lesser extent, by the favourable influence of variation in the tax effect (EAT/EBT). Variations in these factors determined 63.3% (assets turnover) and 17.1% (tax effect) of the total ROE variation.

In 2008, during the outburst of the global economic crisis there was the greatest decrease in the return on equity in the furniture industry – as much as 7.1%. Between 2007 and 2008 the ROE decreased so considerably mainly due to variation in three factors, i.e. the negative influence of decreasing assets turnover (S/A), growing burden of enterprises with financial costs (EBT/EBIT) and increasing capital leverage. However, the last factor positively affected the ROE and reduced the scale of its decrease. These factors determined 83% of variation in the return on equity between 2007 and 2008.

[2] The chain substitution method was used in the factor analysis of variation in return on equity. This method and the logarithm method are the most common methods of factor analysis mainly due to the simplicity of calculations. However, the chain substitution method requires that the influence of individual factors should be calculated in a strict order [see Waśniewski & Skoczylas 2002, Wędzki 2006, Żwirbla 2003a, b].

Table 2. Factor analysis of variation rate of return on equity (ROE) in the furniture industry in Poland in the years 2005-2014

Specification	EBIT/S	S/A	EBT/EBIT	EAT/EBT	A/EQ	ROE
2005	0,0630	1,70	0,8600	0,8470	2,2590	0,1750
2006	0,0590	1,60	0,8500	0,8510	2,2080	0,1540
2007	0,0570	1,70	0,8620	0,8780	2,2250	0,1590
2008	0,0430	1,50	0,7250	0,8010	2,3340	0,0880
2009	0,0710	1,50	0,8590	0,8650	2,1260	0,1670
2010	0,0700	1,40	0,8750	0,8380	1,8730	0,1350
2011	0,0560	1,50	0,8540	0,8660	1,9730	0,1240
2012	0,0570	1,50	0,8440	0,8740	1,8650	0,1170
2013	0,0710	1,50	0,9050	0,8830	1,8060	0,1540
2014	0,0680	1,50	0,9060	0,9220	1,8920	0,1650
Average	0,0615	1,54	0,8540	0,8625	2,0561	0,1438
V[1] (%)	13,8	6,0	5,6	3,5	9,0	18,0
Partial deviations						
2006/2005	-0,0040	-0,1000	-0,0100	0,0040	-0,0510	-0,0210
2007/2006	-0,0020	0,1000	0,0120	0,0270	0,0170	0,0050
2008/2007	-0,0140	-0,2000	-0,1370	-0,0770	0,1090	-0,0710
2009/2008	0,0280	0,0000	0,1340	0,0640	-0,2080	0,0790
2010/2009	-0,0010	-0,1000	0,0160	-0,0270	-0,2530	-0,0320
2011/2010	-0,0140	0,1000	-0,0210	0,0280	0,1000	-0,0110
2012/2011	0,0010	0,0000	-0,0100	0,0080	-0,1080	-0,0070
2013/2012	0,0140	0,0000	0,0610	0,0090	-0,0590	0,0370
2014/2013	-0,0030	0,0000	0,0010	0,0390	0,0860	0,0110
The sum of the	0,0050	-0,2000	0,0460	0,0750	-0,3670	-0,0100
The structure of the partial deviations[2] (%)						
2006/2005	2,4	59,2	5,9	2,4	30,2	100,0
2007/2006	1,3	63,3	7,6	17,1	10,8	100,0
2008/2007	2,6	37,2	25,5	14,3	20,3	100,0
2009/2008	6,5	0,0	30,9	14,7	47,9	100,0
2010/2009	0,3	25,2	4,0	6,8	63,7	100,0
2011/2010	5,3	38,0	8,0	10,6	38,0	100,0
2012/2011	0,8	0,0	7,9	6,3	85,0	100,0
2013/2012	9,8	0,0	42,7	6,3	41,3	100,0
2014/2013	2,3	0,0	0,8	30,2	66,7	100,0
Total[3]	0,7	28,9	6,6	10,8	53,0	100,0

[1]V - coefficient of variation in %, [2]partial structure deviation calculated on the basis of the absolute values of these deviations, [3]The structure of the total deviation is calculated based on the sum of the partial deviations from the period 2005-2014.

Source: own calculations based on Bank for the Accounts of Companies Harmonised [Bank, 2016].

During the next period, i.e. in 2009, the ROE increased significantly by 7.9%. In this case the increase in the return on equity was caused by a relatively strong and positive variation in financial costs (EBT/EBIT) and favourable changes caused by the reduced tax on profit (EAT/EBT). However, it was also negatively influenced by the decreasing capital leverage (A/EQ), which caused the greatest variation in the return on equity. These factors determined 30.9% (financial costs), 14.7% (tax effect) and 47.9% (capital leverage) of ROE variation.

Between 2010 and 2012 the return on equity dropped every year in the furniture industry in Poland. The analysis of the data in Table 2 shows that in all these years the unfavourable tendency in the ROE variation was chiefly caused by reduced capital leverage (A/EQ) and, to a lesser extent, by multidirectional changes in assets efficiency, measured with the assets turnover (S/A). Altogether these two factors determined 76-89% of the ROE variation during that period.

In the last two years (2013-2014) of the period under study the return on equity increased. In 2013 the ROE was 3.7% greater than in 2012 due to considerable reduction of financial costs (EBT/EBIT). However, as results from the data in Table 2, the favourable trend of varying financial costs was considerably weakened by a considerable decrease in the capital leverage (A/EQ). Between 2012 and 2013 these factors had comparable influence on the ROE variation. Variation in the financial costs determined 42.7% of variation in the return on equity, whereas variation in the capital leverage determined 41.3%. If we consider the fact that in 2014 the ROE was greater than in 2013, we can see that the capital leverage also had significant influence on it. Due to the increase in the capital leverage it had positive influence on the ROE and determined as much as 66.7% of the increase in the ROE. It is also noteworthy that between 2013 and 2014 the increase in the return on equity corresponded to a relatively big decrease in the net profit/gross profit ratio (EAT/EBT). It pointed to a decreasing effective tax rate of enterprises and simultaneously had positive effect on their profitability. The variation of this factor was not of marginal importance because the reduction of the effective tax rate determined 30.2% of positive ROE variation in that period.

SUMMARY

As results from the analysis, during the period under study the return on sales and assets in the furniture manufacturing sector in Poland was relatively stable and exhibited a slight rising tendency. However, the return on equity in this sector exhibited a negative trend. The factor analysis of variation in the return on equity shows that during individual periods under investigation both the trends and strengths of factors analysed in the ROE decomposition model were diversified in the furniture manufacturing sector. However, if we consider the sum of deviations of individual factors of the model as well as their structure between 2005 and 2014, we can see that the general negative trend of the ROE variation was chiefly caused by the decreasing capital leverage and assets turnover. During the whole 2005-2014 period variations of these factors accounted for 53.0% (capital leverage) and 28.9% (assets turnover) of the ROE variation. This means that if furniture manufacturing enterprises continue the policy of financing their activity with an increasing share of equity, which reduces the capital leverage, they must considerably improve the assets management efficiency, measured with the assets turnover. The possibilities to increase the return on equity by increasing the return on sales, reducing financial costs and profit taxation seem to be strongly limited.

REFERENCES

1. Bank for Accounts of Companies Harmonised, www.bach.banque-france.fr, dostęp: 20.04.2016.
2. Bednarski, L. (1997). Analiza finansowa w przedsiębiorstwie. Warszawa: PWE.
3. Bieniasz, A., Czerwińska-Kayzer, D., Gołaś, Z. (2010). Analiza rentowności kapitału własnego przedsiębiorstw przetwórstwa przemysłowego w Polsce. J. Agribus. Rural Dev., 2(16), 17-26.

4. Bieniasz, A., Gołaś, Z. (2013). Finansowe uwarunkowania rentowności w przemyśle spożywczym. Przegląd Organizacji, 7, 43-52.
5. Dudycz, T. (2011). Analiza finansowa jako narzędzie zarządzania finansami przedsiębiorstwa. Wrocław: Indygo Zahir Media.
6. Hawawinii G., Viallet C. (2006). Finanse menedżerskie. PWE, Warszawa.
7. NACE Rev. 2 - Statistical classification of economic activities in the European Community, Eurostat, Methodologies and working papers, http://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.pdf, dostęp 20.04.2016.
8. Skoczylas, W. (2007). Determinanty i modele wartości przedsiębiorstw. Warszawa: PWE.
9. Skoczylas W., Niemiec A. (2005). Przyczynowa analiza ekonomicznej wartości dodanej w identyfikacji i ocenie strategii jej wzrostu. Prace Naukowe, Akademia Ekonomiczna we Wrocławiu, 1061.
10. The Bank for the Accounts of Companies Harmonized (BACH) database. (2015). Statistics Paper Series, September 2015, no 11, BACH Working Group, European Central Bank, www.ecb.europa.eu/pub/pdf/scpsps/ecbsp11.en.pdf, dostęp: 27.04.2016.
11. Waśniewski T., Skoczylas W. (2002). Teoria i praktyka analizy finansowej w przedsiębiorstwie. Fundacja Rozwoju Rachunkowości w Polsce, Warszawa.
12. Wędzki D. (2006). Analiza wskaźnikowa sprawozdania finansowego. Oficyna Ekonomiczna, Kraków.
13. Zaleska, M. (2002). Ocena ekonomiczno-finansowa przedsiębiorstw przez analityka bankowego. Warszawa: Wyd. SGH.
14. Żwirbla A. (2003a). Odchylenie względne jako miernik efektywności gospodarowania. Zeszyty Teoretyczne Rachunkowości, 17(73).
15. Żwirbla A. (2003b). Z historii metod deterministycznych analizy ekonomicznej. Zeszyty Teoretyczne Rachunkowości, 15(71).

Emilia Grzegorzewska[3]

REGIONAL DIVERSITY OF THE LEVEL OF INNOVATION IN POLISH INDUSTRIAL ENTERPRISES – THE ECONOMIC DIMENSION

Abstract: Innovation is one of the key factors in socio-economic development. It may be discussed from the perspective of a country, region or enterprise. The article covers the changes in the level of innovation in Polish industrial companies accounting for the administrative division. The paper presents the scale of innovative activity and its influence on economic results of the analysed economic subjects. The effectiveness of these actions has been evaluated based on the share of revenues of industrial enterprises from sales of new or significantly improved products in total revenues from sales and expenditures on innovative activity.

Key words: innovation, industrial enterprises, regional diversity

INTRODUCTION

These days a significant source of the increase of competitiveness on the international arena is innovation. According to the latest findings of the European Committee, Poland belongs to the group of moderate innovators that is the countries with the index (Summary Innovation Index) between 50% and 90% for UE-28. In the last year Poland has advanced by one position and now ranks 24. Poorer results were scored only by Romania, Bulgaria, Lithuania and Latvia[Innovation Union Scoreboard 2015, p. 10]. Thus, Polish performance in this area was far from satisfactory. The introduction of innovative solutions should then be one of the priorities of the participants of economic processes, including enterprises.

The beginning of the theory of innovation is connected with the introduction by an Austrian economist J.A. Schumpeter this term into the literature on the subject. The diversity of definitions of innovation in the contemporary literature is great, however, they may be divided into two categories: these with broad and narrow meaning. Innovation in the broader sense is any change in production consisting in absorbing the acquired knowledge. As regards the narrow meaning, innovation is a change in methods of manufacturing and products, organization of the production process based on new or never used before knowledge [Janasz, Kozioł-Nadolna 2011, p. 12]. Nevertheless, the most typical typology of innovation taking into account the subject criterion was presented in a handbook – Oslo from 2005 compiled by OECD and Eurostat. The document refers to the rules of accumulating and interpreting data from the field of innovation. In accordance with the methodology there are four types of innovation: product, process, marketing and organization innovations [Oslo manual 2005, p. 47-52].

The phenomenon of innovation may be here discussed from the perspective of a country, region or company. The economic innovation (country, region) is understood as the capacity and motivation of companies operating on a given territory to constantly search for and use in practice research and development findings, new concepts, ideas and inventions [Strategy for innovation… 2013, p. 11]. As regards Chądzyński et. al [2007, p. 144] the regional innovation is the capacity of the region to change, improve and introduce reforms and innovative solutions in an array of fields of the socio-economic life in order to improve the functioning of mechanisms supporting development in the region. The innovation of a company can be defined as the ability and motivation of

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companies to search for and commercially use all of the research findings, new concepts, ideas and inventions leading to the increase of the level of advancement and the strengthening of the competitive advantage or the realisation of technical abilities of the entrepreneur [Łuczka, Lachiewicz, Stawasz 2010, p. 458]. Undoubtedly, these terms are not tightly connected since the regional innovation is a product of the innovativeness of companies operating in its region. The companies belong to different branches and sectors, they differ in the scale of their activity, function on different markets, represent different levels of technological development [Grzybowska 2011, p. 118]. Similarly, K. Dyjach [2011, p. 225] stresses that the development capacities of regional economies are determined, among other things, by the scale and the quality of the innovative activity undertaken by the companies operating on their area.

OBJECTIVE AND RESEARCH METHODOLOGY

The primary aim of the research was the economic evaluation of economic innovativeness in industrial companies in Poland accounting for the administrative division of the country. The timeframe of the research covers 2010-2014. To this end, the findings of analyses annually published by GUS in the report entitled 'Innovation activities of enterprises' were used. The article presents change trends in the level of innovation of companies accounting for the administrative division of the country. The research covers the percentage of companies innovatively active and these that may be considered innovative.

According to the research terminology an innovative enterprise is the one which in the analysed period introduced at least one product or process innovation or realised in this period at least one innovative project which was discontinued or abandoned (not successfully finished) or it was not finished up to the end of the period (that is it is being continued). As regards an innovative enterprise, it is the one which launched at least one product or process innovation (either new or greatly improved product or new or greatly improved process) [Innovative activity…. 2015, p. 31].

From the point of view of the effectiveness of the innovation actions what is significant is their impact on the economic performance of an enterprise. On account of the above change trends of chosen ratios have been presented. One of them is the share of revenue of industrial enterprises from the sales of new or greatly improved products in the revenue from total sales and the outlays on innovative activity. According to the methodology of the Central Statistical Office (GUS) the revenue from the sales of new or greatly improved products comprises [Innovative activity… 2015, p. 65]:

- new or greatly improved products for the market on which the enterprise operates, launched over the last three years,
- new or greatly improved products only for the enterprise launched over the last three years.

Another measure applied in the economic evaluation of innovative activity of enterprises are the outlays borne as regards this activity in the frame of product and process innovation. The performance in this field has been presented in current prices for each vioivodeship as well as in equivalent to one enterprise which undertook such an activity. Outlays on innovative activity comprise [Innovative activity… 2015, p. 72]:

- the purchase of knowledge from external sources in the shape of patents, inventions (solutions), non-patent projects, utility and industrial models, licences, know-how disclosures, trademarks as well as technical services connected with the implementation of product and process innovations,
- the purchase of software connected with the implementation of product and process innovations,
- the purchase and installation of machinery and technical devices, the purchase of means of transport, tools, instruments, movables, equipment and outlays on the construction,

extension and modernisation of buildings meant for the introduction of process and product innovation,
- training of the personnel
- marketing connected with new or greatly improved products (inter alia, market research, market tests, advertising of the new or greatly improved products launched on the market),
- research and development work (R&D) connected with devising new or greatly improved products and processes rendered by own development facility or acquired from other units

RESEARCH FINDINGS

From the research conducted by the Central Statistical Office (GUS) it follows that in the years 2010-2012 the greatest percentage of innovatively active industrial enterprises was noted in Podlaskie voivodeship (23.8%) (table 1). Other places were occupied by: Opole (23.0%), Lower Silesian (22.6%), Silesian (20.8%). As regards the innovative activity undertaken the least active were enterprises from the following voivodeships: Pomeranian, Greater Poland and Łódź. The percentage of companies innovatively active amounted to, respectively: 12.3%, 12.8% and 14.4%. At the end of the analysed period the most innovative companies were the enterprises from the voivodeships: Lower Silesian (23.1%), Silesian (21.9%) and Lublin (21.9%). A dissimilar situation was noted in: Świętokrzyskie (14.8%), Greater Poland (15.6%0) and Łódź (15.8%). It needs to be emphasized that in the years 2010-2014 the greatest rise in the ranking was noted in Lublin (8 positions) and Pomeranian (6 positions).

Table 1. Innovatively active industrial enterprises in the years 2010-2014 by voivodships

Voivodeship	2010/2012 [%]	2011/2013 [%]	2012/2014 [%]	Change 2012/2014 – 2010/2012 [%]	Change in the position 2012/2014 – 2010/2012
Lower Silesian	22.6 (3)	20.3 (6)	23.1 (1)	0.5	+2
Silesian	20.8 (4)	16.9 (14)	21.9 (2)	1.1	+2
Lublin	17.7 (11)	17.2 (12)	21.9 (3)	4.2	+8
Opole	23.0 (2)	20.7 (4)	21.3 (4)	-1.7	-2
Mazovian	17.2 (12)	19.3 (8)	20.2 (5)	3.0	+7
Subcarpathian	19.3 (5)	21.0 (3)	19.7 (6)	0.4	-1
Podlaskie	23.8 (1)	24.2 (1)	19.4 (7)	-4.4	-6
Warmian-Masurian	19.1 (6)	21.0 (2)	19.3 (8)	0.2	-2
West Pomeranian	18.4 (10)	17.7 (10)	18.6 (9)	0.2	+1
Pomeranian	12.3 (16)	17.3 (11)	17.0 (10)	4.7	+6
Lesser Poland	18.8 (7)	20.1 (7)	16.3 (11)	-2.5	-4
Lubisz	17.1 (13)	20.5 (5)	16.3 (12)	-0.8	+1
Kujavian-Pomeranian	18.4 (9)	15.2 (16)	16.0 (13)	-2.4	-4
Łódź	14.4 (14)	17.0 (13)	15.8 (14)	1.4	no changes
Greater Poland	12.8 (15)	16.4 (15)	15.6 (15)	2.8	no changes
Świętokrzyskie	18.5 (8)	17.7 (9)	14.8 (16)	-3.7	-8
Total	17.7	18.4	18.6	0.9	-

Source: own study on the basis of CSO reports - Innovation activities of enterprises covering the years 2010-2014.

GUS researches not only the enterprises which are innovatively active, that is those which undertook any activity in this field, even if the project was not finished or was suspended, but also innovative companies that is the ones which in the period of three years launched at least one innovation. From table 2 it follows that in the years 2010-2014 the percentage of these industrial companies increased from 16.5% to 17.5%.

Table 2. Innovatively active industrial enterprises in the years 2010-2014 by voivodships

Voivodeship	2010/2012	2011/2013	2012/2014	Change 2012/2014 – 2010/2012 [%]	Change in the position 2012/2014 – 2010/2012
Lower Silesian	20.7 (3)	19.0 (6)	22.1 (1)	1.4	+2
Lublin	15.9 (12)	15.9 (11)	21.2 (2)	5.3	+10
Silesian	19.1 (4)	15.4 (14)	19.9 (3)	0.8	+1
Opole	22.3 (1)	20.0 (3)	19.5 (4)	-2.8	-3
Mazovian	15.3 (13)	18.5 (7)	19.1 (5)	3.8	+8
Podlaskie	22.0 (2)	23.4 (1)	18.7 (6)	-3.3	-4
Subcarpathian	17.9 (8)	19.9 (4)	18.4 (7)	0.5	+1
West Pomeranian	18.2 (7)	16.7 (10)	17.4 (8)	-0.8	-1
Warmian-Masurian	18.6 (5)	20.1 (2)	17.4 (9)	-1.2	-4
Pomeranian	11.0 (16)	15.3 (15)	16.5 (10)	5.5	+6
Lesser Poland	17.4 (10)	18.1 (8)	15.6 (11)	-1.8	-1
Lubusz	16.4 (11)	19.2 (5)	15.5 (12)	-0.9	-1
Łódź	13.7 (14)	15.6 (13)	15.2 (13)	1.5	+1
Greater Poland	12.0 (15)	15.7 (12)	14.9 (14)	2.9	+1
Kujavian-Pomeranian	17.5 (9)	13.6 (16)	14.9 (15)	-2.6	-6
Świętokrzyskie	18.2 (6)	17.6 (9)	14.9 (16)	-3.3	-10
Total	16.5	17.1	17.5	1.0	-

Source: own study on the basis of CSO reports - Innovation activities of enterprises covering the years 2010-2014.

At the beginning of the analysed period in this field the first three places were occupied by the following voivodeships: Opole (22.3%), Podlaskie (22.0%) and Lower Silesian (20.7%). The latter ranked first in the ranking of the innovative enterprises covering the years 2012/2014 – 22.1%. Moreover, high positions in the ranking were taken by: Lublin (21.2%) and Silesian (19.9%). Among the least innovative economic subjects there were: Świętokrzyskie, Kuyavian-Pomeranian and Greater Poland (14.9% each). In this ranking it is worth noticing Lublin voivodeship as in the analysed period this region rose from 12 to 2 position. A great fall, on the other hand, was noted in Świętokrzyskie, which resulted in the fall by 10 positions.

As regards innovative activity of each enterprise it is of great importance first of all to convert the actions into economic results. One of the ratios visibly reflecting this aspect is the share of revenue from the sales of new or greatly improved products in the revenue from total sales. In 2012 the ratio in question was at the level of 3.1% in Warmian-Masurian to even 36.3% in Pomeranian. Two years later the percentage in Pomeranian voivodeship decreased to 27.2%, however, companies from the region were the leaders of the ranking. The consecutive positions were occupied by Lower Silesian (12.5%) and Silesian (10.7%). The poorest results were achieved by companies from Warmian-Masurian (3.1%), Świętokrzyskie (3.6%) and Podlaskie (4.1%). Such a small share in revenue from innovative activity in total revenue from sales may signify that the conversion of these actions into economic performance of these industrial enterprises is not enough. One has to emphasise here, though, that in the analysed period the percentage of innovatively active and innovative companies in these voivodeships oscillated between several and over 23%.

The economic dimension of innovative activity also comprises outlays borne by industrial companies on this type of activity. In 20014 they were at the level of 24621.6 mln PLN and they were higher by 14% than two year before. It needs to be emphasized that over half of these funds were spent on the purchase of machines and technical devices. This tendency was sustained throughout the whole analysed period.

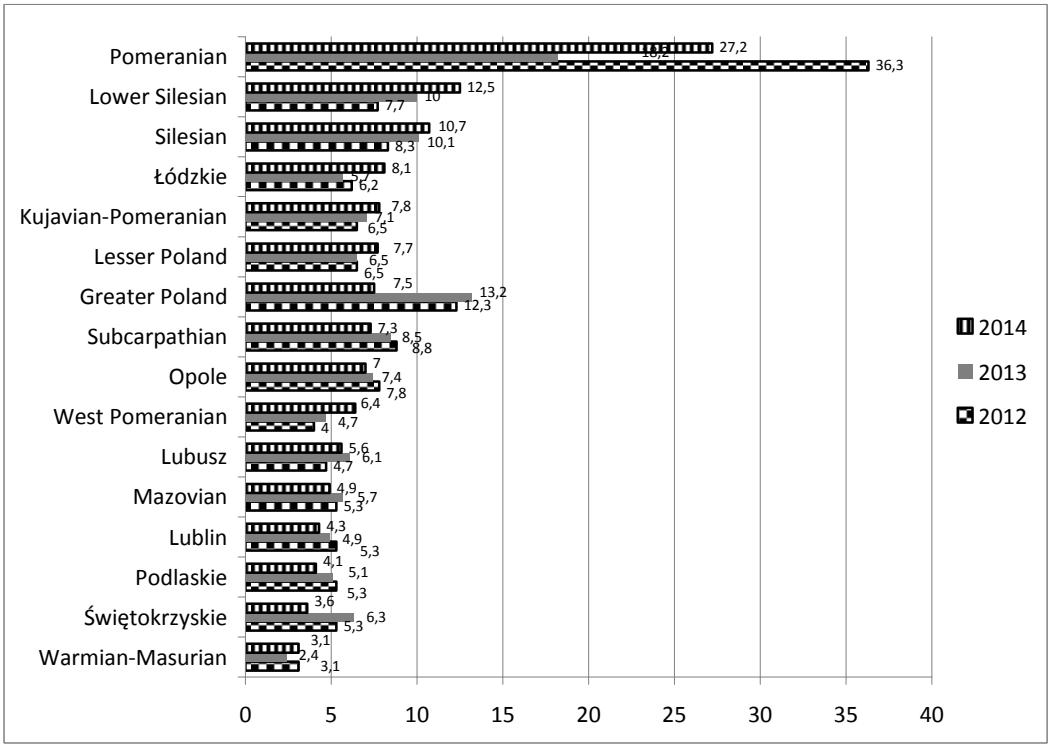

Figure 1. Revenues of industrial enterprises from sales of new or significantly improved products as the share of total revenues from sales in the years 2012-2014 by voivodships

Source: own study on the basis of CSO reports - Innovation activities of enterprises covering the years 2010-2014.

Taking the administrative division of Poland into consideration, the expenditure on innovative activity is characterized by a great territorial irregularity. As it follows from table 3, in 2012 the greatest outlays on innovation were borne by the industrial enterprises operating in the following voivodeships: Mazovian (4.9 billion PLN), Silesian (3.04 billion PLN) and Łódź (2.29 billion PLN), on the other hand, the enterprises which spent the least were located in: Warmian-Mazurian (0.41 billion PLN), Lubusz (0.29 billion PLN) and Opole (0.17 billion PLN). Two years later next to Mazovian voivodeship which ranked first in the whole analysed period, other top positions were occupied by: Silesian and Lower Silesian. It needs to emphasized that there were some unfavourable change trends in Świętokrzyskie voivodeship – the expenditure on innovative activity decreased from 806.7 mln PLN to 195.6 mln PLN, as a result of which it fell in the ranking by 7 positions.

Important information on the subject of economic dimension of innovative activity in industrial enterprises is derived from the index of expenditure borne on this type of activity per one enterprise which incurred such expenditures (table 4). In 2014 expenditure per one industrial enterprise which spent funds on innovative activity, as compared to the year 2012, increased by 0.1 mln PLN to 5.6 mln PLN. The greatest outlays in this field were borne in the following voivodeships: Mazovian (11.2 mln PLN), Łódź (8.0 mln PLN) and Świętokrzyskie (7.1 mln PLN), and the least amount of funds was spent on innovation in Opole (1.3 mln PLN).

Table 3. Expenditures on innovation activities in industrial enterprises by voivodships in the years 2012-2014 (current prices in MLN PLN)

Voivodeship	2012	2013	2014	Change 2014-2012	Change in the ranking 2014 – 2012
Lower Silesian	1768.6 (5)	3047.1 (2)	2956.5 (3)	1187.9	+2
Silesian	3042.5 (2)	2957.4 (3)	3467.6 (2)	425.1	no changes
Lublin	588.9 (11)	475.5 (11)	483.5 (11)	-105.4	no changes
Opole	161.8 (16)	340.8 (13)	217.5 (15)	55.7	+1
Mazovian	4994.7 (1)	3270.5 (1)	4177.9 (1)	-816.8	no changes
Subcarpathian	1182.8 (7)	1149.5 (8)	1881.9 (6)	699.1	+1
Podlasie	495.0 (13)	300.5 (15)	248.7 (14)	-246.3	-1
Warmian-Mazurian	411.9 (14)	247.9 (16)	304.0 (12)	-107.9	+2
West Pomeranian	1012.0 (8)	858.1 (9)	990.4 (9)	-21.6	-1
Pomeranian	749.0 (10)	1273.9 (7)	1327.2 (8)	578.2	+2
Lesser Poland	1360.8 (6)	1807.3 (5)	1688.0 (7)	327.2	-1
Lubusz	292.4 (15)	318.2 (14)	272.8 (13)	-19.6	-2
Kuyavian-Pomeranian	539.4 (12)	825.3 (10)	942.2 (10)	402.8	+2
Łódź	2290.7 (3)	1698.1 (6)	2798.1 (4)	507.4	-1
Greater Poland	1838.0 (4)	2031.4 (4)	2669.6 (5)	831.6	-1
Świętokrzyskie	806.7 (9)	357.5 (12)	195.6 (16)	-611.1	-7
Total	21535.4	20958.9	24621.6	3086.2	-

Source: own study on the basis of CSO reports - Innovation activities of enterprises covering the years 2010-2014.

Table 4. Expenditures on innovation activities per one industrial enterprise which incurred such expenditures by voivodships in the years 2012-2014 (current prices in thousand PLN)

Voivodeship	2012	2013	2014	Change 2014-2012	Change in the ranking 2014 – 2012
Łódź	7954.0 (2)	4796.9 (7)	8997.3 (1)	1043.3	+1
Lower Silesian	4926.6 (7)	8302.8 (1)	8078.0 (2)	3151.4	+5
Subcarpathian	5165.3 (5)	4438.2 (9)	7588.2 (3)	2422.9	+2
Mazovian	11249.2 (1)	5562.0 (3)	7075.3 (4)	-4173.9	-3
Greater Poland	5077.3 (6)	3952.2 (10)	6432.7 (5)	1355.4	+1
West Pomeranian	7027.6 (4)	5500.6 (4)	5758.0 (6)	-1269.6	-2
Pomeranian	4115.6 (11)	5015.4 (5)	5461.6 (7)	1346.0	+4
Silesian	4860.3 (8)	5644.0 (2)	4822.8 (8)	-37.5	no changes
Lesser Poland	4199.9 (10)	4937.9 (6)	4781.8 (9)	581.9	+1
Kuyavian-Pomeranian	2544.5 (14)	4559.4 (8)	4244.1 (10)	1699.6	+4
Podlaskie	3639.6 (12)	2404.0 (14)	2647.5 (11)	-992.1	+1
Lublin	4362.4 (9)	3372.2 (11)	2627.9 (12)	-1734.5	-3
Lubusz	2231.8 (15)	2256.7 (15)	2573.7 (13)	341.9	+2
Świętokrzyskie	7139.3 (3)	3108.8 (12)	2476.4 (14)	-4662.9	-11
Warmian-Mazurian	3582.1 (13)	1609.5 (16)	2417.7 (15)	-1164.4	-2
Opole	1315.7 (16)	2562.6 (13)	1647.9 (16)	332.2	no changes

Source: own study on the basis of CSO reports - Innovation activities of enterprises covering the years 2010-2014.

At the end of the analysed period the first in the field ranked Łódź that on innovative activity spent almost 9.0 mln PLN per enterprise, which defines a rise over two years by almost 1 mln PLN. Other places were occupied by enterprises from voivodeships: Lower Silesian and Subcarpathian, which on average spent on innovative activity 8.1 mln PLN and 7.6 mln PLN. The least developing

in the field once again proved to be Opole (1.7 mln PLN). It follows then that the greatest rise in the ranking was noted in the case of Sielsian voivodeship (5 positions). The greatest fall, on the other hand, (11 positions) was observed in companies from Świętokrzyskie.

CONCLUSION

Innovation is one the most significant factors facilitating the socio-economic development and the rise of competitiveness of certain countries on the international arena. Undoubtedly, innovative activity of an enterprise has a special influence in this context, which is one of the most significant elements of the economic processes. The following article presents change trends in the level of innovativeness of Polish industrial enterprises accounting for the administrative division. The analysis covers the years 2010-2014, and the primary source of research materials were reports entitled 'Innovation activities of enterprises' published by GUS.

From the conducted research it follows that at the end of the analysed period the most innovatively active companies operated in the following voivodeships: Lower Silesian, Silesian and Lublin. The share of innovatively active enterprises in the total number of enterprises was the following: 23.1%, 21.9% and 21.9%, respectively. The very same voivodeships ranked first in the ranking of innovative enterprises that is the ones which in the analysed period launched at least one innovation. On the other hand, however, enterprises which were the least innovative proved to be the companies from Świętokrzyskie (14.8%), Greater Poland (15.6%) and Łódź (15.8%). These regions occupied the lowest positions in the ranking of innovative industrial enterprises. It needs to be emphasized that in the years 2010-2014 the greatest rise in the ranking was noted in companies from Lublin (8 positions) and Pomeranian (6 positions).

Next to undertaking innovative activities, what proves to be of great importance is their effectiveness in economic dimension. Unrivalled in the share of revenues from sales of new or significantly improved products in total revenues from sales proved to be Pomeranian (from 18.2% to even 36.3%). The poorest results were noted in the enterprises from Warmian-Mazurian. In the years 2012-2014 expenditure per one enterprise on innovative activity increased by 0.1 mln zł to 5.6 mln PLN. The greatest outlays in this field were recorded in the following voivodeships: Łódź (9.0 mln PLN) and Lower Silesian (8.1 mln PLN), however, the least was invested in Opole (1.6 mln PLN).

REFERENCES

1. Chądzyński J., Nowakowska A., Przygodzki Z. 2007: Region i jego rozwój w warunkach globalizacji, Wydawnictwo CeDeWu, Łódź
2. Dyjach K. 2011: Innowacyjność przedsiębiorstw jako czynnik konkurencyjności regionu, https://www.ur.edu.pl/file/5684/17.pdf (23.02.2016)
3. Innovation activities of enterprises 2010-2012, CSO, Warsaw 2013
4. Innovation activities of enterprises 2011-2013, CSO, Warsaw 2014
5. Innovation activities of enterprises 2012-2014, CSO, Warsaw 2015
6. Grzybowska B. 2011: Regionalne aspekty aktywności innowacyjnej przemysłu spożywczego, Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnictwa i Agrobiznesu, z. 2
7. Innovation Union Scoreboard 2015. European Commission;
8. http://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards/files/ius-2015_en.pdf (21.02.2016)
9. Janasz W., Kozioł-Nadolna K. 2011: Innowacje w organizacji, PWE, Warszawa
10. Łuczka T., Lachiewicz S., Stawasz E. 2010: Rozwój badań w zakresie zarządzania małymi i średnimi przedsiębiorstwami w polskich ośrodkach akademickich [w:] S. Lachiewicz. B. Nogalski (red.). Osiągnięcia i perspektywy nauk o zarządzaniu, Oficyna Wolters Kluwer, Warszawa

11. Oslo manual guidelines for collecting and interpreting innovation data. Organisation for Economic co-operation and Development, Statistical Office of the European Communities; 2005; http://ec.europa.eu/eurostat/documents/3859598/5889925/OSLO-EN.PDF (21.02.1016)
12. Schumpeter J.A. 1960: Teoria rozwoju gospodarczego, PWN, Warszawa
13. Strategy for innovation and efficiency of the economy, Dynamic Poland 2020, Ministry of Economy, Warsaw 2013

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FINANCIAL STABILITY OF COMPANIES FROM THE WIELKOPOLSKIE VOIVODESHIP QUOTED ON THE WARSAW STOCK EXCHANGE IN 2010-2014, AND JOB SECURITY OF THEIR EMPLOYEES

Abstrakt:When unemployment is a serious social problem, job security of people from a given community is a significant aspect. Companies from a given area are important entities creating jobs. This article examines the financial stability of public companies based in Greater Poland and job security of their employees.

Keywords: financial stability, condition of companies, stock exchange, job security

INTRODUCTION

Under conditions of high unemployment rate in a given country, it seems extremely important for people living in this country to have a sense of job security. It is equally important for them to be confident that they will receive appropriate remuneration and social security. Companies are the basic institutions, providing jobs, as well as remuneration and social security. Thus it seems that financial security of companies is a prerequisite of job security. The purpose of this study is to analyse financial security of public companies based in the Wielkopolskie Voivodeship, as well as examine job security of their employees.

THE SITUATION ON THE LABOUR MARKET IN POLAND AND IN THE WIELKOPOLSKIE VOIVODESHIP

According to the data of the Central Statistical Office, unemployment rate in Poland is quite high and in the years 2010-2014 constantly exceeded 10 %. This is illustrated by the table below:

Table 1.Rate of unemployment in Poland in the years 2010-2014

Year	2010	2011	2012	2013	2014
Overall unemployment rate (state as at the end of the year) in %	12.4	12.5	13.4	13.4	11.5

Source: Website of the Central Statistical Office (GUS) www.stat.gov.pl accessed on 30.07.2015

The above table shows high unemployment rate in the examined period, which, however, decreased at the end of 2014.

In a similar period, unemployment rate in the Wielkopolskie Voivodeship is as follows:

Table 2.Unemployment rate in the Wielkopolskie Voivodeship in the years 2010, 2012, 2013

Year	2010	2012	2013
Rate of unemployment (average of the year) in %	8.7	8.5	8.8

Source: Website of the Central Statistical Office (GUS) www.stat.gov.pl accessed on 30.07.2015

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Comparison of data from tables 1 and 2 shows that the situation on the labour market in the Wielkopolskie Voivodeship is clearly more friendly for employees than in the whole country. The unemployment rate is expressly lower. Significant differences allow for drawing such conclusions despite the data not being fully relevant[5]

EMPLOYMENT POLICY IN A COMPANY

One of the definitions of human resource management describes it as a concept of implementation of personnel functions to adjust human resources to the organisational objectives, harmonised with the needs of employees [Król, Ludwiczyński, 2014, p. 55]. Planning the height of employment in an entity means predicting the number of employees necessary in the proper place and time. [Król, Ludwiczyński, 2014, p. 176]. Notwithstanding the methods of determining the necessary number of employees, its main basis are the economic benefits of hiring employees that can be obtained. These benefits mainly include growth in revenues from sales, and also net profit. Motivating is an important function of personnel management. The basis for motivating is identification of the needs of employees. When the level of unemployment is high, one of the significant needs of employees is job security. Job security is connected to the notions of liquidity and employment retention. Employment liquidity means all changes in the state and structure of employment, as a result of dismissal and hiring of employees, while retention is the stability of employment, implemented mainly through retention of employees [Pocztowski, 2009, p. 62]. Various measures of employment liquidity and retention are proposed, among others: dynamics of dismissals, hiring ratio, ratio of jobs covered by employment liquidity, employment stability ratio, average employment duration, survival ratio [Pocztowski, 2009, p. 71].[6]There are also opinions stating that one of the important factors of job security is "employability," namely the ability to predict and the ability to adapt to changes, flexibility of employees and their competitiveness on internal and external labour market [Marzec, 2010, p. 130].

The literature on economics proposes various measures of the benefits obtained by the company. They can be divided into measures of benefits resulting directly from staff's work and general measures of the financial situation of the company. Measures of benefits resulting from work include: work efficiency [Bednarski, 1996, p. 248]

$$W = \frac{P}{T}, \tag{1}$$

Where:
W – work efficiency in a given period
P – production volume in a given period
T – number of employees in a given period

This ratio determines how many sales revenues are generated for the company by one employee. This ratio can be analysed over time, and also as a comparison between similar companies. Attention is drawn to the fact that smaller efficiency may be caused by factors completely independent from the employee, such as: market situation, technical employment infrastructure, etc.

[5] Partial adequacy of the data is caused by their availability.
[6] These ratios will not be used in this article, so are not discussed in more detail. More in-depth information on these ratios can be found in the cited source.

It is also recommended to compare the growth in work efficiency to the growth in average remuneration. This ratio is calculated according to the following rule [Bednarski, 1996, p. 261]:

(2)

$$O\Delta W = \frac{\Delta WN}{\Delta W},$$

Where:

OΔW – ratio of paying for the efficiency growth

ΔWN – average remuneration growth,

ΔW – efficiency growth.

This ratio shows the extent, to which the remuneration growth is higher than the efficiency growth. The benefits gained by the company are proved by its reverse.

The measures illustrating the overall benefits for the company, used in this paper, are [Sierpińska, 1994, p. 105]:

(3)

$$ROA = \frac{Zn}{A},$$

Where:

ROA – net return on assets,

Zn – net profit

A – size of assets

This ratio shows the benefits for the company gained from involved assets, evaluated according to the principles of drawing up financial statements.

Another measure used in this paper is [Sierpińska, 1994, p. 106]:

(4)

$$ROE = \frac{Zn}{Kw},$$

Where:

ROE – net return on equity

Kw – equity

Zn – as in (3)

The paper also utilises the total level of debt [Sierpińska, 1994, p. 89]:

(5)

$$ZO = \frac{Zd + Zk}{A},$$

Where:

A – as in (3)

ZO – total level of debt

Zd – long-term indebtedness,

Zk – short-term indebtedness

This ratio shows the extent, to which the company's assets are burdened with debt.

The last ratio used for assessing the benefits obtained by the company is quick liquidity [Jerzemowska, 2004, p. 138]

(6)

$$Ps = \frac{Ao - Z}{Zk},$$

Where:
Ps – quick liquidity
Ao – current assets,
Z – reserves
Zk – as in (5).
This ratio determines the capacity of the entity to timely pay current liabilities.

The above measures will be used to define the financial situation of companies and in the attempt to examine the relationship with changes in the level of employment. The synthetic measure of the company's financial condition will be calculated as a sum of ratios specified by formulas (3), (4), (5), (6), regulated by means of the zero unitarisation method [Kukuła, 2000, p. 91-92]

ECONOMIC DATA OF THE ANALYSED COMPANIES

The companies selected for research are public companies seated in the Wielkopolskie Voivodeship. This voivodeship was chosen for the research, since it is economically significant for Poland. Public companies were chosen for two reasons: they are large companies and their data are commonly available, while access to data of other companies is highly limited[7]

Table 3. Economic data of the analysed companies

Company	AMICA Wronki S.A.					Lena S.A.					Coljan				
	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
ROA	0.02	0.05	0.05	0.11	0.06	0.04	0.07	0.09	0.09	0.10	0.04	0.02	0.06	0.03	0.02
ROE	0.05	0.11	0.10	0.21	0.12	0.05	0.09	0.10	0.10	0.11	0.05	0.03	0.07	0.04	0.03
PS	1.17	1.24	1.47	1.32	1.24	2.32	2.89	6.07	7.17	5.52	1.54	1.38	1.73	1.48	1.45
ZO	0.53	0.50	0.43	0.48	0.48	0.27	0.21	0.10	0.09	0.11	0.26	0.31	0.22	0.32	0.26
ΔE	-13.62	-2.60	7.20	10.22	2.40	-3.88	-8.06	-0.88	-0.88	7.14	-8.52	-5.91	-4.10	60.93	-22.78
ΔR	0.06	-0.01	0.04	0.03	0.16	-0.02	0.05	0.01	-0.02	0.09	0.07	0.03	-0.01	0.21	0.09
W	617	630	611	570	665	780	890	910	899	926	399	436	452	357	506
NE	1883	1834	1966	2167	2219	124	114	113	112	120	1557	1465	1405	2261	1746
OΔW	0.54	1.22	-2.62	-0.04	0.27	5.50	0.56	-0.97	-2.38	1.04	-0.38	0.34	-0.02	0.48	0.94
SM	2.75	2.83	2.90	2.95	2.85	3.07	3.23	3.76	3.93	3.69	2.97	2.89	3.04	2.92	2.93

Source: Own calculations of data from companies' reports

[7] The chosen companies prepared reports for the whole researched period, except for INC S.A., since it employs less than 10 people, and PBO Anioł, since it is in liquidation bankruptcy, so examination of these companies is pointless.

Table 4. Economic data of the analysed companies

Company	Groclin					ATREM					BSC printing house				
	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
ROA	0.01	0.01	0.01	-0.02	-0.48	0.11	0.04	-0.08	0.02	0.01	0.08	0.09	0.09	0.08	0.08
ROE	0.01	0.01	0.01	-0.03	-0.95	0.18	0.07	-0.13	0.03	0.01	0.10	0.11	0.11	0.10	0.10
PS	0.91	0.94	0.93	1.27	1.14	1.73	1.56	1.26	1.31	1.28	5.76	6.14	5.75	4.40	5.27
ZO	0.23	0.26	0.24	0.30	0.49	0.42	0.36	0.33	0.31	0.40	0.25	0.22	0.20	0.20	0.17
ΔE	8.41	-11.46	-3.36	50.53	-20.18	-2.99	1.32	-13.91	-11.11	-6.82	19.70	2.95	5.33	-0.78	5.10
ΔR	-0.21	0.22	-0.04	-0.02	0.33	0.36	-0.53	-0.12	-0.22	0.17	0.18	0.14	0.15	0.12	0.11
W	128	184	183	119	223	544	351	363	334	433	432	491	549	628	668
NE	1108	981	948	1427	1139	227	230	198	176	164	237	244	257	255	268
OΔW	1.33	0.77	22.41	-0.12	0.86	0.15	0.15	4.31	1.52	0.54	-2.45	1.20	0.49	0.53	0.66
SM	2.86	2.84	2.85	2.83	1.92	3.02	2.93	2.72	2.88	2.81	3.63	3.71	3.67	3.46	3.60

Source: Own calculations of data from companies' reports

Table 5. Economic data of the analysed companies

Company	Decora					Delko					DGA SA				
	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
ROA	0.02	0.03	0.01	0.01	-0.04	0.07	0.01	-0.04	0.07	0.08	-0.10	0.04	-0.08	-0.13	-0.20
ROE	0.05	0.05	0.02	0.02	-0.07	0.14	0.03	-0.10	0.15	0.12	-0.13	0.05	-0.11	-0.19	-0.33
PS	1.16	1.15	1.41	1.48	1.34	1.33	0.95	0.82	1.00	1.26	3.38	3.61	3.35	2.47	2.11
ZO	0.51	0.51	0.45	0.43	0.44	0.52	0.61	0.59	0.52	0.36	0.20	0.24	0.25	0.34	0.39
ΔE	-13.45	-2.38	-4.31	-12.52	-0.45	6.25	35.29	104.35	-42.55	-11.11	-48.35	-23.40	-16.67	-23.33	-17.39
ΔR	-0.09	0.14	0.05	0.00	-0.05	0.17	0.03	-0.06	-0.01	-0.07	-0.36	-0.56	-0.41	-0.41	-0.34
W	338	400	442	503	481	23840	18161	8381	14419	15098	722	603	515	475	429
NE	547	534	511	447	445	17	23	47	27	24	47	36	30	23	19
OΔW	1.57	-0.14	-0.93	0.88	0.45	0.09	-2.46	0.11	-0.05	-3.59	0.74	1.51	2.56	-1.22	-0.70
SM	2.76	2.77	2.81	2.83	2.72	2.86	2.66	2.55	2.82	2.94	3.08	3.28	3.07	2.82	2.62

Source: Own calculations of data from companies' reports

Table 6. Economic data of the analysed companies

Company	ENEA					Komputronik S.A.					Lubawa S.A.				
	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
ROA	0.03	0.03	0.04	0.06	0.05	0.03	0.04	0.01	0.03	0.02	-0.08	-0.02	0.01	-0.02	0.02
ROE	0.04	0.03	0.05	0.08	0.06	0.07	0.11	0.03	0.08	0.08	-0.10	-0.02	0.01	-0.02	0.02
PS	3.21	2.51	1.97	2.32	3.10	1.02	1.01	1.01	1.03	1.13	2.66	1.78	1.71	1.65	1.71
ZO	0.09	0.09	0.10	0.14	0.22	0.61	0.61	0.64	0.66	0.70	0.17	0.15	0.13	0.11	0.11
PZ	69.61	-26.01	2.60	4.31	-29.93	-1.59	-3.23	13.52	1.76	9.39	20.41	3.11	-9.04	-17.17	-25.45
ΔE	-0.11	-0.13	0.02	-0.15	0.02	-0.12	0.14	0.18	0.25	0.25	0.43	0.03	-0.27	-0.03	0.27
ΔR	12638	15119	15110	12545	18356	1395	1674	1804	2377	2904	108	108	94	110	201
W	519	384	394	411	288	619	599	680	692	757	354	365	332	275	205
NE	0.39	1.83	-295.44	1.11	0.54	1.10	-0.12	-0.43	-0.23	-0.36	-0.37	2.66	0.13	1.31	0.18
OΔW	3.29	3.19	3.12	3.18	3.23	2.70	2.73	2.65	2.68	2.67	3.02	2.99	3.03	2.99	3.05

Source: Own calculations of data from companies' reports

Table 7. Economic data of the analysed companies

Company	PBG in arrangement bankruptcy					Pozbud				
	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
ROA	0.06	0.03	-1.54	0.10	-0.05	0.06	0.04	0.04	0.04	0.04
ROE	0.14	0.08	x	x	x	0.11	0.07	0.06	0.07	0.07
PS	2.65	1.11	0.18	0.21	0.18	2.12	1.27	1.39	1.37	1.25
ZO	0.57	0.58	1.69	1.71	1.88	0.33	0.39	0.37	0.35	0.43
ΔE	-7.91	-1.76	-18.61	-18.18	-14.81	1.98	5.83	12.84	-13.82	5.66
ΔR	0.09	0.06	-3.30	0.33	-0.48	0.28	-0.04	0.00	0.31	0.31
W	2004	2162	617	1132	897	938	856	758	1280	1747
NE	454	446	363	297	253	103	109	123	106	112
OΔW	0.50	-1.65	-0.09	0.46	0.18	0.63	-1.05	0.79	0.31	-0.32
SM	3.02	2.74	0.11	1.09	0.90	3.06	2.87	2.89	2.91	2.84

Source: Own calculations of data from companies' reports

Table 8. Economic data of the analysed companies

Company	Tell S.A.					Tesgas				
	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
ROA	0.05	0.08	0.10	0.11	0.06	0.06	0.06	-0.31	0.04	0.01
ROE	0.11	0.17	0.17	0.18	0.10	0.10	0.07	-0.49	0.05	0.02
PS	1.18	1.25	1.35	1.26	1.29	2.05	3.01	2.36	2.67	3.13
ZO	0.50	0.49	0.41	0.39	0.40	0.38	0.25	0.36	0.33	0.29
ΔE	-8.68	-16.44	-6.64	4.57	4.37	-1.39	-1.41	-7.14	-7.69	-7.78
ΔR	-0.01	-0.10	-0.27	0.00	0.12	0.13	-0.11	-0.48	-0.16	0.31
W	238	258	217	208	226	490	447	325	304	476
NE	505	422	394	412	430	213	210	195	180	166
OΔW	0.56	0.09	-0.31	0.72	0.35	0.65	0.61	-0.10	-0.43	0.11
SM	2.82	2.89	2.96	2.97	2.89	3.01	3.21	2.52	3.09	3.14

Source: Own calculations of data from companies' reports[8]

Most companies in the examined period are characterised by good financial condition. Profitability indicators are in the most cases positive, and quick liquidity exceeds 1. In most cases, indebtedness also exceeded the acceptable level. The synthetic measure in most cases indicates a satisfactory financial condition. Relatively the worst situation applies to PBG in arrangement bankruptcy. Although this company is covered by arrangement bankruptcy (until 06.08.2015), continuation of this company's operations is still threatened.

In the examined period, companies often reduced employment, though cases of increased employment rate were often observed. Changes in work efficiency were irregular.

[8] In tables 3-8: ROA, ROE, PS, ZO, W, OΔW as in formulas (1), - (6), ΔE – change in the number of employees in %, NE – number of employees, SM – synthetic measure.

The ratio of paying for the efficiency growth occasionally exceeded 1. This proves that the management boards tried to make the growth in work efficiency exceed the growth in remunerations, which means that the economic interest of companies was pursued more than that of the employees.

FINANCIAL PERSPECTIVES OF THE SURVEYED COMPANIES AND JOB SECURITY OF THEIR EMPLOYEES

For the majority of the surveyed companies, financial situation at the end of 2014 was worse as compared to 2010. Comparing profitability of the concerned companies over time, it should be noted that in the case of 10 out of 17 companies ROE is lower at the end of the analysed period than at the beginning of that period. This indicates that the profitability of equity for the majority of companies decreased. Similar conclusion can be drawn for profitability of assets, but in this case this regularity occurred for 9 out of 17 companies. Liquidity standards were not met only by PBG in arrangement bankruptcy in 2012, 2013 and 2014, Delko in 2011 and 2012, Groclin in 2010-2012; apart from that, the required liquidity was preserved. The indebtedness exceeded the safe level of (0.66) only in the case of PBG in the period 2012-2014 and Komputronik S.A. in 2014. Apart from that, it stayed within the acceptable levels.

The synthetic measure of the financial situation of companies in most cases exceeded 2.00 (half of the maximum possible level), which proves good condition of these companies. The only companies in adverse condition were PBG in 2012-2014 and Groclin in 2014. However, in the case of Groclin, so far no clear financial risk is present, and with appropriate management, operations of this company should not be endangered. On the other hand, the operations of PBG in arrangement bankruptcy are highly endangered.

The arithmetic mean of the synthetic measure for all companies for the examined years is as follows:

Table 9. Average synthetic measure of analysed companies

	2010	2011	21012	2013	2014
SM	3.00	2.98	2.79	2.90	2.80

Source: own calculations

The deteriorating tendency is clearly visible (except for small improvement in 2013), however, this deterioration is so minute that it should be assumed that financial security is maintained.

Total employment in the examined companies in the analysed years was:

Table 10. Total employment in the analysed companies

	2010	2011	2012	2013	2014
Number of employees	8514	7996	7956	9268	8355

Source: own calculations

In the case of total employment in the analysed companies, it should be noted that the number of jobs decreased in 2011 by 6.08 %, in 2012 it remained at an identical level, it substantially increased in 2013 by 16.49 % and decreased in 2014 by 9.85 %. At the end of 2014, the number of employees was lower by 1.87 % than at the end of 2010.

The study also proved lack of significant dependences between changes in employment and work efficiency, or changes in revenues and financial condition. In all of these cases, the module of

the linear correlation coefficient is lower than 0.5. Thus, there is no direct linear relationship between these values. Hence, it is impossible to predict changes in employment on the basis of the planned changes in sales revenues.

Therefore, it should be stated that the number of jobs in the examined entities at the end of the analysed period is similar to that at the beginning of this period, so job security in public companies of the Wielkopolskie Voivodeship is generally maintained, although some perturbations occur that may get in the way of the employees' confidence. Certainly, we cannot say that the jobs of 253 employees of PBG S.A are secure, since this company is in arrangement bankruptcy.

CONCLUSIONS

The conducted study of companies based in the Wielkopolskie Voivodeship, quoted on the Warsaw Stock Exchange, which submitted reports for 2010-2014, shows that, in general, their condition does not threaten their financial security. They are in a good, stable situation.

The analysis of changes in the employment level indicates that the total number of jobs has decreased, but the decrease was not significant enough to endanger job security. However, changes in particular years indicate perturbations, which may negatively affect employees and their families.

An exception from the aforementioned conclusions is PBG S.A., which is in arrangement bankruptcy, which results in a threat to the existence of the company and a threat for the 253 employees employed there at the end of 2014.

REFERENCES

1. Bednarski L., Borowiecki R., Duraj J., Kurtys E., Waśniewski T., Wersty B. 1996: Analiza ekonomiczna przedsiębiorstwa, Publishing House of the Oskar Lange University of Economics in Wrocław, Wrocław, ISBN83-7011-224-2.
2. Jerzmanowska M. (ed.). 2004: Analiza ekonomiczna w przedsiębiorstwie, PWE, Warsaw, ISBN978-83-01-15671-8.
3. Król H., Ludwiczyński A., 2014 Zarządzanie zasobami ludzkimi, PWN, Warsaw ISBN 978-83-01-14813-3.
4. Kukuła K. 2000: Metoda unitaryzacji zerowanej, PWN, Warsaw, ISBN 83-01-13097-0.
5. Marzec I., 2010, Zatrudnialność jako czynnik bezpieczeństwa zatrudnienia i sukcesu na współczesnym rynku pracy, Scientific Papers of the University of Occupational Safety Management in Katowice, Kartowice, ISSN 1895-3794.
6. Pocztowski A. (ed.), 2009 Procesy płynności i retencji zatrudnienia w organizacji, Publishing House of the University of Economics in Cracow, Cracow, ISBN 978-83-7252-466-9.
7. Sierpińska M., Jachna T., 1994, Ocena przedsiębiorstwa według standardów światowych, PWN, Warsaw, ISBN83-01-11187-9.

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SPATIAL DIVERSIFICATION OF ORGANIC FARMING

Abstract: The article discusses spatial diversification of organic farming in Poland between 2004 and 2014. The following quantitative determinants of organic farming growth were analysed: the number of farms, the farmland area, mean farm area, the volume of production of selected organic crops (rye and potatoes). This article is based on source materials acquired from reports on organic farming 2004-2014 provided by the Central Inspectorate for Commercial Quality of Agri-Food Products. The article discusses spatial diversification in the development of organic farming. It indicates high dynamics of quantitative growth in organic farming, especially in three voivodeships: West Pomeranian, Warmian-Masurian and Podlaskie.

Key words: organic farming, diversification, voivodeships

INTRODUCTION

Organic farming is an atypical system of management, where special importance is attributed to environmental functions. The implementation of these functions involves the use of specific means of production and elimination of other means, especially of chemical origin. Deliberate elimination of these means increases two types of safety: environmental and food-related. They require specific treatments which have positive influence on the maintenance and improvement of soil fertility and the production of food of high nutritional value. Organic farming plays a particularly important role in guaranteeing two types of safety: environmental and food-related. In view of increasing use of external factors in agriculture, whose long-term and accumulated consequences have not been identified yet, this role becomes particularly important for consumers searching for alternatives to the conventional system of agricultural production. According to Komorowska [2015, p.122], the importance of food safety is growing as it determines consumers' decisions. (…) Organic food is perceived as natural. It inspires consumers' confidence and translates into their market behaviours.

Organic farming is also an important component of sustainable development. Due to relatively rigorous environmental standards of organic farming, it perfectly matches the concept of sustainable development and in a way it is a point of reference for other management systems in agriculture. Although organic farming has been developing dynamically in recent years, its share in total agriculture is still minimal. Nevertheless, in the future it may play a more important role in the dual model of European agriculture, which is, on the one hand, oriented to efficiency in conventional farming, and on the other hand, to the environment in organic and integrated farming.

The aim of the article was to discuss spatial diversification in the development of organic farming in Poland. The article is based on data acquired from reports on organic farming provided by the Central Inspectorate for Commercial Quality of Agri-Food Products. The article points to the high dynamics of quantitative growth of organic farming, especially in three voivodeships: West Pomeranian, Warmian-Masurian and Podlaskie.

SPATIAL DIVERSIFICATION IN THE NUMBER OF ORGANIC FARMS

Organic farming has been developing dynamically since 2004, i.e. since the integration with the European Union, when it was given considerable support under agricultural and environmental programmes. The development of organic farming resulted not only from the support system but also from consumers' growing demand for its products. In 2003 there were 2,286 organic farms in

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Poland. They occupied a total area of about 30,000 ha of farmland. In that year about 7 million zlotys was given to support organic farming, including nearly 6 million zlotys in subsidies to plantations (83.7% of total subsidy) and 1.1 million in subsidies to inspection costs (16,3%). In 2004 the number of farms increased considerably up to 3,760. The increase continued until 2013, when the number of farms amounted to 27,093. In 2014 the number of farms dropped slightly to 25,427, which contrasted with some statistic forecasts, according to which the number of farms was predicted to increase to 31,439 [Luty 2014, p. 78].

During the period under study the greatest number of organic farms was noted in Warmian-Masurian Voivodeship (number one) and West Pomeranian Voivodeship (number two). In 2014 the number of these farms amounted to 31% of all organic farms in Poland. It is noteworthy that in 2004 Warmian-Masurian Voivodeship was in the sixth place and West Pomeranian Voivodeship was in the ninth place in the ranking of voivodeships according to the number of organic farms. In 2004 Świętokrzyskie Voivodeship and Lesser Poland Voivodeship were in the first and second place, which corresponded to the fragmented agrarian structure of farms in these areas. It was in agreement with the belief that organic farming should primarily develop in areas dominated by fragmented farms. It seems that the financial support caused reorientation of the development of this type of farming towards regions dominated by large farms.

Table 1. The number of organic farms in individual voivodeships in Poland in 2004 and 2014.

Voivodeship	2004		2014		Growth dynamics 2014/2004
	Number	%	Number	%	%
Lower Silesian	197	5.24	1,078	4.24	447.2
Kuyavian-Pomeranian	89	2.37	419	1.65	370.8
Lublin	393	10.45	2,037	8.01	418.3
Lubusz	66	1.76	1,384	5.44	1,997.0
Łódź	71	1.89	544	2.14	666.2
Lesser Poland	697	18.54	1,419	5.58	103.6
Masovian	434	11.54	2,529	9.95	482.7
Opole	26	0.69	81	0.32	211.5
Subcarpathian	430	11.44	1,511	5.94	251.4
Podlaskie	207	5.51	3,453	13.58	1,568.1
Pomeranian	66	1.76	878	3.45	1,230.3
Silesian	47	1.25	262	1.03	457.4
Świętokrzyskie	547	14.55	1,003	3.94	83.4
Warmian-Masurian	244	6.49	4,244	16.69	1,639.3
Greater Poland	70	1.86	1,036	4.07	1,380.0
West Pomeranian	176	4.68	3,549	13.96	1,916.5
Total	3,760	100.00	25,427	100.00	576.3

Source: Organic Farming in Poland in 2004, Central Inspectorate for Commercial Quality of Agri-Food Products, Warsaw 2005; Report on Organic Farming in Poland Between 2013 and 2014, Central Inspectorate for Commercial Quality of Agri-Food Products, Warsaw 2015.

There are still few organic farms in Opole, Silesian and Kuyavian-Pomeranian Voivodeships. In 2014 the number of these farms ranged from 81 to 419. We can expect that in the future there will still be little interest in organic farming in these voivodeships. A moderate increasing trend can be expected in northern voivodeships. However, the current high increase is not very likely to

continue. So far its high dynamics resulted from the application of a new financial instrument in the form of support given to organic farming under agri-environmental schemes. New conditions of using this instrument were introduced in 2014. They extend the range of organic farmers' commitments. In consequence, some of them may abandon participation in agri-environmental schemes and organic production.

SPATIAL DIVERSIFICATION IN THE ORGANIC FARMLAND AREA

During the period under study the number of organic farms increased by more than 600%.The organic farmland area increased even more, from 82,700 ha in 2004 to 657,900 ha in 2014. Some forecasts predicted that the organic farmland area would increase to 799,104 ha [Luty, 2014, p.79]. There were not so many changes in the ranking of voivodeships according to the farmland area as in the ranking according to the number of farms. West Pomeranian Voivodeship remained the leader (129,500 ha). It was followed by Warmian-Masurian (117,100 ha) and Podlaskie Voivodeships (64,900 ha). The organic farmland area is mostly concentrated in northern Poland, where state-owned farms and the related specific agrarian culture used to be very important. In the other voivodeships organic farms are scattered and located at a considerable distance from the market, which has negative influence on their development.

Table 2. The organic farmland area in individual voivodeships in 2004 and 2014.

Voivodeship	2004		2014		Growth dynamics 2014/2004
	ha	%	ha	%	%
Lower Silesian	8,789.1	10.6	37,005,16	5.6	321,0
Kuyavian-Pomeranian	1,719.1	2.1	11,573,87	1.8	573,3
Lublin	5,705.6	6.9	38,466,64	5.9	574,2
Lubusz	2,297.7	2.8	53,299,83	8.1	2,219,7
Łódź	1,195.4	1.4	11,228,87	1.7	839,3
Lesser Poland	7,626.4	9.2	15,528,88	2.4	103,6
Masovian	6,075.0	7.3	60,354,37	9.2	893,5
Opole	446.7	0.5	3,306,45	0.5	640,2
Subcarpathian	10,711.4	13.0	23,509,74	3.6	119,5
Podlaskie	3,863.3	4.7	64,897,11	9.9	1,579,8
Pomeranian	1,781.3	2.2	29,281,64	4.5	1,543,8
Silesian	486.6	0.6	7,787,90	1.2	1,500,5
Świętokrzyskie	4,994.6	6.0	13,037,43	2.0	161,0
Warmian-Masurian	9,496.6	11.5	117,097,00	17.8	1,133,0
Greater Poland	4,815.9	5.8	42,071,21	6.4	773,6
West Pomeranian	12,724.8	15.4	129,456,00	19.7	917,4
Total	82,730.2	100.0	657,902,06	100.0	695,2

Source: Organic Farming in Poland in 2004, Central Inspectorate for Commercial Quality of Agri-Food Products, Warsaw 2005; Report on Organic Farming in Poland Between 2013 and 2014, Central Inspectorate for Commercial Quality of Agri-Food Products, Warsaw 2015.

The high dynamics of organic farming growth during the period under study was stimulated by the support system with particularly favourable agri-environmental conditions, which consisted of 8-14 variants. There were diversified payment rates, which depended on the following two criteria:

- type of organic plantations,
- period of production shift: during the shift or after the end of the shift (with a certificate).

In the first and second RDP, i.e. 2004-2006 and 2007-2013, the maximum payment rates were 1,800 zlotys per ha and they encouraged many farmers to shift to pomicultural and berry production. As a result, by 2013 the area of orchards had increased eight times. However, usually there was no yield of fruit, because farmers received payments to newly established plantations without the requirement to gain yield within five years of the agri-environmental commitment. As we can read in the report of the Supreme Audit Office, the total amount of 708.7 million zlotys expended from public funds on organic orchard and berry plantations under RDP 2004-2006 and RDP 2007-2013 did not increase the production or sales of fruit from these plantations. During the programmes (…), after 2004 the yield of fruit suddenly dropped from 15 tonnes per ha in 2005 to 1 tonne per ha in 2013. [Wykorzystanie..2014, p. 7]

Subsidies stimulated increase in the area listed in applications under the organic farming package. Simultaneously, they improved the economic results of farms and resulted in positive income [Nachtman, 2013]. As results from the study, subsidies are an important factor improving the economic results of farms, especially in those with a large area [Nachtman, 2008].

Table 3. Payment rates for agri-environmental commitments in the organic farming package.

Type of plantation	Organic farming subsidies (zlotys per ha)		
	RDP 2004-2006	RDP 2007-2013	RDP 2014-2020
Agricultural plantations:			
- during shift period	680	800	966
- with certificate	600	750	792
Permanent grassland :			
- during shift period	330	400	428
- with certificate	260	350	428
Vegetable plantations:			
- during shift period	980	1,540	1,557
- with certificate	940	1,300	1,310
Herbal plantations:			
- during shift period	-	1,150	1,325
- with certificate	-	1,050	1,325
Pomicultural and berry plantations			
- during shift period	1,800	1,800	1,882
- with certificate	1,540	1,540	1,510
Other pomicultural and berry plantations			
- during shift period			
- with certificate	-	800	790
	-	650	660
Feed plantations on arable land			
- during shift period	-	-	787
- with certificate	-	-	559

Source: based on data of the Ministry of Agriculture and Rural Development, www.minrol.gov.pl

SELECTED PROBLEMS OF ORGANIC FARMING

As results from the study, organic farms in Poland are characterised by extensive production. Fodder plants make about 70% of total farmland owned by these farms. Until recently there was a considerable percentage of small production orchards, which amounted to 10%. There is also small production of animals due to rigorous breeding requirements. This results in small production of meat, especially beef and pork. Due to the absence of many data on the volume of organic

production in 2004, we can use rye and potato production as examples illustrating spatial diversification of crop production. In 2004 there was small rye production in all voivodeships. However, at the end of the period under investigation there were a few voivodeships with relatively high production. In this group the largest rye production was noted in West Pomeranian, Warmian-Masurian and Lower Silesian Voivodeships. The volume of production in these three voivodeships amounted to 41% of total organic production.

Table 4. Spatial diversification in organic production of cereals and potatoes in 2004 and 2014.

Voivodeship	2004		2014	
	cereals	potatoes	cereals	potatoes
Lower Silesian	1,591	181.8	15,313.90	519.95
Kuyavian-Pomeranian	757.7	367.2	3,873.82	1,055.50
Lublin	3,344.2	1,548.4	8,063.71	664.76
Lubusz	766.1	68.5	10,472.59	307.20
Łódź	361.7	284.1	4,145.14	421.97
Lesser Poland	1,384.5	1,882.4	2,646.22	1,135.83
Masovian	4,091.5	2,514.9	11,370.89	1,187.77
Opole	263.6	212.8	873.80	48.10
Subcarpathian	2,674.6	2,311.5	3,309.01	1,366.71
Podlaskie	1,443.1	1,367.7	11,608.96	3,229.83
Pomeranian	494.3	389.5	5,473.55	525.77
Silesian	236.5	106.0	1,378.88	86.47
Świętokrzyskie	4,216.2	5,110.3	4,068.42	1,791.95
Warmian-Masurian	1,674.4	284.1	15,857.31	3,228.09
Greater Poland	365.9	200.8	10,577.39	287.6
West Pomeranian	2,205.2	404.7	22,829.41	1,211.54
Total	25,870.5	17,234.7	131,863.0	17,069.04

Source: Organic Farming in Poland in 2004, Central Inspectorate for Commercial Quality of Agri-Food Products, Warsaw 2005; Report on Organic Farming in Poland Between 2013 and 2014, Central Inspectorate for Commercial Quality of Agri-Food Products, Warsaw 2015.

There were some differences in potato production. The volume of production remained stable during the period under study and in 2014 it amounted to more than 17,000 tonnes. As far as spatial diversification is concerned, Masovian and Subcarpathian Voivodeships dropped out of the top three, where they were in 2004, and they were replaced by Podlaskie and Warmian-Masurian Voivodeships. The volume of production in these voivodeships was similar, i.e. 3,229.83 tonnes and 3,228.09 tonnes, respectively. Świętokrzyskie Voivodeship dropped from the first to the third place.

CONCLUSIONS

The following conclusions can be drawn from the study of spatial diversification in the development of organic farming between 2004 and 2014.

1. During the period under study there were changes in the spatial development of organic farming. At the end of the period the spatial distribution of organic farming differed in the number of farms and farmland area from the status quo at the beginning of the period.
2. Integration with the European Union increased the significance of organic farming in northern Poland. However, it was a quantitative increase, measured with the number of farms and farmland area.

3. In 2014 the spatial distribution of selected organic production was minimally the same as in 2004. Masovian and Subcarpathian Voivodeships lost the lead in potato production and were replaced by Podlaskie and Warmian-Masurian Voivodeships, whereas Świętokrzyskie Voivodeship dropped from the first to third place. As far as cereals are concerned, the production was concentrated in West Pomeranian, Warmian-Masurian and Lower Silesian Voivodeships, but at the beginning of the period under study the production was low in these regions.

REFERENCES

1. Luty L., (2014), Wpływ akcesji Polski do Unii Europejskiej na rozwój rolnictwa ekologicznego, Roczniki Naukowe Ekonomii Rolnictwa i Rozwoju Obszarów Wiejskich, t.101, z.1.
2. Jończyk K., (2014), Rolnictwo ekologiczne w Polsce, Zeszyty Naukowe WSEI, seria Ekonomia, nr 8.
3. Komorowska D., (2015), Znaczenie rolnictwa ekologicznego w Polsce, Roczniki Naukowe SERiA, t. XVII, z. 2.
4. Nachtman G., (2013), Dochodowość gospodarstw ekologicznych a wielkość użytków rolnych, Roczniki Ekonomii Rolnictwa i Rozwoju Obszarów Wiejskich, t.100, z.1.
5. Nachtman G., (2008), Ocena dochodów gospodarstw ekologicznych na tle gospodarstw konwencjonalnych w 2008 roku w świetle danych polskiego FADN, Zagadnienia Ekonomiki Rolnej, nr 3.
6. Raport o stanie rolnictwa ekologicznego w Polsce w latach 2013-2014, GIJHARS, Warszawa 2015.
7. Rolnictwo ekologicznego w 2004 roku, GIJHARS, Warszawa 2005.
8. www.minrol.gov.pl/wsparcierolnictwa

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CANONICAL CORRELATION ANALYSIS BETWEEN THE INSTITUTIONAL INFRASTRUCTURE AND INNOVATION OF ENTERPRISES – REGIONAL PRESENTATION

Abstract: An aim of the work is to define the relations between development level of the institutional infrastructure in regions and innovation level of enterprises. Due to multidimensionality of analyzed categories, the canonical analysis was used, which is a generalization of linear multiple regression for two sets of variables. The study was conducted for all 16 provinces in Poland. Canonical analysis was preceded by the identification of outliers and the assessment of normal disintegrations. As a part of canonical analysis, the significant number of rates was calculated, including among others canonical correlations, total redundancy, and distinguished variances.

Keywords*:* innovation, institutional infrastructure, canonical analysis

INTRODUCTION

Along with increased importance of knowledge and technology, in the business practice an increase in importance of innovation is observed. It is assumed that modern enterprises should operate in the innovative environment. Such an environment constitutes "extracted territorially team in which innovative networks develop by the practice of these actors by mutual exchange that generates specific externalities for innovation carried out thanks to the convergence of practices and greater achievements in creation of technology" [Godlewska 2001]. According to T. Grosse [2002] the innovative environment includes scientific and research resources of the region (in particular university resources). It is hard to disagree with the fact that development and absorption of innovation requires support of individual elements of the institutional infrastructure. It is very important, since in our times the capacity of business entities to creation and absorption of innovation often depends on their development potentialities. Therefore, analysis of the environment institutional may have an impact on the location and investment decisions of enterprises.

An aim of the work is to conduct canonical analysis, which will enable to identify relations between sets of variables relating to two multidimensional categories - level of the innovation of enterprises and institutional infrastructure. The analysis was carried out on a level of provinces. Their completeness and availability of objects for all investigated objects in 2014 were the main criterion for selection of variables.

THE INSTITUTIONAL INFRASTRUCTURE IMPORTANCE IN CREATION OF INNOVATION

It is possible to perceive the infrastructure as a certain set of devices and objects, associated with various fields of economy that are essential for proper operation of the social and economic activity, as well as a set of institutions that normalize function of business entities. Due to functions, which the infrastructure carries out, most often in the subject literature are found its dichotomous division into economic and social. In such an approach, the social infrastructure includes devices and institutions that directly meet the needs of society and ensure appropriate living conditions. L. Kupiec defines the social infrastructure as "a complex of devices for public utility essential above all for direct satisfaction of needs of the given society and to enable appropriate living conditions of

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population" [Kupiec et al. 2004]. Due to the generic criteria as a part of the social infrastructure, there are most often distinguished two systems [Kuciński 1994; Kupiec et al. 2004]: social (among others health care, tourism, accommodation sector) and institutional (among others public administration, professional organizations). Transport, energy and drainage devices, services in communications, production security processes and exchange are included in the economic infrastructure. In contrast to social infrastructure, the economic infrastructure provides mainly transfer functions.

Some authors as a part of infrastructure distinguish the third, separate subsystem – the institutional infrastructure. R. Jochimsen distinguishes the institutional infrastructure next to material and personal infrastructure, as one of three main components of the infrastructure. An author identifies it with the standards and ways of behavior in their constitutional dimension that creates the frames for independent action of individual business entities [Ratajczak 1999]. Authors often combine the concept of institutional infrastructure with a number of organizations, which include, among others: [Chądzyński 2007]: public institutions (among others higher education institutions, public authorities), public and private institutions (among others regional development agencies), non-governmental institutions of the civil sector (among others foundations in support of business development), private institutions (among others economic organizations), private sector associations (among others professional associations). In order to avoid any misunderstanding for the purposes of this work, it was assumed (among others L. Kupiec 2004) that the institutional infrastructure constitutes a social infrastructure subsystem. It is justified by the fact that component parts of the social infrastructure contained in many definitions, most often include elements of the institutional infrastructure. M. Ratajczak as a part of the institutional infrastructure distinguishes two subsystems, i.e.: material (financial and intellectual capital) and immaterial (formalized and not-formalized) institutional infrastructure [Ratajczak 1999]. M. Reichel to institutional infrastructure includes institutions operating in the region focused on promotion of the entrepreneurship and innovation, to which qualifies among others self-government authorities, regional and local development agencies, universities, institutes of research and development, technology transfer centers, counselling centers, consulting and financial institutions [Reichel 2006]. Similarly, C. Longhi perceives the institutional infrastructure; he identifies it with the institutions in business environment. He includes to it among others local government, regional banks, service centers [Longhi 1999]. In SOOIPP terminology the institutional infrastructure is identified with innovation and entrepreneurship centers, which carry out number of utility functions that enable enterprises for dynamization of developmental processes and implementation of strategies [Bąkowski, Mażewska (ed.) 2015]. They are classified in three groups, such as: entrepreneurship centers (training and consulting centers, business incubators); innovation centers (technology transfer centers, preincubators, academic business incubators, technology incubators, technology parks) and para-banking financial institutions (among others guarantee funds, seed capital funds). It is hard to disagree with M. Ratajczak, who such diverse interpretations of the institutional infrastructure, explains with different ways of interpretation of the "institution" term - as principles that regulates relations between entities. The first perspective is typical for analyses of the sociological nature, while the second is characteristic for deliberations from the organization and management scope [Ratajczak 1999]. With above in the further part of this work, the author will focus on the material institutional infrastructure.

Services provided by individual elements of the institutional infrastructure can bring added value to entities conducting business activity, contributing to increase in absorption of innovation. In consequence, by support of the innovative activity of enterprises, institutional environment has an important role in a growth of innovation in the entire economy. It has particular importance in the

context of building a competitive advantage due to the fact that innovation is regarded as the basic determinant of many economic processes occurring in the economy.

Institutional environment by creation of innovation and support of new technologies, contributes to develop of more efficient working methods, improvement of production quality and provided services, reduce time of releasing new goods on the market, or also enables flexible response to changes in the environment.

In our times, the role of innovation centers dynamically grows, which include entities that carry out supporting programs in the innovation. It results from diverging from the linear model of innovative process (in which deed and sale of technological solutions dominated) for the interactive process (in our times, technology transfer is a process in which various loops of feedbacks appear between senders and recipients). This constitutes a special case of communication process and includes all kinds of diffusion forms in innovation and technical education. Traditional forms of transfer are widened by issues: creation of small technological enterprises and support of innovative undertakings in SMEs; consulting and technological mediation, as well as information about new technologies; initialization of network support, collaboration and cooperation [Matusiak 2005].

According to A.H. Jasiński every effectively operating business entity should be oriented to innovation. In author's opinion the innovative company is such, which: conducts research and development works in a wide range (or purchase projects of new products or technology); allocates relatively high financial outlays on this activity; systematically implements new scientific and technical solutions; represents a large share of novelties in the volume of production and services; constantly introduces innovations to the market [Jasiński 1992]. Taking into account the open nature of business activity, an obvious issue is that innovation of enterprises significantly depends on the efficiency of provided service by the institutions to support development of entrepreneurship and innovation. Insufficient financial resources of enterprises and poor quality of human capital constitute (especially for micro and small-sized enterprises) significant barriers to conduct their own research, aimed to develop innovative solutions that can be used in business practice. In the context of these barriers, elements of institutional infrastructure constitute not only an important external sources of innovations (e.g. research and development units, technology parks) conducting activity among others in applied research, but perform number of other functions aimed to stimulate transfer of innovation and to elimination of barriers hindering cooperation of scientific sphere with the sphere of economic practice. Institutional infrastructure elements are important in identification of innovative entrepreneurs needs (it can be preceded by the audit of technological needs), they assess possibilities of commercial new solutions (technological, organizational, product), provide support to seek modern technologies (in specially created databases with offers of modern technologies) or immediate producers of technology that are able to carry them out in accordance with the requirements of contracting authority. They also participate in searching for recipients of modern technologies, taking action aimed to promote modern solutions (e.g. activities of technology transfer centers), organizing among others conferences and direct meetings. Moreover, they create procedures that enable evaluation and application for the legal protection of innovation (e.g. research and development units, universities). These institutions also provide assistance in terms of financial support to entities that want to apply innovative solutions in their activity (e.g. local loan funds), as well as support the process of innovation in economic practices (among others training and consulting centers), verifying e.g. adaptive abilities of the given entity.

RELATIONS BETWEEN THE DEVELOPMENT LEVEL OF INSTITUTIONAL INFRASTRUCTURE AND INNOVATION OF ENTERPRISES

In accordance with the *Innovation Union Scoreboard* (IUS) methodology, the innovation economy rates used to appoint the *Summary Innovation Index* – SII, can be divided into three

groups [*Innovation Union Scoreboard* … 2012]: potential (basic elements that describe the capacity of economy to innovate (human resources, research system, financing), activity of enterprises (business action taken in terms of innovation (investment, intellectual resources, enterprise connections), products (effects of innovative actions (activity of innovators, economic effects)). By analogy, in the model for comprehensive evaluation of the innovation of enterprises, drawn up by Fraunhofer Institut [*Überholspur Innovation* 2007], three groups of characterizations relating to innovation were distinguished, i.e.: expenditure on innovations, design area of the innovation process (among others strategy, processes, project management) and effects of innovative action.

In order to assess the innovation potential of enterprises, the following set of rates, classified in three focus groups, was adopted: I. Potential: W_{11} - enterprises with the Internet (in %); W_{12} - enterprises with means of automations, up to 10 thousand entities registered in REGON (Statistical Identification Number); W_{13} - industrial enterprises, which cooperated in the innovative activity in total percent. II. Incurred expenditures: W_{21} - relation of the internal expenditure on B+R activity to GDP (in current prices)[11]; W_{22} - expenditure on research and developmental activity in the field of technical and engineering sciences on 10 thousand people; W_{23} - expenditure on the innovative activity in enterprises from the service sector on 10 thousand people; W_{24} - expenditure on the innovative activity in industrial enterprises on 10 thousand people. III. Effects: W_{31} - enterprises, which released new or significantly improved products (in %); W_{32} - inventions reported on 10 thousand people; W_{33} - granted patents and reported utility models on 10 thousand people.

7 subindices were used in order to determine the development level of institutional infrastructure in individual provinces, which were divided into 3 focus groups: I. innovation centers: I_{11} - weighted average[12] density rate of technology parks that conduct an operational activity; I_{12} - weighted average density rate of technology incubators; I_{13} - weighted average density rate of technology transfer centers. II. entrepreneurship centers: I_{21} - weighted average density rate of business incubators; I_{22} - weighted average density rate of training and consulting centers. III. other institutions that support the innovation development: I_{31} - weighted average density rate of higher education institutions; I_{32} - weighted average density rate of units actively conducting research and developmental activity (excluding units in the business sector).

Selection of variables was largely determined by the availability and completeness of data for all objects and their current status. In both analyzed sets, fragmentary variables taken into account are indicative, rather than values of absolute character. It was assumed that features, for which the value of variation coefficient was smaller than determined in an arbitrary way, the critical threshold value of this rate on a level of 10%, will be eliminated from the set of potential variables. Apart variation, an important criterion for selection of variables is their correlation (so-called capacitive criterion). It is understood that two high correlated variables provide similar information, so it is recommended to eliminate one of them. One of discrimination features methods was used for evaluation of information value depending on the value of correlation matrix – so-called method of reverse correlation matrix. Reverse correlation matrix was calculated for each of thematic subgroups of variables. In the next step - if it was conic - a variable characterized by the diagonal maximum value that exceeded the arbitrarily determined threshold value on a level of 10 was eliminated. A set of diagnostic features relating to the level of enterprises innovation was reduced due to the low degree of differentiation, eliminating variables: W_{11} and W_{22}. Moreover, the W_{23} variable was

[11] Due to the lack of data regarding relations of internal expenditures on B+R activity to GDP in 2014, data was accepted for 2012.

[12] Weighted average density rate of spot elements, includes both the population numbers and surface of the given area. In mathematical figure this rate is described as the quotient of objects and square root of the surface area and population number [cf. Grzywacz 1982].

eliminated with regard to capacitive criterion. Other variables (in both considered sets) due to high discriminatory capacity, as well as high information capacity, were used in further analysis. Since in methods of multidimensional statistical analysis, one of main requirements that are put in view of diagnostic variables is their comparability, the standardization process through the classical standardization of variable was conducted.

In order to present the relation between sets of variables that describe the innovation level of enterprises and saturation of regions with the institutional infrastructure, canonical analysis was conducted. Due to multidimensional nature of analyzed categories, the use of this multidimensional exploratory technique seems to be justified. This method is a generalization of linear multiple regression for two sets of variables. Its main idea leads the study of relations of two variable sets to analyze the relations between two new types of variables (so-called canonical variables). They are weighted sums of the first and second set, and weights are selected in such a way that two weighed sums were maximum correlated [Hardoon et al. 2003, Ter Braak 1990, Naylor et al. 2010]. In case of considering two linear combinations $x = x^T \hat{w}_x$ and $y = y^T \hat{w}_y$, it is seek to maximize the expression [cf. Weenink 2003, Hardoon et al. 2003]:

$$r_l = \frac{\left(w_x^T R_{xy} w_y\right)}{\sqrt{\left(w_x^T R_{xx} w_x w_y^T R_{yy} w_y\right)}},$$

where: R_{xx} - correlation matrix of dependent variables; R_{yy} - correlation matrix of explanatory variables; R_{xy} - correlation matrix of both variable types; w_x, w_y - weights for canonical variables of the first and second type; r_l - canonical correlation coefficient.

At first, proposed fragmentary variables were subjected to the detection procedure of diverging observations (they can significantly distort the results of canonical analysis, especially in case of small number of observations), which may arise e.g. from errors of transcription. For that purpose, the rule of "3 sigma" was applied, according to which observations outside the range are removed [average –3*standard deviation; average +3*standard deviation]. In case of identifying diverging values, they were replaced with average values calculated for macro-regions, in which provinces characterized by variables exceeding limit values are located[13].

The normalcy of distribution of considered variables was assessed based on graphs of the normalcy and Shapiro-Wilk's test results. In case of variables without normal distribution, Box-Cox transformation was applied in order to bring the normal distribution. This transformation has a form of:

$$y_i^{(\lambda)} = \begin{cases} \dfrac{y_i^{\lambda} - 1}{\lambda}, dla \quad \lambda \neq 0, \\ log \quad y_i, dla \quad \lambda = 0. \end{cases}$$

where selection of λ transformation parameter is carried out with the Maximum Likelihood classification.

In a set of variables that describe the level of innovation, the W_{14} variable was subjected to transformation, while among variables that describe the level of regions saturation in institutional infrastructure, the Box-Cox transformation was carried out for I_{12} variable. After transformation, the

[13] Amongst variables that describe the institutional infrastructure of individual regions, there have not been identified outliers. However, in a set of variables relating to the level of innovation in one case the outlier was observed - W_{24} (Masovian Voivodeship).

W_{14} variable showed normal compatible distribution, while the distribution of I_{12} variable still deviated from a normal distribution. For this reason the variable relating to regions saturate with technology incubators are omitted in further analysis.

Table 1. Wilks' lambda test results

Removed element	Canonical correlation	The value of $\chi 2$ test	Number of degrees of freedom for χ 2 test	Probability level p for $\chi 2$ test	The value of statistics Wilks' lambda
0	0,9935	72,8942	42	0,0022	0,0001
1	0,9441	38,0739	30	0,1480	0,0086
2	0,8871	20,3147	20	0,4385	0,0789
3	0,6710	7,9425	12	0,7896	0,3705
4	0,4706	3,1559	6	0,7890	0,6740
5	0,3664	1,1530	2	0,5619	0,8658

Source: Own elaboration based on Central Statistical Office data (GUS) and Bąkowski, Mażewska (ed.) 2015

The "foundation" of canonical analysis is a pair of canonical variables with determined correlation degree. As mentioned above, the canonical weights are determined in such a way as to maximize the correlation between pairs of canonical variables. The total number of canonical variables is equal to minimum number of variables in some of analyzed sets (in this case 6). In this type of analysis, it is necessary to determine how many first pairs of canonical variables should be used for in-depth analysis. For that purpose, the severity test of canonical correlation Λ-Wilks was applied (Wilks' lambda). In order to verify the severity of pairs of canonical variables, the test statistics was used for s-k set of changeable forms [Panek, Zwierzchowski 2013]:

$\Lambda_k = \prod_{l=k}^{s}(1-r_l^2)$, where: s - number of canonical variables. Test statistic has a probability distribution of Λ-Wilks with the number of freedom: $d_{f_1} = m-s-k+1$ and $d_{f_2} = n-k-m+s.$

Based on the critical value of severity level, further analysis includes only the first canonical variable. The analytical form of this variable is as follows:

U_1=-0,1907I_{11} - 0,1418I_{13} - 0,5927I_{21} + 1,2332I_{22} + 22,5163I_{31v}- 23,2824I_{32};

V_1=0,4551W_{12} + 0,5618W_{13} - 0,4930W_{21} + 0,6727W_{24} - 0,6675W_{31} +0,3399W_{32}- 0,9248$W_{33.}$

Appointed weights reflect the specific contribution of each variable to weighed sum. Along with an increase in the number of absolute weight, a contribution increases (positive or negative) to generate the canonical variable. The calculations show that for considered canonical variable, the largest (absolute) values of weights have I_{32} (23.2824) and W_{33} (0.9248) variables.

Table 2. Factor structure for two considered sets of variables

Factor structure							
Set of variables that reflect development level of the institutional infrastructure				Set of variables that reflect the innovation level of enterprises			
I_{11}	-0,1515	I_{22}	0,2890	W_{12}	0,5365	W_{31}	-0,3858
I_{13}	-0,5299	I_{31}	-0,4293	W_{13}	-0,0290	W_{32}	-0,5939
I_{21}	0,1018	I_{32}	-0,4409	W_{21}	-0,5224	W_{33}	-0,6764
				W_{24}	-0,2475		

Source: Own elaboration based on Central Statistical Office data (GUS) and Bąkowski, Mażewska (ed.) 2015

Hence, it is possible to assume that creation of this canonical variable in a large degree is affected by correlation between entities actively conducting B+R activity, and the number of

granted patents and reported utility models in converting into 10 thousand residents. In next step, the canonical factor loadings and redundancies were calculated. Factor loadings are identified with correlation between canonical and spare variables in each set.

In a set of variables relating to the development level of institutional infrastructure, for the first canonical variable the largest factor loading shows the I_{13} variable (-0,5299). In case of the second set of variables, the largest factor loading has the W_{33} variable (-0.6764). The average from squares of factor loadings was calculated for each canonical variable – the value of distinguished variances, which describes what percent of the variance of input variables, explains these canonical variables. It is possible to describe them with the expression:

$$\overline{R_{u_l}^2} = \frac{1}{q}\sum_{j=1}^{q} c_{jl}^2 \text{ or } \overline{R_{v_l}^2} = \frac{1}{m-q}\sum_{j=q+1}^{m} d_{jl}^2 \text{ , } l=1,2,\ldots,s,$$

where: q - number of underlying variables; c_{jl} - canonical factor loading located at j of underlying variable and l of canonical variable of the first type; d_{jl} - canonical factor loading located at j of underlying variable and l of canonical variable of the second type.

When this average is multiplied by the square of canonical correlation, we will receive the redundancy rate. This provides information how much of the average variance in one set is explained by the given canonical variable at the given another set of variables. This rate has a form of:

$$R_{u_l,x^2}^2 = \overline{R_{u_l}^2} \cdot \lambda_l \text{ or } R_{v_l,x^1}^2 = \overline{R_{v_l}^2} \cdot \lambda_l \text{ , } l=1,2,\ldots,s,$$

where: λ_l - characteristic element of the square matrix of canonical correlation.

Table 3. Distinguished and redundancies variances

Detailed list	Institutional infrastructure		Innovations of enterprises	
	Distinguished variance	Redundancy	Distinguished variance	Redundancy
The first canonical variable	0,1294	0,1277	0,2260	0,2231

Source: Own elaboration based on Central Statistical Office data (GUS) and Bąkowski, Mażewska (ed.) 2015

The first canonical variable distinguishes 12.94% of variance in a set of variables, which reflect the development level of institutional infrastructure, and 22.60% in the second considered set. For a set of input variables that reflect the innovation level of enterprises we can explain appropriately 22.31% of variance in a set of variables concerning the development level of institutional infrastructure. However, with a set of input variables concerning the development level of infrastructure we explain 12.77% of variance in the second set based on a first significant statistically canonical variable. In further step, a total redundancy was calculated, which is interpreted as the average percent of variance explained in one set of variables by the given second set, based on all canonical variables. The calculations show that with the knowledge of variable values describing the development level of institutional infrastructure, it is possible to explain variables over 58.45% of variance from a set relating to the innovation level of enterprises. It is worthwhile to point to a very large and importantly highly significant statistically value of canonical correlation (see Table 1). The value is interpreted as a correlation between weighed summary values in each set with calculated weights for subsequent canonical variables. Correlation for the first canonical variable was 0.9935, which shows that adopted model well describes both data sets.

CONCLUSIONS

Realization of innovative projects is burdened with a high risk, in particular in the initial phase (research and developmental phase), above all in relation to the lack of appropriate knowledge, experience, or insufficient amount of financial means. This cause that often it is necessary to support the business institutional environment, which is a kind of inspire (and moderator) in implementation of innovative solutions in the business activity. Due to the number of functions conducted by individual elements of the institutional infrastructure, it is possible to assume that it seems as a necessary, but insufficient to increase the innovation level of enterprises in the region. Research shows that between analyzed phenomena is high statistical dependency. Based on received canonical analysis model, the redundancy analysis was carried out, as a result of which it is possible to state that with the knowledge of variable values describing the equipment of individual regions in the institutional infrastructure, it is possible to explain over 58% of variance from a set relating to the innovation level of enterprises. Moreover, it is worthwhile to emphasize that there were received very high values of canonical correlation coefficient. For the first canonical variable this value exceeded 0.99. Due to the problem of ensuring normality of analyzed variables, the use of canonical correlation to analyze socio-economic phenomena is more relevant to descriptive purposes than statistical analysis. Carried out research and obtained results can constitute a material for further analysis with other statistical methods and/or diagnostic variables. In order to increase the reliability of this analysis type, it is worthwhile to conduct similar tests at lower administrative levels (e.g. districts), which would increase the number of observations. However, a substantial limitation is that aggregation of necessary and widely available data is mostly conducted on the level of regions.

REFERENCES

1. Bank Danych Regionalnych. Baza danych GUS online. http://stat.gov.pl/bdl (dostęp 18.06.2016)
2. Bąkowski A., Mażewska M. (ed.), (2015), *Ośrodki Innowacji i Przedsiębiorczości w Polsce. Raport 2014*, Wyd. SOOIPP, Poznań-Warszawa.
3. Chądzyński J. (2007), *Środowisko przedsiębiorczości*. In: Chądzyński J., Nowakowska A., Przygodzki Z., *Region i jego rozwój w warunkach globalizacji*, CeDeWu, Warszawa.
4. Godlewska H. (2001), *Lokalizacja działalności gospodarczej. Wybrane zagadnienia*, WSHiFM, Warszawa.
5. Grosse T.G. (2002), *Przegląd koncepcji teoretycznych rozwoju regionalnego*, Studia Regionalne i Lokalne, 1(8).
6. Grzywacz W. (1982), *Infrastruktura transportu*, Wyd. KiŁ, Warszawa.
7. Hardoon D.R., Szedmak S., Shawe-Taylor J. (2003), *Canonical correlation analysis; An overview with application to learning methods*, University of London, London.
8. *Innovation Union Scoreboard 2011* (2012), European Commission, Belgium.
9. Jasiński A.H. (1992), *Przedsiębiorstwo innowacyjne na rynku*, Książka i Wiedza, Warszawa.
10. Kuciński K. (1994), *Geografia ekonomiczna. Zarys teoretyczny*, Wyd. SGH, Warszawa.
11. Kupiec L., Gołębiowska A., Wyszkowska D. (2004), *Gospodarka przestrzenna. Tom VI. Infrastruktura społeczna*, Wyd. Uniwersytetu w Białymstoku, Białystok.
12. Longhi C. (1999), *Networks, collective learning and technology development in innovative high technology regions: The case of Sophia-Antipolis*. Regional Studies, 33(4), p. 333-342.
13. Naylor M. G., Lin X., Weiss S.T., Raby B.A., Lange C. (2010), *Using Canonical Correlation Analysis to Discover Genetic Regulatory Variants*, PLoS ONE 5(5).
14. Matusiak K.B. (ed.), *Ośrodki innowacji w Polsce* (2005),Wyd. PARP-SOOIPP, Poznań-Warszawa.

15. Panek T., Zwierzchowski J. (2013), *Statystyczne Metody wielowymiarowej analizy porównawczej: Teoria i zastosowania*, Oficyna wydawnicza SGH, Warszawa.
16. Ratajczak M. (1999), *Infrastruktura w gospodarce rynkowej*, Akademia Ekonomiczna w Poznaniu, Poznań.
17. Reichel M. (2006), *Potencjał innowacyjny Polski południowo-wschodniej w strukturach subregionalnych*, Państwowa Wyższa Szkoła Zawodowa w Nowym Sączu, Nowy Sącz.
18. Ter Braak C.J.F. (1990), Interpreting Canonical Correlation Analysis Through Biplots of Structure Correlations and Weights, PSYCHOMETRIKA, VOL. 55, NO. 3, p. 519-531.
19. *Überholspur Innovation* (2007), Fraunhofer IAO, Stuttgart.
20. Weenink D. (2003), *Canonical Correlation Analysis*, University of Amsterdam, Proceedings 25, p. 81-99.

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RELATIONS BETWEEN INVESTMENT EVALUATION METHODS AND PERFORMANCE IN MANUFACTURE: CASE OF SLOVAKIA

Abstract: Economic effectiveness of investment can be evaluated by several approaches and various methods or indicators can be used in companies. The objective of presented article was to analyze selected methods and groups of indicators in investment effectiveness valuation and their possible impact on better business performance. We asked about four types of methods in questionnaire section aimed in investment effectiveness valuation indicators. Discounted cash flow valuation is only one of several ways of approaching valuation, however, it is the foundation of all other valuation approaches, so we are mainly interested in discounted cash-flow indicators. Presented part of the research has focused on manufacturing enterprises in Slovakia. Our research has statistically confirmed that better business performance is significantly dependent on use of certain investment valuation methods.

Key words: business performance, manufacturing enterprises, investment, investment evaluation methods, discounted cash flow indicators.

INTRODUCTION

Recent development in most enterprises suggests that the effects of the global economic crisis have a significant impact on the performance of enterprises, with direct impact on the level of economy as well as the level of investment. The development of each sector or company requires appropriate investment. Without investment they cannot fully meet particular economic objectives of the business (Merková, Drábek & Polách, 2011). There is a review by the perception of prices, while investors will not certainly decide for the lowest current price - as low production costs and cheap labor or low tax cost - but primarily on the lowest cost throughout the life cycle of the investment (Merková, Drábek & Jelačić, 2012).

Investment measurement and management and its impact on business performance is only partial area of our complex research (more results in Rajnoha et al., 2013 or Sujová, Rajnoha & Merková, 2014). In evaluation of investment we evaluate their suitability, efficiency and feasibility of the particular project. Moreover we evaluate the impact of the project on total effectiveness, prosperity and financial stability of the company (Polách et al., 2012, Rajnoha, Jankovský & Merková, 2014 and others). Successful economic development require besides the application of traditional methods also the application of new modern methods based on traditional systems of financial indicators and are completed by time and qualitative indicators (Sujová & Marcineková, 2015). Investment evaluation should analyze acceptability, economic effectiveness and project realization possibilities. It should define the impact of the investment on the performance of company and this is the issue of presented work. The objective

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was to analyze selected methods and groups of indicators in investment effectiveness valuation and their possible impact into better business performance.

THEORETICAL BACKGROUND - INVESTMENT EFFECTIVENESS EVALUATION METHODS

Modern methods of investment project efficiency evaluation lean on estimation of capital resources and presumed financial income out of the investment. Total amount of investment is known as flow of money – cash-flow of investment.

The task of estimating presumed cash-flow of investment is the most complex and the most difficult task of capital planning and investment decision making. Certain cash-flow of investment project, or certain alternative, is not unique, especially form the point of all factors influence on income and expenses. The goal of decision making on best project alternative selection is probably inaccurate if every single factor is not taken in consideration and if only self-sufficient mathematical-statistical methods should be used.

In theory and in practice (Brealey & Myers, 2003, Levy & Sarnat, 1986, Drábek & Polách, 2008 and others) they say that it is harder to calculate estimated money income out of investment then certain capital expenses. Some capital expenses in a form of machines, appliances, etc. can be calculated easily. Therefore, calculation of estimated money income is taken as critical, as a main point in a process of capital planning and investment decision making. Hard circumstances are as follows:

- Investment life cycle is longer than a process of getting investment,
- Time factor has bigger influence on decision making, evaluation, return of assets,
- Amount and time definition of estimated income are limited by more factors (especially expenses like), then capital expenses,
- Level of entrepreneurial risk can influence on the difference between real and estimated income, i.e. keeping the proposed time line and level of returning the foreign capital.

The basis of investment effectiveness evaluation lays on equalizing invested capital with estimated income project brings, i.e. it is about calculation of short-term investment expenses and estimated annual income during investment life cycle. The final result of that calculation is a selection of suitable project (alternative), i.e. decision making on which we recommend to start the project realization in given circumstances or that the project brings to much entrepreneurial risk and it is not possible to realize it, so we decline it (Drábek & Jelačić, 2007).

Only complex evaluation of investment project can assure fulfilment of entrepreneurial goals – increase of production abilities, cost decrease, ennobling of invested capital, increase of the enterprise market value. If investment basis is placed correctly and investment projects properly prepared, it is necessary to evaluate them equally well.

Based on the theoretical sources (Baum & Hartzell, 2012, Brealey & Myers, 2003, Damodaran, 2012, Levy & Sarnat, 1986, Renkema & Berghout, 1997, Ward, Taylor & Bond 1996 and others) can be commonly used investment evaluation methods briefly summarized and characterized below.

Evaluation methods based on **annual indicators** are useful for short-term evaluation of project effectiveness. Countries with developed market economy don't use those methods as relevant because they don't use the so called time factor into consideration. Mainly, we talk about following methods:

- Comparison of costs (cost minimization)
- Comparison of profit (profit maximization)
- Return on investment – ROI
- Return on investment from cash-flow

- Payback period.

Discounted methods for investment evaluation remove faults of annual valuation methods. In the process of quantification of chosen criteria they take time factor into consideration. In economic life time factor makes things more serious, it enables the change of money evaluation. If that change was taken wrongly, it would be possible to make a wrong decision which would have significant influence on project effectiveness, enterprise stability. Discounted evaluation methods of investment based on analysis of dynamic abilities and estimation on capital expenses and investment project income in whole are:

- Net present value - NPV
- Internal rate of return - IRR
- Profitability index - PI
- Payback period - PP

Additional methods could increase the investment decision making process quality. As additional indexes following methods can be used:

- Break-even analysis
- Project commercial life cycle
- Beside previously mentioned methods (mostly used in theory and practice) can be applied modern methods based on investment controlling:
- Method of modified internal rate of return
- Method of final value.

While discounted cash flow valuation is only one of the three ways of approaching valuation, it is the foundation on which all other valuation approaches are built (Damodaran, 2012). Suggested financial-mathematical methods of discounted character consider time changes of money values, and they take two basic rules of financing into consideration (Brealey, Myers, 1999):

1. Value of one money unit today is bigger than the value of one money unit tomorrow, because today's money unit can be invested and it could earn on interest. It means that income to come in future has lass value for us. Therefore, it is necessary to calculate estimated income with current (today) value (CVCF), i.e. on the same time basis we usually observe time from introducing the project to realisation. Only on the base of CVCF it is possible to estimate project effectiveness correctly and to make the right decision about its realisation.
2. Safe money unit has greater value then risky money unit. Most investor go away from the risk, totally if possible, so they sacrifice some profit because of it. During the realisation of investment projects it is impossible to avoid the risk. That risk is necessary to identify properly, evaluate it, and estimate its influence on enterprise economical results and to find the way to decrease the entrepreneurial risk (market, economic, social, working, etc.).

Each company usually sets its own methods, criteria, which are the most acceptable and which enable right investment decision making, according to their own point of view considering investment effectiveness and suitability.

OBJECTIVE AND METHODOLOGY OF THE RESEARCH

We focus on complex area of investment measurement and management in the research and in this part we investigated the investment effectiveness evaluating. We categorized groups of valuation methods and certain indicators for each group and then we aimed at the most common group of methods.

The research objective was to analyze relationships between the use of investment evaluation methods based on discounted cash-flow and performance given by the indicator Return on Equity

(ROE). To goal was to find out statistically relevant determinants with the impact in better performance of companies. On the base of questionnaire we analyzed obtained results.

Selected results of the research presented in this work content analyses:

- Obtained business performance
- Use of investment effectiveness evaluation methods
- Use of methods based on discounted cash-flow and their relationship with the business performance.

Several hypotheses have been established in the complex research, within this publication of selected part we focused and tested the one, we formulate the null hypothesis H0 and alternative H1:

H_0: The use of methods based on discounted cash flow does not affect the performance of enterprises in terms of the ROE indicator.

H_1: Using methods based on discounted cash flow affects the business performance. We assume these methods are applied in enterprises that achieve average or higher ROE. If companies do not use tested methods, we will statistically prove that they are not powerful.

What is the current situation and trends in use of investment effectiveness measurement in Slovakia, dominantly in the research sample of manufacturing companies, we presented in our work.

Methodologically, there was created on-line questionnaire through internet application to build data collection of companies in Slovakia (more in Questionnaire Survey or Rajnoha et al., 2013). We maintain complete anonymity of participating firms. The size of research sample was 164 counts. In complex research we analyzed all companies, we created samples according certain industries (engineering, automotive, wood processing etc.). Part of research presented in this paper has mainly focused on manufacturing enterprises (core of business was production) with 106 counts.

Companies were initially analyzed according the distribution of the achieved performance of the 6 particular groups (Groups 0-5, group 0 – the worst performance with negative ROE, Group 5 - the highest performance with the ROE over 10%).

We have used mathematical and statistical methods in the research of interdependencies and impacts of individual factors on achieved performance of companies.

One-dimensional inductive statistics:

In research, we analyzed selected descriptive statistics for one variable – absolute and relative frequencies, cumulative frequency and cumulative relative frequency, mean, median and mode. Statistical methods were used: frequency tables showing the frequency by categories, histograms, pie charts, bar and cumulative bar charts, time series and trends.

Two-dimensional inductive statistics between categorical variables

The research consisted from qualitative – nominal variables, their relationship cannot adequately describes the correlation analysis, so the association between variables we examined with contingency (Pearson, 1904, Everitt, 1977, Pánik, 2005 and others). We applied chi-squared test, which is commonly used for testing the independence between two categorical variables. Results of chi-squared tests describe selected statistics: Pearson's chi-square and significance p-value „p", Maximum-Likelihood chi-square and p-value, Pearson's contingency coefficient (CC), Adjusted contingency coefficient (Adj. CC) and degrees of freedom (df).

Pearson's Chi-square: $\chi^2 = \sum_{i=1}^{k} \left[(f_{o_i} - f_{e_i})^2 / f_{e_i} \right]$; while $\sum (f_o - f_e) = 0$ (1)

Pearson's contingency coefficient CC: $$CC = \sqrt{\chi^2 / \chi^2 + N)} \quad (2)$$

Maximum contingency coefficient CC_{max}: $$CCmax = \sqrt{(q-1)/q} \quad (3)$$

Adjusted contingency coefficient Adj. CC: $$Adj.\ CC = CC/CCmax;\ \text{while} CC \leq CCmax \quad (4)$$

Where:
f_{o_i} – observed frequency in an field of the table,
f_{e_i} – expected (theoretical) frequency in an field of the table,
k – number of cells in the table
N – sample size
q – number of rows or columns (in square tables)

We also applied analysis of variance (ANOVA) in the research. The purpose of ANOVA (Shapiro & Wilk, 1965, Iversen & Norpoth, 1976 and others) is to test differences in means (for groups or variables) for statistical significance. Assumptions of ANOVA are:

- Normality - the normal probability distribution with mean equal to zero.
- Homogeneity of variances - the variances are equal for all values.
- The individuals are independent - observations in groups are different objects.

For testing of homogeneity of variances we used Levene´s test. Levene's test is an inferential statistic used to assess the equality of variances for a variable calculated for two or more groups (Levene, 1960).

For statistical analysis, numeric and graphical presentation of the research results, we used the program MS Office Excel and Statistic software from StatSoft, Inc.

FINDINGS FROM THE RESEARCH

Using of investment evaluation methods

In analysis of investment effectiveness evaluation methods companies could choose any number of responses and identify one or more methods or group of methods. As we defined in theoretical part, we focused on four groups of methods for investment evaluation.

Performance of companies can certainly not be associated with a number of methods or evaluation groups that are used in the evaluation. For example, an enterprise which uses two groups of methods - annual and additional methods may not be successful and powerful than company using only one group, for example. Discounted cash-flow methods, which take into account the time factor when considering a long-term capital are significant. In order to categorize businesses by relevance of using of certain combinations of methods, enterprises were divided into four categories (Figure 1):

- Without evaluation: Companies indicated that they are not engaged in evaluating of investment efficiency and do not use assessment methods.
- Annual evaluation: Enterprises are characterized by using only annual or complementary methods, but the do not use discounted methods appropriate for longer period than one year or controlling methods of assessing the effectiveness of investments.

- Discounted cash-flow indicators: Businesses are characterized by the fact that they use discounted cash-flow indicators or some other but in terms of importance for investments less important methods. Surely they do not use controlling methods.
- Controlling evaluation: Enterprises are characterized by exploiting the discounted and controlling methods of assessing the effectiveness of the investment.

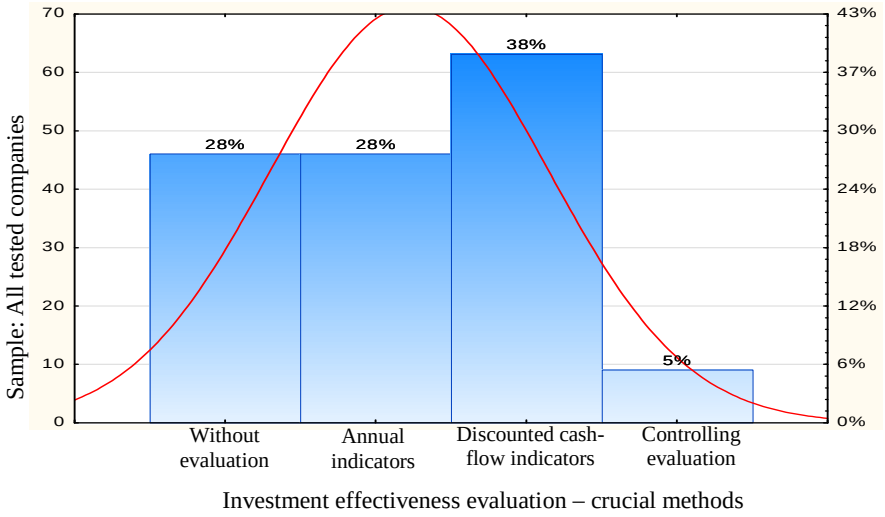

Figure 1. Focusing on investment effectiveness evaluation – crucial methods

Source: authors

When we analysed each group of evaluation methods separately, the most common were annual indicators (108 companies). But when we specify what the basic focus and crucial evaluation is, frequency and use of annual methods was reduced to 46 companies and the greatest number of enterprises (63 enterprises, 38%) has focused on discounted cash-flow assessment methods.

Discounted cash-flow methods and the impact on business performance

This part of research was focused on the analysis of the use and impact of discounted cash-flow evaluation methods of investment projects, while businesses could choose to answer consisting of four methods, their combinations and option that do not use this kind of investments assessment. The issue was further investigated statistically as a binary variable for each method, to determine whether the use of certain method affects the performance of the company. We analyzed the following discounted cash flow methods of investment evaluation:

- Net Present Value (NPV)
- Profitability Index (PI)
- Internal Rate of Return (IRR)
- Payback Period (PP).

Performance of companies in this analysis was categorized into three performance groups according the ROE indicator (the questionnaire originally contained six performance groups, but because of low frequencies we connected them and created only tree groups). In the research have

been demonstrated statistically significant relationships for certain methods characterized below. On the other hand, general purpose of discounted cash-flow methods without specifying the concrete method, has no statistically significant effect on the business performance.

In all tested enterprises, a statistically significant relationship is between performance and two indicators: Profitability Index and Internal Rate of Return (Table 1 and 3). Both pursued relationships show moderate dependence with similar Adj. CC at 0.26 (and 0.25 respectively). The data presented residuals (Table 2 and 4) show that if companies do not use specified evaluation method, they obtain poor performance with negative or very low positive ROE to 2%. When they use the mentioned methods, the differences between observed and expected frequencies are significant for the second and third group of performance (positive ROE above 2%), residuals are slightly higher for the second group (ROE 2-7%). So, we cannot say, that with application of these methods companies have extremely high performance; probability to result with the ROE indicator at the level of 2% or 10% is the same. But it is sure that without analyzed methods companies are very weak with the ROE under 2%.

Table 1. Contingency: All tested companies; PI Method vs. Performance – statistics

Statistics	Chi-square	df	p
Pearson´s chi-square	6.470499	df=2	p=0.03935
M-L chi-square	6.795803	df=2	p=0.03344
Contingency coefficient (CC)	0.1948248		
Cramér. V coefficient	0.1986310		
Adjusted CC	0.25581		

Source: authors

Table 2. Contingency: All tested companies; PI Method vs. Performance – frequencies

Profitability index- PI	Group 1 Low Performance (ROE<0, 0-2%)	Group 2 Middle Performance (ROE 2-4%, 4-7%)	Group 3 High Performance (ROE 7-10%, >10%)	Row Totals
Observed Frequencies				
Without use of the method	66	48	23	137
Use of the method	6	13	8	27
Totals	72	61	31	164
Expected Frequencies				
Without use of the method	60.14634	50.95732	25.89634	137.0000
Use of the method	11.85366	10.04268	5.10366	27.0000
Totals	72.00000	61.00000	31.00000	164.0000
Residual Frequencies				
Without use of the method	**5.85366**	-2.95732	-2.89634	0.00
Use of the method	-5.85366	**2.95732**	**2.89634**	0.00

Source: authors

Table 3. Contingency: All tested companies; IRR Method vs. Performance – statistics

Statistics	Chi-square	df	p
Pearson´s chi-square	6.349167	df=2	p=0.04181
M-L chi-square	7.171801	df=2	p=0.02771
Contingency coefficient (CC)	0.1930583		
Cramér. V coefficient	0.1967598		
Adjusted CC	0.25345		

Source: authors

Table 4. Contingency: All tested companies; Method IRR vs. Performance – frequencies

Internal Rate of Return – IRR	Group 1 Low Performance (ROE<0, 0-2%)	Group 2 Middle Performance (ROE 2-4%, 4-7%)	Group 3 High Performance (ROE 7-10%, >10%)	Row Totals
Observed Frequencies				
Without use of the method	70	52	27	149
Use of the method	2	9	4	15
Totals	72	61	31	164
Expected Frequencies				
Without use of the method	65.41463	55.42073	28.16463	149.0000
Use of the method	6.58537	5.57927	2.83537	15.0000
Totals	72.00000	61.00000	31.00000	164.0000
Residual Frequencies				
Without use of the method	4.58537	-3.42073	-1.16463	0.00
Use of the method	-4.58537	3.42073	1.16463	0.00
Totals	0.00000	0.00000	0.00000	0.00

Source: authors

Table 5. Contingency: Manufacturing enterprises; PI Method vs. Performance – statistics

Statistics	Chi-square	df	p
Pearson´s chi-square	6.217915	df=2	p=0.04465
M-L chi-square	5.591632	df=2	p=0.06107
Contingency coefficient (CC)	0.2353918		
Cramér. V coefficient	0.2421974		
Adjusted CC	0.30860		

Source: authors

In the research sample of manufacturing companies was statistically demonstrated the relationship between performance and in theory often cited method related to the rate of return on invested capital - Profitability index (Table 5). Dependence strength is medium (Adj. CC 0.31). Residual frequencies (Table 6) clearly show that if manufacturing enterprises apply the method,

typically obtain outstanding performance with the ROE above 7%. On the other hand, manufacturing enterprises that do not use the method of profitability index, typically achieve the lowest performance with a negative or very low ROE to 2%.

Table 6 Contingency: Manufacturing enterprises; PI Method vs. Performance – frequencies

Profitability index- PI	Group 1 Low Performance (ROE<0, 0-2%)	Group 2 Middle Performance (ROE 2-4%, 4-7%)	Group 3 High Performance (ROE 7-10%, >10%)	Row Totals
Observed Frequencies				
Without use of the method	44	31	13	88
Use of the method	5	6	7	18
Totals	49	37	20	106
Expected Frequencies				
Without use of the method	40.67925	30.71698	16.60377	88.0000
Use of the method	8.32075	6.28302	3.39623	18.0000
Totals	49.00000	37.00000	20.00000	106.0000
Residual Frequencies				
Without use of the method	**3.32075**	**0.283019**	-3.60377	0.00
Use of the method	-3.32075	-0.283019	**3.60377**	0.00
Totals	0.00000	0.000000	0.00000	0.00

Source: authors

Analysis of the relationship of the individual discounted cash flow methods and business performance differentiated originally to the 6 groups also showed the p-value $p<0.05$ in the sample of manufacturing companies. Due to the unfulfilled assumptions of expected frequencies was not appropriate to interpret the values of contingency coefficients or residual frequencies in contingency tables. However, the results of the p-value have led us to the decision to examine further the use of discounted cash-flow investment evaluation methods and performance by statistical analysis, which would offer sufficient evidence of a statistically significant dependence of variables. We used analysis of variance. Significant results, where was demonstrated the impact on performance, we display in Figures 2 and 3.

We analyzed relationship between individual methods and performance differentiated originally to six groups (0 - the lowest performance, 5 - the highest performance) in the sample of manufacturing enterprises. Levene´s test determined the p-value $p> 0.05$ for all methods, whereby we did not reject the null hypothesis of equal variances; assumption for ANOVA test was fulfilled.

In the ANOVA test, p-value was $p<0.05$ and thus statistically significant dependence of proven performance in relation to methods Profitability index and Internal rate of return. Moreover, using the method of IRR can be reported higher average performance than when applying the method of IR. Based on the results of applying statistical analyses, despite slight differences in means, use of both investment evaluation methods we consider as significant factors affecting the performance of manufacturing enterprises.

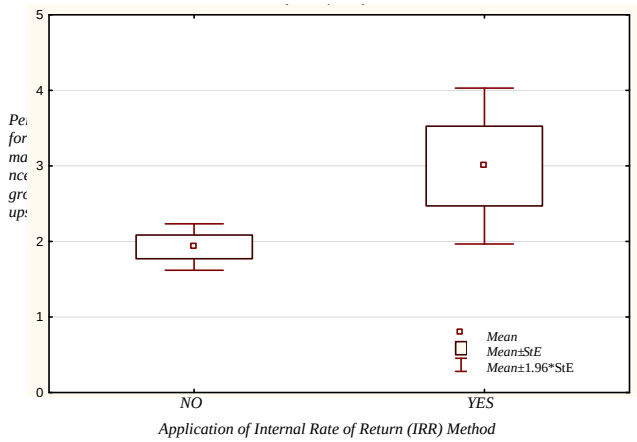

Figure 2. Manufacturing enterprises: Using of Internal Rate of Return (IRR) vs. Performance

Source: authors

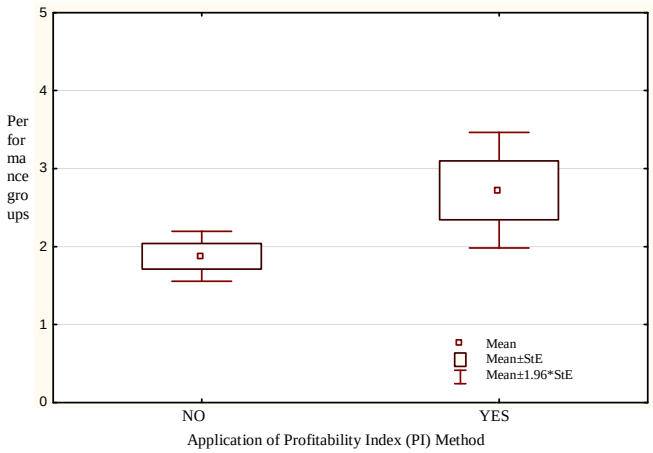

Figure 3. Manufacturing enterprises: Using of Profitability Index (PI) vs. Performance

Source: authors

SUMMARY OF THE RESULTS AND DISCUSSION

On the basis of research results focusing on methods for evaluating the effectiveness of investments we have made the decision on the hypothesis formulated at the beginning of the study: We reject null hypothesis H0 and conclude the alternate hypothesis H1 is true. Dependence of business performance on using discounted cash-flow methods was statistically proven in the sample of all tested enterprises as well as in the sample of manufacturing enterprises. Performance of enterprises in the first mentioned sample using specific methods - Profitability Index and Internal Rate of Return, achieves medium (ROE 2-7%) and higher (ROE above 7%) performance level. On

the other hand, we demonstrated that if companies do not use tested methods, they reach low performance with negative ROE or to 2% ROE.

The result in sample of manufacturing companies is more important compared with sample of all tested companies, because in the second sample we can say that using of tested method the Profitability Index leads to the ROE above 7% (in contrast with more than 2% ROE in the first sample).

Methods of assessing the effectiveness of investments based on discounted cash-flow analyzed in this paper are only partial part of the research. We are sure it is necessary to analyze also other possibilities of investment evaluation and other parameters of investment measurement and management to achieve the investing objectives.

The theory consider the important also controlling methods, but in our research their use in enterprises in Slovakia did not reach assumption of expected frequencies needed for statistical analysis by used methodology - examining of contingency and therefore it was not appropriate to interpret the results of chi-square test. The results of p-value, however, led us to further research of the statistically significant dependent variables. We used analysis of variance. As reveals the use of controlling methods, the ANOVA test was detected p-value <0.05 (0.0360 in the sample of all tested enterprises and 0.0287 in the sample of manufacturing enterprises) and thus statistically significant dependence of performance on the use of controlling methods. Differences in performance with or without using of tested methods were significant in samples with a relatively large size: all enterprises (N=164) and manufacturing firms (N=106). Controlling methods can therefore be considered as an important factor affecting the business performance. Just the issue of investment controlling evaluation methods and their impact on the performance of enterprises is a priority area for our further investigation.

CONCLUSION

Right decisions shall stem fromusing appropriate measurement methods. According to the fact that we demonstrated statistically significant relationship between investment effectiveness evaluation and business performance, we concluded that the use of certain methods of investment evaluation is necessary for the development, competitiveness and better performance of companies. Appropriate methods of investment effectiveness evaluation and subsequent investment decision-making we consider as an important part of business measurement and management and fundamentals for better performance.

REFERENCES

1. Baum, A.E. & Hartzell, D. (2012). Global Property Investment: Strategies, Structures, Decisions. Wiley-Blackwell.
2. Brealey M.A. & Myers, S.C. (1999). Financial Theory and Corporate Policy. Praha: East Publishing.
3. Brealey M.A. & Myers, S.C. (2003). Principles of Corporate finance. New York: Mc Braw Hill.
4. Damodaran, A. (2012). Investment valuation, tools and techniques for determining the value of any asset, 3rd ed. New Jersey: John Wiley & Sons.
5. Drábek J. & Jelačić, D. (2007). Investment projects. Zvolen: Nikara. 65 p.
6. Drábek J. & Polách J. (2008). Real and Financial Investment of Companies. Zvolen: Technical University in Zvolen, (Chapter 4).
7. Everitt, B. S. (1977). The analysis of contingency tables. London: Chapman & Hall.
8. Iversen, G. R., & Norpoth, H. (1976). Analysis of Variance.
9. Levene, H. (1960). Contributions to Probability and Statistics: Essays in Honor of Harold Hotelling. Stanford University Press. pp. 278–292.

10. Levy, H. & Sarnat, M. (1986). Capital Investment and Financial Decisions. New Jersey: Prentice-Hall.
11. Merková M., Drábek J. & Polách, J. (2011). Impact of Investment on Labour Productivity Growth in Wood Processing Industry in Slovak Republic. Finance and the Performance of Firms in Science, Education and Practice. International Scientific Conference, p.324-332.
12. Merková, M., Drábek, J. & Jelačic, D. (2012). Determinants of Effects of Foreign Direct Investment in Terms of Slovak Republic and Wood-Processing Industry of Slovakia. Drvna industrija 63 (2), 129-142. doi:10.5552/drind.2012.1136
13. Panik, M. J. (2005). Advanced Statistics from Elementary Point of View. London: Elsevier Academic Press.
14. Pearson, K. (1904). On the Theory of Contingency and Its Relation to Association and Normal Correlation. London: Dulau & Company.
15. Polách, J. Drábek, J., Merková, M. & Polách, J. Jr. (2012). Real and Financial Investment. 1st ed. Praha : C. H. Beck. 264 p.
16. Questionnaire Survey of the Grant Project of the Ministry of Education Nr. 1/0089/11 - Measurement and performance management of the wood industry companies in SR.
17. Rajnoha, R. et al. (2013). Measurement and Management of Business Performance. Zvolen: Technical University in Zvolen.
18. Rajnoha, R. Jankovský, M. & Merková, M. (2014). Economic comparison of automobiles with electric and with combustion engines: An analytical study. Procedia - social and behavioral sciences 109, 225-230. doi:10.1016/j.sbspro.2013.12.449
19. Renkema, T. J. & Berghout, E. W. (1997). Methodologies for information systems investment evaluation at the proposal stage: a comparative review. Information and Software Technology, 39(1), 1-13. doi: 10.1016/0950-5849(96)85006-3
20. Shapiro, S. S., & Wilk, M. B. (1965). An analysis of variance test for normality (complete samples). Biometrika 52, 591-611.
21. Sujová, A. & Marcineková, K. (2015). Modern Methods of Process Management Used in Slovak Enterprises. Procedia-Economics and Finance Journal 23, 889 - 893. doi:10.1016/S2212-5671(15)00381-0
22. Sujová, A., Rajnoha, R. & Merková, M. (2014). Business process performance management principles used in Slovak enterprises. Procedia - social and behavioral sciences 109, 276-280. doi:10.1016/j.sbspro.2013.12.457
23. Ward, J., Taylor, P. & Bond, P. (1996). Evaluation and realisation of IS/IT benefits: an empirical study of current practice. European Journal of Information Systems, 4(4), 214-225. doi:10.1057/ejis.1996.3

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IMPROVEMENT OF KITCHEN FURNITURE PRODUCTION WITH THE USE OF FMEA METHOD

Abstarct: In the paper a pilot implementation of the FMEA method in the production of kitchen furniture in one of the Sub-Carpathian companies manufacturing furniture has been discussed. The company within its strategy focuses on key customers, and their needs require to specialize in manufacturing of kitchen furniture. Growing customers' requirements necessitate a continuous improvement. As a part of this work the tools of Lean Manufacturing have been implemented. Now it is high time to implement the FMEA method. The presented implementation can also be used as an instruction for the improvement in other processes of the company or in the industry.

Keywords: FMEA, furniture production

INTRODUCTION

The economic situation makes companies look for new, increasingly effective methods and tools of quality management required to compete effectively in the European markets, or even in the world. As a result of these changes, the old, proven methods are not sufficient to succeed. The company, operating in a highly competitive market, needs to strive to meet the needs of its customers, which is possible only through systematically conducted innovative measures or perfecting.

A tool that helps solve the problem of continuous improvement is to analyze the causes and effects of defects (*Failure Mode and Effect Analysis* - FMEA). This method allows to detect and remove, already at the earliest stages of formation of a given product, the failures which effects could be detected only in the later stages of production, and even its later life. By using FMEA one can prevent errors, but also save company resources. These benefits are possible due to the use of this method in the design phase and the preparation of the manufacturing process of products. The second variant of this method relates to the improvement proposed or operating processes.

Purposeful, it seems to analyze the implementation of the analysis of the causes and consequences of defects in furniture manufacturing company, since the results of the analysis of this implementation may translate into the quality of the process and the final product. Moreover, the practical approach can be used by other companies to improve work organization and proper production management. The study shows the important steps in the activities carried out on the basis of the analyzed company developed for the FMEA process.

FMEA FOR THE PRODUCTION PROCESS OF KITCHEN FURNITURE

An analysis of complaints in the analyzed company is carried on by the Customer Service. Figure 1 shows the photo of the analyzed kitchen furniture as well as the change in the number of complaints of the furniture in the past six years on a similar largest production. The chart has been prepared based on an analysis of justified complaints made by customers from 2010 - 2015 year. On the basis of fig. 1 it can be concluded that it seems expedient to carry out the process of production improvement of kitchen furniture.

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The purpose of FMEA, whose methodology is described in the literature e.g. [1, 2, 3, 4], was the early recognition of potential errors in the manufacturing process, and then - by taking appropriate measures - to remove them. FMEA method was carried out according to the methodology in a working team consisting of representatives of the construction office, production department and quality department. First the types of errors were analyzed. Fig. 2 shows the percentage of the causes of complaints divided into three groups: manufacturing errors, errors in supplies, defectiveness of materials (e.g. wood moisture). The data on causes of complaints come from the reports created in the company after consideration of each complaint.

Fig. 1. The number of justified complaints made by customers from 2010 - 2015 year.

Own research based upon [5].

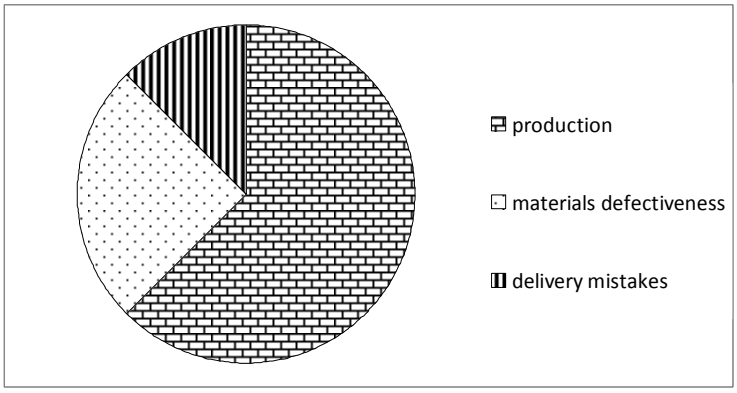

Fig.2. Reasons for complaints.

Own research based upon [5].

Then the team analyzed the process of manufacturing process of kitchen furniture. The production of the whole set of kitchen furniture takes place in four main stages. The first stage involves the treatment of construction components, which consists of cutting, drilling and milling. The second stage is the finishing of the construction components, namely veneering and painting. The third stage is followed by the assembly of additional components such as hinges, handles, etc. The last stage includes the total assembly of components, i.e. assembly of surfaces, bodies and fronts. In table 1. The division of the manufacturing process of kitchen furniture into stages.

Tab.1. Stages in the manufacturing process of kitchen furniture. Own research.

Stage 1	**Stage 2**	**Stage 3**	**Stage 4**
Cutting	Veneering	Hinges assembly	Bodies screwing
Drilling	Polishing	Handles assembly	Fronts assembly
Milling		Slideways assmbly	Surfaces assembly
Sanding			

Kitchen furniture manufacturing process consists of the following operations:
10 - Cutting boards to size,
20 - Veneering,
30 - Drilling mounting holes,
40 - Drilling holes for hinges,
50 - Milling fronts,
60 - Grinding fronts,
70 - Painting,
80 - Installation of additional elements,
90 - Final assembly.
The complete set of kitchen furniture includes:
• bodies,
• fronts,
• surfaces
• hinges, rails, handles, mounting components, panes of glass, etc.

During the next step, the team identified possible errors, estimated their weight due to: the importance (Z) in the operation phase of the product (the process of production) and the possibility of detection (W) and risk of occurrence (R). Each of the figures could take priority value on a scale of 1-10. The selection chart is shown in the table. 2-4. Based on these assessments the risk ratio (LPR) has been calculated, which is the product of the partial notes, which can vary in the range of 1-1000. The FMEA results are presented in table. 5. Because of the length of the FMEA sheet, it was decided to present only a fragment of the work of selecting one failure of each operation.

Tab. 2. Indicators to estimate Z.

Z	Failure significance	Description
1	Very small	Failure of the process does not affect the quality of the product
2-3	Small	Failure of the process causes a slight difficulty
4-6	Average	Failure of the process causes difficulties, which requires repair
7-8	Big	Failure of the process has a major impact on the production of non-conforming products
9	Very big	Failure of the process causes the inability to repair non-conforming products
10	Critical	Failure of the process results in the production threatening the security of the user.

Tab. 3. Indicators to estimate W.

W	Failure detection	Description
1-2	Very high	Failure of the process will certainly be detected
3-4	High	A big chance of detecting failures in the process
5-6	Average	Limited opportunity for detection of failure in the process
7-8	Low	High probability of undetected failures in the process
9	Very low	Very high probability of undetected failures in the process
10	Impossible	The lack of any opportunity to detect failures

Tab.4 Indicators to estimate R.

R	Failure occurence	Description	Frequency occurence
1	Improbable	Process failure almost excluded	1 per 10 000
2	Very rarely	Relatively very few process failures	1 per 1 000
3	Rarely	Realtively very few proces failures	1 per 400
4-6	On average	Sporadic occurence of proces failures	1 per 80
7-8	Often	Process failure repeats cyclically	1 per 20
9-10	Very often	Process failure is almost inevitable	1 per 2

Tab. 5. An excerpt of the FMEA manufacturing process of kitchen furniture.

Operation no.	**Potential type of failure**	**Potential failure results**	**Potential failure casues**	**Z**	**R**	**W**	**LPR**	**Recommended corrective actions**
10	Plate nick	No aesthetics of the product. Lower grade product. Loss of material. Delays in production. The increase in production costs. The need to repeat the operation for another material. Excessive wear of cutting tool.	Worker's error	6	5	6	**180**	Increased self-control of the worker at the workplace. Subjecting employees to periodical training. Monitoring of the individual operations by the most experienced employee. Giving particularly demanding jobs to employees with great experience. Use of equipment operating on the POKA – YOKE principle.
			Improper choice of the treatment tool		3	4	72	
			Low quality of materials		3	2	36	
			Faulty treatment of tools		4	5	120	
			Worker's error		5	6	120	
20	Glue leakage outside the plate edge	The need to remove unnecessary glue. Delays in production. Possible material damage. The increase in the cost of repairs.	Too much glue	4	3	3	36	
			Maladjustment of machine tool		3	6	72	
			Wrong setting of cutting parameters		3	4	24	
			No material cleaning after the operation		6	2	24	
			Overexploitation of machine tool		3	5	30	

	Too many holes	Loss of material. Delays in production. The increase in production costs. Excessive wear of the tool machining.	Wrong project analysis	9	2	3	54	
			Worker's error		5	6	**270**	Increased self-control of the worker at the workplace. Subjecting employees to periodical training. Monitoring of the individual operations by the most experienced employee. Giving particularly demanding jobs to employees with great experience. Use of equipment operating on the POKA – YOKE principle.
40	No perpendicularity of the hole axis relative to the plate plane	Difficulties with hinges. Difficulty with assembly of the front with the body. Damage to the work piece. The increase in the cost of repairs. Delays in production. Damage during use by the customer. Problems with the use of the product by the customer.	Improper material assembly on the machine tool	7	4	5	**140**	Increased self-control of the worker at the workplace. Subjecting employees to periodical trainings and tests.
			Inaccurate mounting of cutting tool in the machining head		4	5	**140**	Increased self-control of the worker at the workplace. Subjecting employees to periodical trainings and tests.
			Deregulated machine head		2	6	84	
			Placing of material on the shavings layer.		2	2	28	
			Untreated machine tool before the operation		3	2	18	
50	Nick in the wrong place	Wrong final appearance of the product. Worse aesthetics of the product. Unnecessary use of cutting tool. Shredded material. Delays in production. The increase in production costs.	Wrong analysis of the project by the worker	9	5	6	**270**	Increased self-control of the worker at the workplace. Subjecting employees to periodical training. Monitoring of the individual operations by the most experienced employee. Giving particularly demanding jobs to employees with great experience.Use of equipment operating on the POKA – YOKE principle.

			Incorrectly sized surface of the material		4	6	**216**	Increased self-control of the worker during taking dimensions. The creation of additional posts for taking dimensions.
			Damaged measuremen t tools		3	7	**189**	Periodic technical tools inspection. The employee is obliged to report any fault to the manager. Replacing the measuring equipment.
60	No well treated front	Complications during painting. Lower grade product. Need to repeat the operation. Delays in production. The increase in production costs. Possible burrs on the surface of the product.	Omission of the operations (the detail has not been delivered to the operation)	6	3	2	36	
			Materials confusion during the operation		3	3	54	
			Incorrect machine setting		3	4	72	
			Damaged machine tool		3	8	**144**	Periodic technical inspection of the machine. Control of the first piece. Replacing of the machine.
			Exploited machine tools		3	5	90	
			Unstable power supply		1	2	12	
			Incorrect installation or lack of cutting tool		2	3	36	
70	The surface as the „cellulite ”	No aesthetics of the product. Lower grade product. The need to remove layers of paint and repeat the operation. Delays in production. The increase in	The use of inappropriat e diluent	6	4	5	120	
			Too little diluent		4	4	96	
			Improper application		3	6	108	

		the cost of repairs. Excessive consumption of paint.						
80	Improper accessories	The need to remove the incorrect accessories and reassembling already correct ones. Delays in production. No aesthetics of the product. Damage to accessories. The increase in costs case of damage to the installed accessories.	Confusion of materials during an operation	9	3	6	**<u>270</u>**	Increased self-control of the worker at the workplace. Subjecting employees to periodical training. Monitoring of the individual operations by the most experienced employee. Giving particularly demanding jobs to employees with great experience. Use of equipment operating on the POKA – YOKE principle.
			Confusion from supplier of accessories		2	4	72	
90	Gaps between the front and the body	No aesthetics of the product. The necessity of dismantling the furniture and re-correct assembly. Delays in production.	Worker's innacuracies	7	4	4	112	
			The application of the wrong assembly elements		2	4	56	
			Furniture damage during operation		2	7	98	
			Improper hinges mounting		3	5	105	
			Worker's innacuracy		4	4	64	

Own research based upon [5].

It was assumed that if the LPR is greater than 125, the recommendation (proposal) for changes in the production process is issued. Once the appropriate changes are subjected to the process, again after some time the verification by the FMEA is done.

Fig. 2 shows the ranking of LPR equal and larger than 125 points, of all operations where there may be possible defects, adversely affecting the subsequent operations in the process of manufacturing of kitchen furniture or aesthetic properties and operating of the finished product.

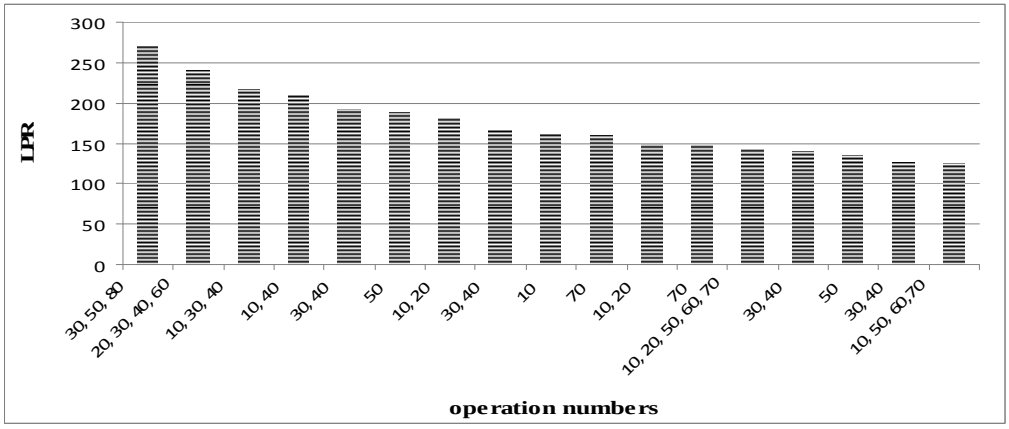

Fig. 2. Ranking of failures at various operations.

Own research.

Based on the tab. 5 and fig. 2, it is possible to identify areas in the production of kitchen furniture, which should be paid special attention to. For these areas the appropriate corrective actions have been proposed. In operations no. 30, 50 and 80 (drilling, milling, installation of additional components) there are identified potential drawbacks with the highest value of the LPR index. In the operation 90 (final assembly) the defect exceeded a predetermined threshold LPR index has not been recognized.

CONCLUSIONS

In terms of manufacturing processes the FMEA is recommended for hard-to-control processes. The flexibility of the method allows to evaluate the processes already in place. The analysis of the FMEA process of manufacturing of kitchen furniture shows that the largest number of defects are caused by errors of workers and the poor condition of the machines. In order the quality of manufactured products was high and tailored to customers' requirements, the operators' errors should be eliminated. This will be possible due to the introduction and application of POKA – YOKE devices. The company must also establish a system of employees; training as well as to take care of the technical condition of the machinery, test equipment and tooling machining.

The FMEA method, despite its many advantages and opportunities, should be used with extreme caution. Particularly controversial in the FMEA is the valuation of the individual evaluation criteria. In order to make the most objective estimation of numerical ratings one needs to have comprehensive information about the reporting process.

REFERENCES

1. *Analiza Potencjalnych Przyczyn Wad i ich Skutków (FMEA) Edycja Trzecia*, Podręcznik Referencyjny, Chrysler Corporation, Ford Motor Company, General Motors Corporation 2001
2. Hamrol A.: *Zarządzanie jakością z przykładami.* Wydawnictwo Naukowe PWN, Warszawa 2007
3. Huber Z.: *Analiza FMEA procesu*, Internetowe Wydawnictwo Złote Myśli, Gliwice 2006
4. Sęp J., Perłowski R., Pacana A.: *Techniki wspomagania zarządzanie jakością, Oficyna Wydawnicza Politechniki Rzeszowskiej*, Rzeszów 2010
5. Wildanger A., Pacana A.: Doskonalenie produkcji mebli z wykorzystaniem metody FMEA dla przedsiębiorstwa „WIĘCPOL", Unpublished material, Rzeszów 2015

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NEW COMPETENCIES NEEDED IN THE FURNITURE INDUSTRY 2020

Abstract: The aim of this study was an attempt to determine the qualifications and skills of staff in Polish furniture industry and indicate its main needs in this area and the desired directions of education and improvement of employees' competences at various levels of education. The complex nature of the analyzed issues means that different testing methods of economic and social phenomena were used in the research process, mainly the inductive-deductive method, logical reasoning, creative thinking and qualitative methods. These were in particular: desk research, expert method, brainstorming, survey (conducted in selected furniture industry enterprises) and analogy (similarities to industries with characteristics comparable to the furniture industry). The analysis shows that in the future, it should be expected that the role of knowledge in creation of advancement in all fields of activity will grow in importance and the significance of human resources will rise among all development factors, especially in terms of personnel quality. If the competitiveness of the furniture industry on the global market and its innovativeness is to increase, it is necessary to provide highly-skilled labor, ready for working in new economic conditions. One should remember though, that the future is not so much about "industrial workers" as "knowledgeable employees".

Keywords: furniture industry, personnel/human capital, employee profile, education and professional training

CHANGES IN THE GLOBAL FURNITURE INDUSTRY AS A REASON FOR CHANGING THE EMPLOYEE COMPETENCY PROFILE

Globalization and technological progress are key reasons for profound changes occurring in all sectors and industries of the global economy, including the furniture industry.

The growing importance of trade, the increased flow of foreign direct investments and the growing significance of transnational corporations – all result from globalization. The basis for all activities is prompt and equal (at least in theory) access to information. This has a direct effect on business models of companies, also furniture companies. Thanks to modern telecommunications solutions companies have unprecedented technical possibilities facilitating real-time management and communicating with the part of the world of one's choice. This is why geographical relocation of business processes becomes not only productive, but also offers companies the economics of scale in the field of design, research, customer service, and management. At the same time, it is clear that before seizing the opportunities created by globalization and the development of profitable production in other countries, the entrepreneurs have to consider local conditions, such as production costs, environmental protection requirements or energy efficiency. In the case of furniture industry, there is yet another factor, i.e. the huge importance of family businesses (with unknown scale of profit reinvestment).

One of the globalization effects, which is not always positive, is increasing competitiveness on the international markets. Europe feels especially the competitive pressure of China and, additionally, it has to face the tensions connected with immigration crisis, as well as economic

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issues, which are a long-term effect of the world crisis of 2007-2009. These trends are accompanied by the evolution of consumption demand and changes of furniture distribution channels.

All these phenomena bring the need for a new type of employee with new competencies. This, on the other hand, entails the necessity of evolution of education and professional training systems allowing for new knowledge and new needs. Although such changes are already observed, it is necessary to accelerate them.

NEW COMPETENCIES ESPECIALLY IMPORTANT IN THE FURNITURE INDUSTRY

Change of the employee professional profile is particularly important in the furniture industry. There are many reasons for this; firstly – the great importance of this industry in economies of many regions of the world, secondly – the need for taking advantage of the value added generated by furniture manufacturing, which is the highest value generated by wood-based industries, and thirdly – the huge role of the furniture industry as regards creation of cooperation relationships with "non-wood" industries and further business environment. Furniture industry, as a leading industry in numerous European and world countries, stimulates not only the development of many cooperating industries (delivery chain), but also the communities of designers, IT specialists, market analysts etc.

Table 1. Production and employment in the furniture industry in the European Union in 2013 (acc. to NACE 31)

Production (€ m)		**Employment**	
Germany	20.031	Poland	150620
Italy	19.642	Italy	144493
Great Britain	7.805	Germany	140554
Poland	7.326	Great Britain	83384
France	6.438	Romania	61242

Source: EPF, 2015, p. 22, 27.

The global furniture production amounts to approx. US$ 437bn [CSIL, 2014b]. Around 80% of it is concentrated in 10 countries (2012), while 40% in China alone. The second world's largest furniture producer is the US (14%). A similar share within the furniture production has the group of three European Union leading producers, i.e. Germany, Italy, and Poland [CSIL, 2014a, p. 19] – Table 1.

Europe

European furniture industry is constituted mainly by the European Union states. It encompasses 124,000 companies producing furniture of the value exceeding € 90bn annually and employing approx. 1m people (EU-28, 2013) [EPF, 2015, p. 22, 27-28]. EU is a net exporter of furniture (positive trade balance); however, only 15% of manufactured furniture is exported outside this economic region (as per value). In 2013 the export value was € 13.1bn. On the other hand, imports from outside the European Community amounted to € 11.2bn, while the biggest supplier of furniture to the EU market is China [EPF, 2015, p. 23-24].

Poland

For many years, Poland has been among the biggest world producers of furniture. Currently, Poland is the sixth manufacturer in the world, following China, US, Germany, Italy, and India (until 2013 Japan was also ahead of Poland) [CSIL, 2014a, p. 19; Anon., 2015c], and the third in the

European Union (following Germany and Italy). In Poland furniture production has a long tradition and is an important driver of the entire economy. Recently, it has been one of the most dynamically developing processing industries. This was mainly due to export. In recent years, 95-98% of manufactured furniture has been exported. Owing to this, Poland is the fourth world exporter of furniture (following China, Germany, and Italy), whose share within the global exports exceeds 6% [CSIL, 2014b, p. 19; Anon., 2015c], and the third in Europe (following Germany and Italy).

The feature characteristic of Polish furniture industry is its significant dispersion, i.e. almost 93% of approx. 28 thou. business entities are micro companies employing less than 10 people [CSO, 2016, p. 41]. Furniture industry provides jobs for almost 150 thou. people [CSO, 2015, p. 246], which makes it the biggest European employer as regards this branch. Approx. 77% people is employed in the production of furniture for rooms, dining rooms, bedrooms, rest furniture and similar, 15% – in the production of office and store furniture, 5% – in the production of kitchen furniture, and 3% – in the production of mattresses [CSO, 2014].

IS FURNITURE INDUSTRY AN ATTRACTIVE EMPLOYER?

The world's furniture industry is very diverse. Nevertheless, in many countries, especially in the US and European Union, one may observe its transformation from a quite traditional manufacturing sector into a typical highly industrial. This is a result of globalization processes, use of new working methods and tools, the implementation of innovative and ecological materials, as well as the introduction of compulsory standards and legal regulations.

Yet, despite the clear positive development trends, the image of the furniture industry as an employer is less than attractive. Surprisingly, this is a common phenomenon, observed in both developed countries (e.g. the US, most EU states) and catching-up countries, including Poland. The furniture industry is often perceived to be a mature industry, obsolete even, with a high share of manual activities carried out in difficult and onerous conditions. This is why furniture producers in many countries face the shortage of skilled labor, as in the case of most production sectors [ABTV, 2014, p. 5-6; Ratajczak, 2013, p. 205-207]. The shortage on the labor market is additionally fueled by ageing of the furniture industry labor, high rotation of employees, difficulties in finding skilled specialists, and the lack of interest showed by prospect young employees in working in this industry. For instance, in the years 2008-2012 European furniture industry recorded a decrease in the share of young employees within the employed from 12% to 8% [CSIL, 2014a, p. 79]. In this situation, furniture producers in order to develop their companies already today make up their mind about employing foreign staff – in Poland this concerns mainly labor from Eastern Europe [Anon., 2015a, p. 28].

As accurately noted, the problem is that the industry changes, but its image/perception does not [CSIL, 2014a, p. 78-82]. Furniture industry is still attributed features which contribute to association of furniture making with craftsmanship and a high share of simple manual activities carried out in dirty and onerous conditions, while for many years this industry, like many other production sectors, has been introducing technologies substituting traditional manual processes with operation of technologically advanced machines and tools. In many countries the furniture sector is already a highly industrial sector, and the standards of production cleanliness and work safety are very high. Furniture, on the other hand, may certainly be classified as "green/clean" products.

Lack of changes of conditions on the labor market will cause intensification of unfavorable phenomena and, in effect, problems with maintenance of current level of skilled labor resources, which will eventually result in difficulties with keeping the tradition continuity [European Economic and Social Committee, 2011, p. 10]. Therefore, it is obvious that in order to attract skilled labor, the furniture industry has to pursue an image change. Paradoxically, the recent economic crisis has been conducive to this, for due to it a large group of prospect employees emerged on the

labor market, i.e. people who want to change the course of their carrier, the unemployed or immigrants. It should be added, that if the labor market is considered in the context of innovation, two ostensibly opposing trends can be observed, for innovations in general, especially technical (consisting in mechanization and automation/robotization), cause reduction of jobs. However, this generally concerns activities directly connected with the production process, including operation of machines and tools. Still, at the same time technological progress creates a high demand for new professions and competencies, e.g. in the field of product design, logistics, e-commerce, environment management, environmental protection, utilization etc. In short, there is a need for skilled employees who know how to deal with highly advanced technologies.

A SCENARIO OF EUROPEAN FURNITURE INDUSTRY DEVELOPMENT BY 2020

In order to formulate development strategies of companies, including strategies of human resources development, it is important that the companies possess knowledge of the probable course of future economic and social phenomena. For Europe 2020 a probable scenario of the development of situation in the furniture industry was drawn up within the framework of FUNES project "Furniture New European Skills 2020" [Funes Project, 2015]. Initially three scenarios of the furniture sector development had been taken into account, defined by the following keywords: WELL-KNOWN BRAND, LOW DEMAND, and INTELLIGENT SOLUTIONS. Considering conditions resulting from globalization processes, the forecasted evolution of the furniture industry in various European countries and still noticeable negative effects of the world economic crisis, one most probable scenario of the furniture industry development was drawn up based on the three above-mentioned proposals.

Table 2. Development scenario for the furniture industry in Europe 2020

Population and society	• Ageing of population: increase of life expectancy, retirement age increases • Difficulties creating young households • Stagnation in consumption of furniture • Stagnation of jobs and salaries • Purchase of furniture based on lowest price
Raw materials and production	• Increasing costs of raw materials • High competitiveness of countries with low production costs
Products, trends for living, environment and technologies	• Generalization of alternative and renewable materials; generalized eco-consumption • Sustainable/green houses and furniture components • Interactive technology • Flexible and (technologically) advanced lifestyles • Predominant environmental aspects of health and wellness
Consumer purchasing behavior	• Innovative consumer acting as leader and designer of his/her own furniture • Sale and purchase: point of sale as a key figure; purchase of furniture through multiple channels; stores aimed at the generation of experiences; use of information and communication technologies

Source: Based on Funes Project [Funes Project, 2015].

This scenario integrates social, demographic, economic and technological perspective and allows for such phenomena as: strong migration tensions, cultural differences, various life styles, the development of infrastructure at the expense of the environment and environmental issues, business fluctuations/declines, the unemployment rate increase, companies' profit decrease, worsening of production relocation conditions, searching for energy-saving alternatives, and ageing of population (Table 2).

At the same time, it points out major challenges which already exist and are anticipated to occur in European furniture industry in the near future, because, on the one hand, globalization allows significantly greater flexibility of market and consumption creation, but, on the other, brings about higher unpredictability of future conditions.

A key challenge for Europe are demographic changes, especially ageing of societies, accompanied by alterations in life models and life styles, which result in emergence of new needs and new purchasing behaviors of consumers. These new needs are the effect of, inter alia, new concepts of house building and furnishing, fresh concepts of public space management (e.g. sustainable/green/intelligent houses and cities – smart homes&cities), as well as the emergence of new family models (descending number of children, growing number of single-person households, starting of a family at later age). A factor that grows in importance is the environmental health perspective and pursuit of better living conditions (ecoconsumption). A relatively new phenomenon on the furniture market is prosumption, i.e. striving for personalization of products, meaning that more and more often innovative consumer will be simultaneously the originator and, to some extent, designer of the furniture they purchase.

European furniture producers meet the great challenge from companies operating in low production-cost countries, such as China or India. In this case, the competitive advantage of European furniture producers has lain in and, in the near future, will lie in high quality of their products, which may be a decisive criterion for the selection of furniture by more demanding consumers.

IDEAL EMPLOYEE FOR THE FURNITURE INDUSTRY OF THE FUTURE

In light of changing business conditions, there is a strong need to adjust human resources in order to constantly improve the competitive position on the market. Hence the demand for new competencies and skills, at least in the field of delivery chain management, development of new business models, knowledge of production automation, material innovations, and working ergonomics. If a company is to develop continuously, it has to have access to personnel with new skills (creation of new specializations to replace traditional professions), but it also has to take care that the personnel supplement their education, improve and retrain systematically. Employees with appropriate skills better understand the surrounding reality and act more efficiently in it. They often also point out in which direction the necessary changes in their workplace should go. Thanks to that, the company they work for becomes more innovative and competitive.

An ideal employee should demonstrate not only appropriate education, but also professional experience and various skills. The important competencies and skills especially concern the efficiency of learning and self-development, problem-solving, analytical thinking, communication, organization of work, mastering working techniques and tools, planning of activities, and also accepting responsibility for the outcomes of one's work. Therefore, the employee should possess profound general knowledge, which they will be able to deepen and broaden as the professional activities require, and be able to act flexibly, as well as to use all technical achievements efficiently and communicate with other people.

Poland

The latest research [Ratajczak, et al., 2015, p. 28-42, 48-52] suggests that furniture producers, as all employers, are most interested in employees with versatile/universal skills, who are willing to learn continuously and are involved in work, and also know the specificity of a particular industry. Depending on the position and conducted tasks, employees who are especially sought for are those skilled in strategic management, business management, planning and management of production (inter alia *lean management*, Quality Management Systems – QMS), strategic management of human resources and training needs [Konkel, 2015, p. 21], cooperation within network structures, collaboration with the R&D sphere, availing themselves of IT tools and systems (for setting up virtual offices, integrated design, creation of online sales platforms and tools), and using IT tools and design programmes (e.g. CAD – *Computer Aided Design*, CNC – *Computerized Numerical Control*; programmes for integration of furniture with digital and electronic systems [Wiktorski, 2015, p. 4]). As regards production workers, companies mainly look for: carpenters, upholsterers, wood technologists, and, more and more often, furniture designers. Presently, carpentry is a reviving profession; carpenters are sought for by employers in Poland and abroad.

DESIRED EDUCATION PROFILES OF PERSONNEL FOR FURNITURE INDUSTRY

International development strategies of the furniture industry point to the need for cooperation between the entire forestry-wood sector, educational institutions and other organizations involved in education and training on all levels. Answering to the demand from the furniture industry for new skills and competencies of personnel, educational institutions try to adjust their teaching programmes to conditions found in the economic practice. It is commonly believed, that employees should learn life-long and systematically improve their skills and productivity [European Commission, 2013, p. 37].

In light of challenges which the furniture industry faces, the education system should continuously evolve and adapt its methods and educational contents to changes in the economy and trends in higher education in Europe and in the world. Thanks to this, graduates will be able to find satisfying job, and employers – personnel with desired skills and competencies [Anon., 2015b, p. 23].

Due to technical and technological progress it is desirable that the personnel for the furniture industry are educated on various levels, not only in traditional professions (such as wood technologist, carpenter or upholsterer), but also in modern specializations (e.g. automation specialists, applied computer science engineers, computer programmers, operators of CNC machines, production line assemblers, economists familiar with modern IT tools, and specialists in: e-commerce and marketing, logistics, environmental protection, and quality systems).

An important element of the process of the future personnel education is cooperation between science and business, and more precisely, between higher education institutions/schools and the economic practice. It is necessary to change study programmes of all specialties so as to facilitate better than before teaching of attitudes and skills expected by the companies. To this end, one should implement participatory forms of education, which are aimed at, inter alia, encouraging students to use unconventional methods of solving problem tasks. Moreover, it is indispensable to move away from narrow specializations toward universalization of student education. The point is to gain profound basic knowledge in a given field and the ability to self-educate, which would become a habit. It is necessary to combine theoretical and practical classes, which would indeed facilitate practical knowledge of techniques and methods indispensable to practice particular profession.

In the face of the variety of needs of the furniture industry, a desired "set" of professional competencies has already been broadened, and should be extended continuously. This stems from

striving for the improvement of technological process effectiveness and manufacturing of products meeting various and changing expectation of customers. In the light of the above, it becomes important that education of a graduate, especially from a higher education institution, comprises not only general technical knowledge, but also specialist knowledge, for instance in the field of IT, automation, operation of CNC machines, commerce, logistics etc. Hence, education methods and contents (at all education levels) intended for human resources for the furniture industry should be constantly adapted to changes in this industry. Globalization, technical progress, shorter production cycles, and new forms of work organization result in a need to change the selection, scope and methods of education. A flexible approach to education programmes and specializations at all levels of education is also forced by changing requirements in relation to professions, their evaluation, the emergence of new professions and also vanishing of the existing. The process of gaining skills may be aided by e-learning, which makes it possible to conduct training at work or in professional training centers, as well as enables employees to learn on their own.

CONCLUSIONS

In the future, it should be expected that the role of knowledge in creation of advancement in all fields of activity will grow in importance and the significance of human resources will rise among all development factors, especially in terms of personnel quality.

Development of the furniture industry is conditioned, on the one hand, by the established position of this industry among other types of manufacturing, the long-standing experience of employees, the high quality of manufactured products, and, on the other, a need for continuous improvement as regards employee competencies and conscious strategic management, including creation of a strategy of human resources management. Changes in the economy result in changes in the structure of demand for employee's competencies and skills, and thus emerges a need for education programmes assuring a high level of employee competencies.

If the competitiveness of the furniture industry on the global market and its innovativeness is to increase, it is necessary to provide highly-skilled labor, ready for working in new economic conditions. One should remember though, that the future is not so much about "industrial workers" as "knowledgeable employees".

REFERENCES

1. ABTV (2014), The American Furniture Industry: 2014 Industry Watch Update, Anderson Bauman Tourtellot VOS, Greensboro.
2. Anon. (2015a), Branża meblarska szuka rąk do pracy [Furniture industry looks for the hands willing to work], Biznes meble.pl, 9, 28 [in Polish].
3. Anon. (2015b), Fachowiec jest nadal potrzebny [Expert still needed], Kurier drzewny, 9, 23 [in Polish].
4. Anon. (2015c). Meblarze poszukują nowych rynków [The furniture manufacturers look for new markets]. Puls biznesu, 26, 9 [in Polish].
5. CSIL (2014a), The EU furniture market situation and a possible furniture products initiative. Final report, Centre for European Policy Studies, Brussels. Retrieved March 31, 2016, from https://www.google.pl/?gws_rd=ssl#q=the+eu+furniture-+market+situation+and+a+possible+furniture+products+initiative.
6. CSIL (2014b), The global furniture outlook according to CSIL. Furniture News. Retrieved March 7, 2016, from http://www.furniturenews.net/resources/articles/2014/02/165819900-global-furniture-outlook-according-csil.
7. CSO (2014), Dane Departamentu Badań Demograficznych i Rynku Pracy [Data of Demographic Surveys and Labour Market Department], Central Statistical Office, Warsaw.

8. CSO (2015), Statistical Yearbook of the Republic of Poland 2015, Central Statistical Office, Warsaw.
9. CSO (2016), Structural changes of groups of the national economy entities in the REGON register, Central Statistical Office, Warsaw.
10. EPF (2015), Annual Report 2014-2015, European Panel Federation, Brussels.
11. European Commission (2013), A blueprint for the EU forest-based industries, Commission staff working document, SWD [2013] 343, Brussels.
12. European Economic and Social Committee (2011), Opinion of the Consultative Commission on Industrial Change (CCMI) on Opportunities and challenges for a more competitive European woodworking and furniture sector (own-initiative opinion), CCMI/088 European woodworking and furniture sector, Brussels: European Economic and Social Committee.
13. Funes Project (2015), Report of Intellectual Output O2, Activity O1: Defining scenarios for the future. Retrieved April 1, 2016, from http://www.funesproject.eu/docs/FUNES%20-%20O2-A1%20-%20Defining%20scenarios%20for%20the%20future.pdf.
14. Konkel M. (2015), HR-owiec partnerem prezesa [HR-person as a partner of company's president], Puls Biznesu, 208, 21 [in Polish].
15. Ratajczak E. (2013), Sektor leśno-drzewny w zielonej gospodarce [The forestry-wood sector in the green economy], Wydawnictwo Instytut Technologii Drewna, Poznan.
16. Ratajczak E., Szostak A., Bidzińska G., Herbeć M., Leszczyszyn E., Dolska J. (2015), Analiza zasobów kadrowych przemysłu meblarskiego w Polsce i określenie zapotrzebowania na nowe kompetencje i umiejętności [Analysis of human resources for the furniture industry in Poland and determination of the demand for new competencies and skills], Instytut Technologii Drewna, Poznan [in Polish].
17. Wiktorski T. (2015), Meble – inteligentna specjalizacja. Czas przygotować wnioski o dotację [Furniture – the inteligent specialisation. Time to prepare the grant propoosals]. BIZNES meble.pl, 9, 4. [in Polish].

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A COMPARISION OF OPERATING AND TECHNICAL PARAMETERS BETWEEN A FRONT-END LOADER BEING MANUFACTURED IN POLAND AND LOADERS OF THE WESTERN EUROPEAN PRODUCTION

Abstract: The paper presents an analysis of technical and operating parameters of a front-end loader of domestic production being compared with loaders of the Western manufacturers. The analysis was based on technical data provided by manufacturers and on own research results. The analysis being performed have revealed that parameters of the front-end loader of Polish manufacturer does not differ from the standards provided by the Western competitors, and frequently, it surpasses them with its parameters. According to the research study, the price for the front-end loader of Polish manufacturer is an average of 30% lower than prices of Western loaders.

Key words: front-end loader, machinery stock, agricultural machinery

INTRODUCTION

One of the main factors determining the competitive abilities of Polish agriculture is the use of modern and economically viable production technologies. Technological progress evokes the need for constant machinery renewal, especially in commercial farms, which allows for sourcing products of better quality [4]. Efficient machinery within the reach of farmers is one of the most important factors ensuring effective and profitable operation of agricultural production. The quality of technical facilities and modernity of owned production means is the economic development-based differentiator for farming. The development of agricultural technology is conditioned by both, the needs of agricultural holdings and capabilities for their implementation [3, 6]. It should be bear in mind that farming machinery form a group of technical facilities, which -in terms of usage- are clearly distinguishable from others. This puts numerous requirements in terms of their durability, quality, operational and technical parameters, efficiency, reliability, and ergonomics of use, which is stemmed mainly from characteristics of agricultural production [5].

The level of income in agriculture is insufficient to maintain machinery at a satisfactory level of modernity and technical efficiency conditioning occupational health and safety. Average farm surface area is enlarging; small farms are being replaced by larger ones, and therefore, there arises the urgency to invest in more and more efficient machinery. Farms with low economic threshold are forced to purchase second-hand machinery. This leads to increased costs for operating these machines due to the need of maintaining costly repairs in order to restore their technical efficiency [2, 6, and 7].

Market information on agricultural machines do not deliver sufficient knowledge that allows undertaking right investment decisions by farmers. Improper decisions endanger financial losses to agricultural holdings and limit their further development [1]. Farm owners believe that machinery of Polish manufactures are of questionable quality, and therefore they prefer to buy used machines of western production, rather than new machinery produced in Poland. Since the Polish accession to

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the European Union, farmers can use the co-financing from the European Union funds for purchasing machinery within the frame of the common agricultural policy. As a result of this, the problem on undertaking the decision of buying second-hand machine or a new one is often solved. However, there arises the issue of choosing between the new machines of domestic whether western manufacturer. The price differences between the Polish production machines, and those made in Western Europe reach as much as several tens of percent.

Front-end loaders are of great importance for agricultural holdings, which are the retrofitting to agricultural tractors. On the one hand, they facilitate efficient performance of agricultural treatments strictly related with loading, unloading and reloading operations without the necessity to purchase expensive self-propelled loaders; and on the other hand, they do not restrict the tractor's performance. Devices of front-end loaders that are currently available on the market allow for their quick assembly and disassembly from the tractor.

RESEARCH OBJECTIVE, SCOPE AND METHODOLOGY

As it was indicated in the introduction section of the paper, reasonably suited machinery stock in terms of quantity and quality constitutes a not inconsiderable role in production processes. Appropriate decisions related to the purchase of machinery create possibilities of using cost-effective technologies, and this contributes to obtaining higher yields with increased quality.

The objective of this study was to compare front-end loaders being manufactured by key Western producers and loaders of domestic production. Loaders with similar technical and working characteristic were subject of the research studies and analysis. As a reference parameter was adopted the lifting ability to the bucket pivot point. All of the above-mentioned loaders have been oscillating at 400 cm.

Scope of the research work included analysis of technical parameters of selected front-end loaders in accordance with the data presented by their manufacturers. The main criteria that were compared are: lifting height, maximum lifting capacity with boom being down and raised to its maximum height. The bucket pivot point has been appointed as a measuring point. Such parameters as: loader weight, picking up angle at the ground, and the unloading angle with boom raised to its maximum height were analysed, as well. Due to the fact that front-end loaders are mounted directly on agricultural tractors, there often arises the need of quick-mount boom in order to perform certain agricultural treatments. In further part of the research work, a comparison of measurements of time required for assembly and disassembly of the boom was carried out. Loaders vary from one another in price, therefore, based on information from dealers of agricultural machinery operating in the Wielkopolska region, a comparison of loaders' prices were also analysed.

In the study were omitted names of manufacturers and models of the analysed loaders. The loader manufactured in Poland was further marked as loader ***E***, while loaders of Western manufacturers were analogically described as loader ***A***, loader ***B***, loader ***C***, and loader ***D***.

RESEARCH RESULTS AND ANALYSIS

Five models of front-end loaders were given under analysis in terms of their technical and working parameters, based on publicly available data. The first criterion was the maximum lifting height to the axis of bucket pivot. As it can be seen in Figure 1, all loaders are operating at around 4 m. The leading position in this field with the value of 4.14 m was taken up by the loader ***E***, being manufactured in Poland.

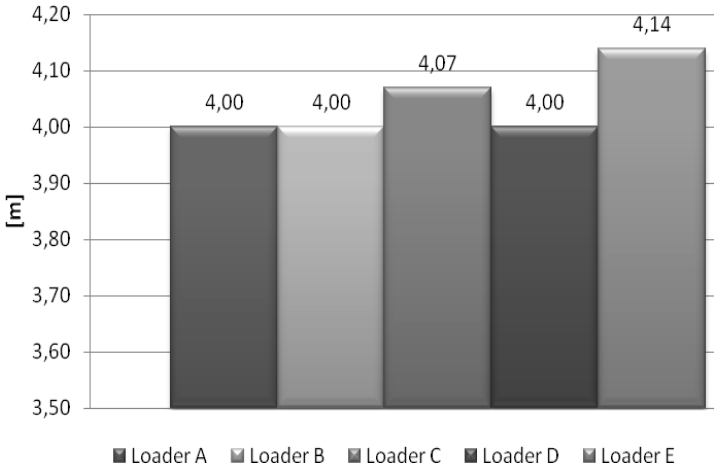

Fig. 1. Maximum lifting height of bucket pivot points in front-end loaders

Subsequent parameter being analysed was the maximum lifting capacity with boom down at the bucket pivot point. As it can be determined from Figure 2, the best among all of the devices turned out to be the loader ***D*** with lifting capacity of 2520 kg. Then, loaders ***E*** and ***C*** followed the position on the list. The lowest lifting capacity values, amounting 2200 kg and 2190 kg were characteristic for the loaders ***A*** and ***B***, respectively.

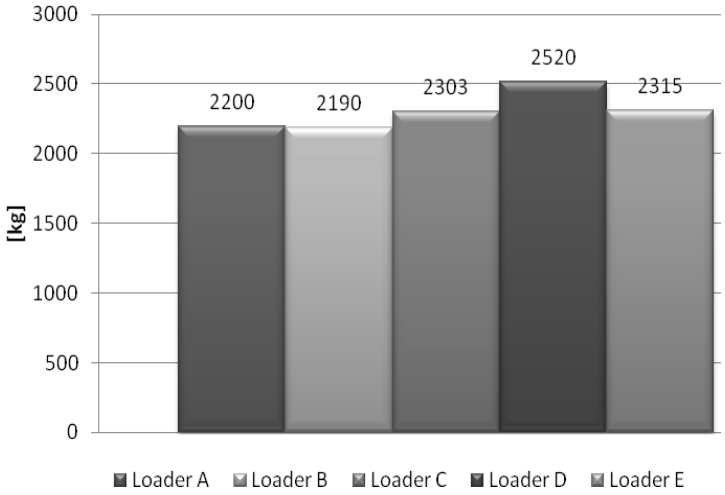

Fig. 2. Front-end loader lifting capacity at minimum height

The next analysed parameter was the maximum lifting capacity with the boom raised to the bucket pivot point. Flagship position occupied loaders A and B. Their lifting capacity values are the same as in the case of boom being lowered, and they are 2200 kg and 2190 kg, respectively. Other of the analysed loaders have lower lifting capacities with boom raised. The biggest variation was observed in the front-end loader B, where the capacity decreased to the amount of 1768 kg. Detailed data is shown in Figure 3.

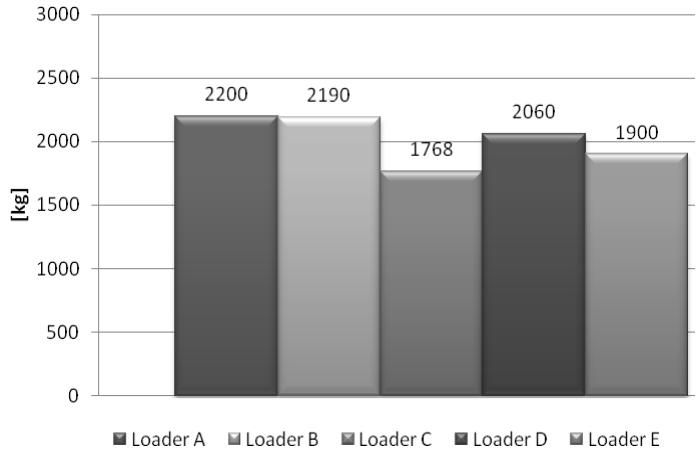

Fig. 3. Front-end loader lifting capacity at maximum height

Another parameter is the angle of picking up material from the ground level, which according to the manufacturer should have a relatively high value, while this implies that the charging process runs smoothly. The highest value of the angle of picking up the material (52^{o}) obtained the loader ***B***. The next on the list with the value of 50^{o} was the loader ***E*** manufactured in Poland, while the lowest value received the loader ***D***. Detailed parameters are defined in Figure 4.

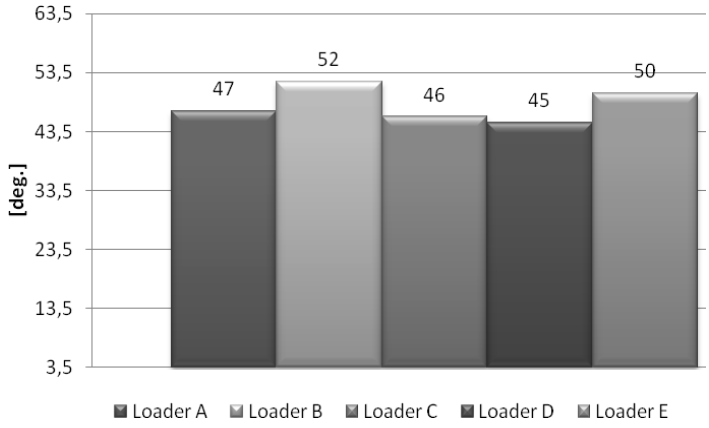

Fig. 4. Material loading angle of front-end loaders

A key operating parameter for front-end loaders is the angle at maximum height during unloading. According to the technical data, the higher the parameter is, the more efficacious is the unloading of the loaded loader. As it can be determined in Figure 5, on forehead position is emerged the loader E by Polish manufacturer, having the angle of 66o. The lowest values of 55o are presented by loaders A, B, and D.

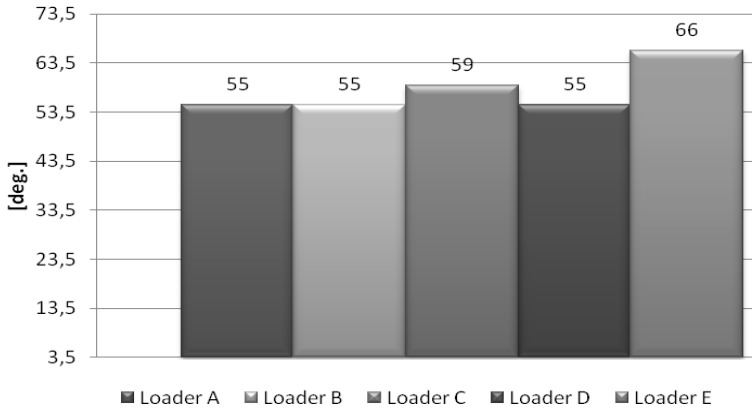

Fig. 5. The angle at maximum height during unloading in front-end loaders

Forthcoming parameter is the loader mass, which is directly related to sufficient strength of the superstructure and stability of the design. Elements being most exposed to overloading due to continuous changes in boom positioning are couplers of the loader, which are rigidly fixed to the tractor. Front-end loaders should be made of high quality steel; on the one hand – it allows reducing the weight of the loader, and on the other hand – it leads to achieving proper strength parameters. As it can be seen in Figure 5, weight of the analysed loaders ranges between 535 and 620 kg.

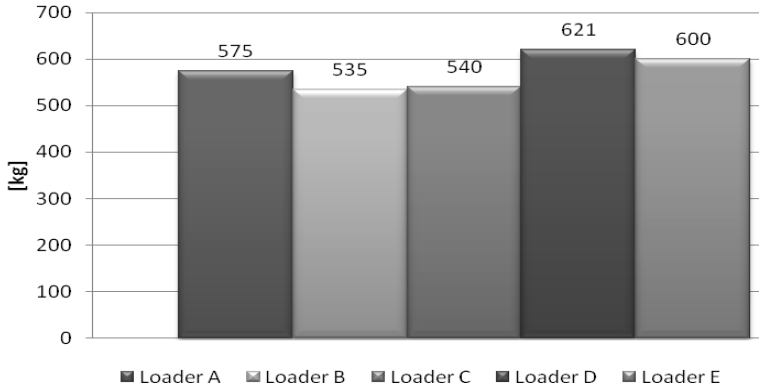

Fig. 6. Mass of front-end loaders

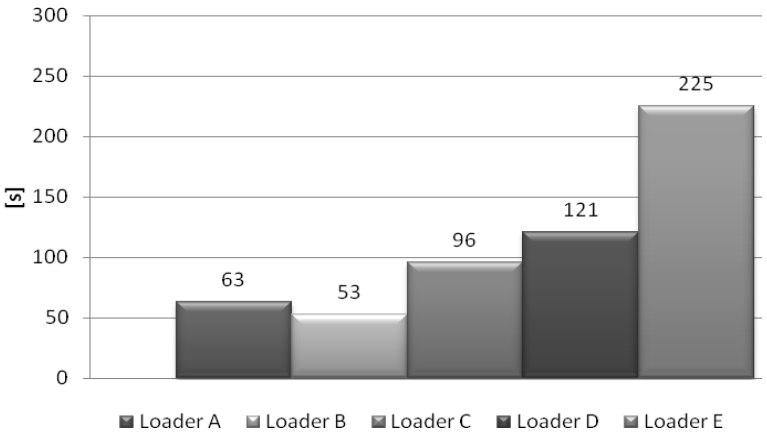

Fig. 7. Assembly time of front-end loader

Subsequent stage of the research work was the time analysis for mounting and dismounting the boom in front-end loaders. The results indicate average time measures taken in three trials. Each of the tested front-end loaders was equipped in the system of quick-mount/dismount of hydraulic lines. The measures were performed in five various farms located in the Wielkopolska Voivodeship. As Figures 7 and 8 demonstrate, the shortest time for assembling and disassembling the boom in the tractor was received by the loader B.

The longest time required for mounting and dismounting the boom in the tractor is characterized by the Poland's manufactured loader E; these values are twice or even sometimes three times as high as in case of other analysed loaders.

The final parameter being analysed, which is often a key one, when selecting a machine, is the price of the loaders. Net price of each loader having similar equipment was determined based on information obtained from three independent dealers operating in the Wielkopolska region, and the obtained results -as the arithmetic mean - are shown in Figure 9.

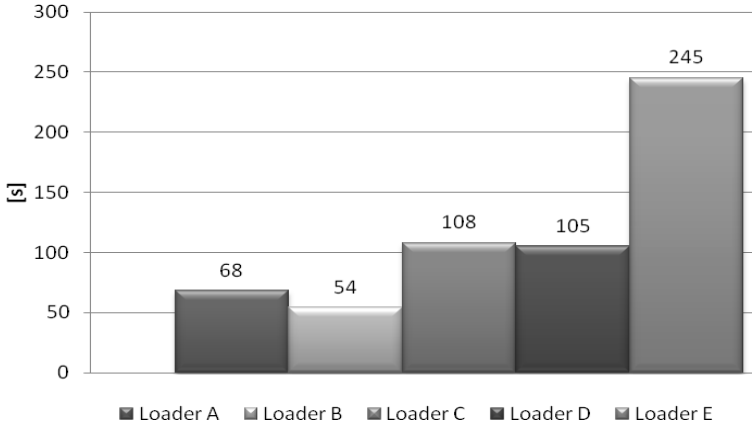

Fig. 8. Front-end loader disassembling time

The loader ***E*** being manufactured in Poland had the lowest net price, maintained at the level of 21.000PLN, which costed less by approx. 11.100 PLN (in net value) then the most expensive one.

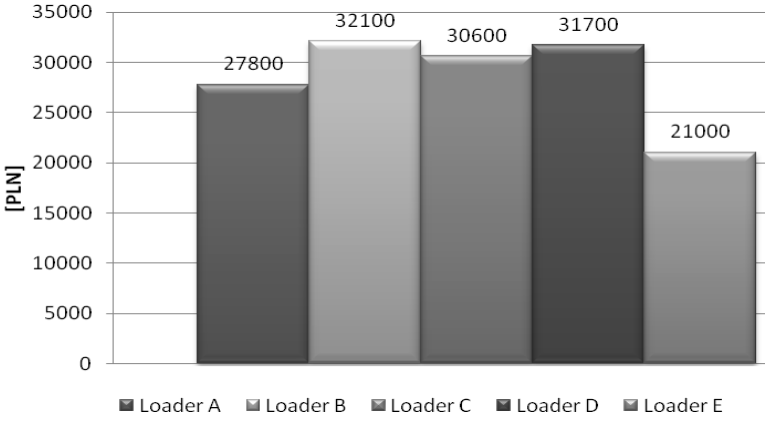

Fig. 9. Price of front-end loaders

CONCLUSIONS

The performed research and carried out extensive analysis of the results allow to formulate the following conclusions:

1. Front-end loader of Polish manufacturer is characterized by good technical and operating parameters and it can successfully compete with machinery of Western manufacturers.
2. The time needed for assembling and disassembling a boom in the front-end loader manufactured in Poland is the longest, and it is mainly caused by the boom coupler design.
3. The price for the front-end loader manufactured by a Polish company is 30% lower. This difference empowers to equip the loader with additional operating means.

REFERENCES

1. Cupiał M., Wnęk A. 2008. Porównanie sposobów pozyskiwani a informacji o maszynach rolniczych w gospodarstwach Małopolski. Inżynieria Rolnicza. Kraków, No 9 (107). pp. 61-66
2. Czarnocki S., Turska E., Wielogórska G. 2008. Zasoby maszynowe gospodarstw, wiek i zainteresowanie zakupem nowych maszyn w gospodarstwach Polski środkowo-wschodniej. Inżynieria Rolnicza. Kraków, 4(102), pp. 217-224
3. Muzalewski A., 2000. Aktywność inwestycyjna i wyposażenie gospodarstw w środki mechanizacji. Problemy Inżynierii Rolniczej. IBMER, Warszawa, 3, pp. 95-102
4. Osuch A., Rybacki P., Buchwald T., Staszak Ż., Ratajczak J. 2015. Analiza stanu wyposażenia gospodarstw rolnych w ciągniki rolnicze. Aktualne problemy Inżynierii Biosystemów. Wydawnictwo Uniwersytetu Przyrodniczego w Poznaniu, pp. 91-101, ISBN 978-83-7160-778-3

5. Rybacki P., 2012. System oceny jakości serwisowania maszyn rolniczych. Habilitation Dissertation, Poznań, First Edition, Publishing Sheet 17,4; ISSN: 1896-1894
6. Szeląg A., Kowalski J. 2008. Źródła dochodów a poziom wyposażenia w park maszynowy gospodarstw rolnych. Inżynieria Rolnicza. Kraków, 2(100), pp. 269-276
7. Szeląg-Sikora A., Cupiał M. 2010. Pozyskiwanie informacji rolniczej a poziom wykorzystania funduszy unijnych na inwestycje techniczne w gospodarstwach rolniczych. Inżynieria Rolnicza. Kraków, 2(120), pp. 193-200

Michał Sznajder, Joanna Staniszewska[28]

THE SUBJECTS OF THE SWEDISH NATIONAL BANK'S PRIZE IN ECONOMIC SCIENCES IN MEMORY OF ALFRED NOBEL FROM 1969 TO 2015

Abstract: The aim of this article was to use the data in the titles justifying Nobel Prizes in Economic Sciences to present the development of economic sciences from 1969 to 2015. These titles are an ideal research material to show trends in the development of economics resulting from the accomplishments of economists all over the world. However, this development could not have been deliberately coordinated during that period. Therefore, it is justified to use the term 'drift', which combines controlled development and inertia. The article presents the essence of funding the Nobel Prize in Economic Sciences and the controversies it arouses. The key words and phrases were used to present the drift in the development of economic sciences during the period of awarding this distinction.

Key words: Alfred Nobel, Swedish National Bank, Royal Swedish Academy of Sciences, economic sciences, Nobel Prize in Economic Sciences, laureates of the Nobel Prize in Economic Sciences, drift of key words and phrases, development of theory of economics

INTRODUCTION

For an economist the Swedish National Bank's Prize in Economic Sciences in Memory of Alfred Nobel is the most prestigious distinction. A study of the subjects of scientific considerations and the results of research published by laureates of the Nobel Prize in Economic Sciences, which are listed in the justification of the prize by the Royal Swedish Academy of Sciences, gives major economic issues a new perspective. Undoubtedly, not all authors of the most important accomplishments in economic sciences have been distinguished with this prize, but laureates of the Nobel Prize in Economic Sciences are outstanding researchers – economists who are usually pioneers in their specialisation, who contribute to the development of economy and are widely popular.

This article describes the circumstances of funding the Nobel Prize in Economic Sciences. The appendix lists the laureates from 1969 to 2015, including the citizenship and research area for which the Prize was awarded. The article analyses the age and citizenship of all the laureates of the Nobel Prize in Economic Sciences from 1969 to 2015.

The article also discusses the method of awarding the Prize as well as the controversies it arouses. It presents the official name of the Nobel Prize in Economic Sciences, which has not changed ever since it was established.

In order to characterise the areas of economic sciences in which the prize was awarded between 1969 and 2015 (the period during which the Nobel Prize in Economic Sciences was awarded) an analysis of the development drift based on key words and phrases was used.

CONTROVERSY AROUND THE NOBEL PRIZE IN ECONOMIC SCIENCES

The Nobel Prize is a distinction known all over the world. It is awarded for outstanding accomplishments in physics, chemistry, physiology or medicine, literature and peace. The prize is awarded for scientific merits for communities and mankind. It was established by the will of Alfred Nobel, the inventor of dynamite. However, Nobel did not establish the prize in economic sciences.

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In fact, the Nobel Prize in Economic Sciences is funded by the Bank of Sweden. Its full name is 'The Swedish National Bank's Prize in Economic Sciences in Memory of Alfred Nobel'. It was established in 1968 to commemorate the 300th anniversary of the establishment of the Swedish National Bank [Tarnowska 2001]. It is a problem to provide the official name of the prize as there were numerous legal perturbations related with its real name. Table 1 lists the official names of the prize in its nearly 50-year history.

The laureate of the Nobel Prize in Economic Sciences is elected by the Nobel Committee, i.e. a group of professors of economics of the Royal Swedish Academy of Sciences. The Nobel Prize laureates receive the award from the King of Sweden during the ceremony which is held on 10 December every year, which marks the anniversary of Alfred Nobel's death. During the ceremony the laureates of the Nobel Prize in physics, chemistry, physiology or medicine, literature and the Nobel Peace Prize all receive the awards [Matkowski 1991]. In other words, on 10 December the King of Sweden hands both Nobel Prizes and the Prize in Economic Sciences in Memory of Alfred Nobel.

In 2015 the prize funded by the Swedish National Bank was worth 8 million Swedish crowns, i.e. more than 860,000 euros. The Nobel medal each laureate in Economic Sciences receives with a diploma was designed by a Swedish artist and sculptor, Gunvor Svensson-Lundqvist. The name of the laureate in Economic Sciences is engraved on the edge of the obverse of the medal. The reverse shows the North Star and the logo of the Royal Swedish Academy of Sciences with the inscription in Swedish 'Kungliga Vetenskapsakademien' around the edge of the medal. The front of the medal shows the face of Alfred Nobel. Around the upper edge is the inscription 'Sveriges Riksbanktill Alfred Nobel Minne 1968'. The lower half shows the crossed horns of the abundance bank – see Fig. 1. [http://www.nobelprize.org].

Fig. 1. The Nobel medal for Economic Sciences

Source: The Medal for the Swedish National Bank's Prize in Economic Sciences in Memory of Alfred Nobel. Nobelprize.org.http://www.nobelprize.org/nobel_prizes/economic-sciences/medal.html

Alfred Nobel did not establish a prize for economists. The prize is not paid from the Nobel Prize funds. The establishment of the prize still arouses controversy. Peter Nobel, who is Alfred Nobel's great-grandson and a human rights defender, objects to the prize. In his opinion, the name of the prize abuses their family name in view of the fact that no member of his family intended to establish a prize in economic sciences [Gertchev 2011]. Alfred Nobel's will to award prizes concerned inventions and discoveries, from which mankind benefited most. It referred to practical discoveries rather than theoretical considerations. This allegation made the Nobel Prize in economics in a way 'unofficial', because laureates receive the prize in memory of Alfred Nobel rather than the Nobel Prize, contrary to the general opinion. At present the full name of the prize is:

'The Swedish National Bank's Prize in Economic Sciences in Memory of Alfred Nobel' [Michalski 2015]. The rules of awarding the Nobel Prize in economics are the same as in the other branches. The prize of the Swedish National Bank aroused even more controversies when it was awarded. Economists commonly thought that the prize was mostly used to create laureates' image and develop their political and scientific career. Their theories had strong impact on governments and communities but they had no practical influence on the economy [Jasiński 2016].

Table 1. History of the official names of the Nobel Prize in Economic Sciences.

Period	Name
1969-1970	*Prize in Economic Science Dedicated to the Memory of Alfred Nobel*
1971	*Prize in Economic Science*
1972	*Bank of SwedenPrize in Economic Science in Memory of Alfred Nobel*
1973-1975	*Prize in Economic Science in Memory of Alfred Nobel*
1976-1977 i 1983	*Prize in EconomicSciences in Memory of Alfred Nobel*
1978-1981 i 1984-1990	*Alfred Nobel MemorialPrize in EconomicSciences*
1982	*Alfred Nobel MemorialPrize in Economic Science*
1991	*Sveriges Riksbank (Bank of Sweden) Prize in Economic Sciences in Memory ofAlfred Nobel*
1992-2005	*Bank of SwedenPrize in EconomicSciences in Memory of Alfred Nobel*
since 2006	*The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel*

Source: Kłobukowska 2013 [after J. Misala 2011]; www.nobelprize.org.

The official name of the Nobel Prize in Economic Sciences in Swedish is 'Sverigesriksbankspris i ekonomiskvetenskaptill Alfred Nobelsminne' (The Swedish National Bank's Prize in Economic Sciences in Memory of Alfred Nobel) [The Committee for the Prize in Economic Sciences in Memory of Alfred Nobel: Consumption, great and small, 2015]. The phrase 'in Memory of Alfred Nobel' makes the prize retain its individual character. Since the establishment of the prize its English translations have changed several times, as can be seen in Table 1. However, the phrase 'economic science' or 'economic sciences' has been used repeatedly. This means that the Nobel Committee distinguishes achievements in economic sciences rather than economics. Thus, the research area scientists can represent is broader and the prize is awarded to laureates with accomplishments not only in economics but also in related sciences [Kłobukowska 2013].

Apart from that, laureates' scientific findings often combine economics, mathematics, psychology and sociology. As far as laureates' education and research methods are concerned, they have often crossed the boundaries of economics in its narrow sense [Jasiński 2016].

STATUS QUO

So far the Nobel Prize in Economic Sciences has been awarded 47 times to 76 laureates. The prize has been awarded to one laureate 24 times, to two laureates – 17 times and to three laureates – 6 times.

No Poles have been awarded the prize. The prize was first awarded in 1969 to two scientists: Jan Tinbergen from the Netherlands and Ragnar Frisch from Norway for having developed and applied dynamic models for the analysis of economic processes. The first and only woman laureate was Elinor Ostrom, who received the prize in 2009 for her analysis of economic aspects of governance. In 2014 the prize was awarded to a French economist Jean Tirole from the University of Toulouse for his analysis of market power and regulation. In his studies he explained how governments could control the activity of large companies dominating the market

[http://www.nobelprize.org]. In 2015 the prize was awarded to Angus Deaton for his accomplishments in consumption economics and analysis of the causes of poverty and welfare. In his work he concentrated on three key issues, i.e.: how consumers divide their expenditures for various goods, which part of people's income is spent and which is saved and what the best method of measuring and analysing welfare and poverty is [The Committee for the Prize in Economic Sciences in Memory of Alfred Nobel: Consumption, Poverty and Welfare, 2015].

The average age of all laureates of the Nobel Prize in Economic Sciences between 1969 and 2015 was 67. The youngest laureate was Kenneth J. Arrow, who was 51 when he received the prize in 1972. The oldest laureate was Leonid Hurwicz, who was 90 when he received the prize in 2007 [http://www.nobelprize.org].

In the beginning there was balanced competition between European and American scientists. However, if we analyse the percentage of laureates according to their country of origin (Fig. 2), we can see a vast majority of Americans, i.e. 68.42% of all laureates. British laureates are runners-up (9.21%). Other laureates came from Norway, France, Sweden, Israel, Canada, Cyprus, India, Austria, Germany, the Netherlands and the former Soviet Union. A certain kind of doubt also arises – perhaps the predominance of American and British laureates results from the marginalisation of accomplishments of non-English speaking scientists.

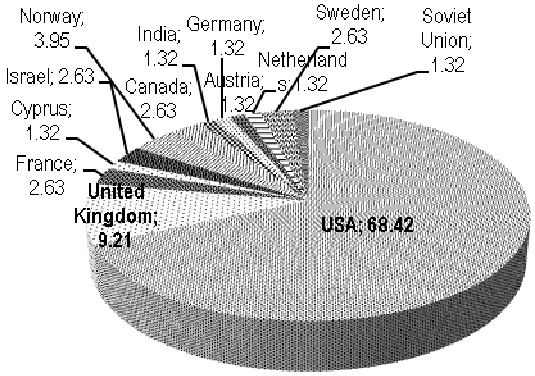

Fig. 2. The percentage of laureates of the Nobel Prize in Economic Sciences by citizenship between 1969 and 2015.

Source: Compiled by the authors.

THE DEVELOPMENT OF ECONOMICS ACCORDING TO TITLES JUSTIFYING NOBEL PRIZES IN ECONOMIC SCIENCES

Justification is an important element in the procedure of awarding the Nobel Prize in Economic Sciences. The list of titles justifying awarding the Nobel Prize in Economic Sciences is an ideal material for researching world tendencies in the development of economic sciences. The justifications enable analysis of key words and phrases indicating the most important areas of development of economics in the opinion of the Noble Committee. It is an important methodological axiom whether the development of science is a deliberate man-controlled process or a sum of random movements or the resultant of these two processes. This question is justified,

because there are hundreds of thousands of researchers conducting studies in different fields of science and so far it has been impossible to coordinate the range of these studies. Within a short time span and subject concentration a researcher may be convinced that they have total control of development trends in the research area. However, in a longer time perspective and wide research area this belief is usually unjustified and individual researchers have minimal influence on long-term development trends. The term 'drift' is a good illustration of the process of development of economics, because it is the resultant of man-controlled development processes in science and a strong inertial development trend generated by accumulation of individual researchers' accomplishments. The list of titles justifying the awarding of the Nobel Prize in Economic Sciences enables description and assessment of the development of economics in the context of individual achievements of the world's best economists.

The drift in the development of economic sciences can be analysed by means of key words and phrases. The drift shows that in history some key words appeared earlier and later they disappeared or they were used less frequently as the development of science progressed. They were replaced with other words illustrating the current status quo in the development of science. The analysis of the development drift in economic sciences consists of two parts. In the first part key words and phrases are assigned to a subject. In the other part the drift is determined. Axis X indicates the passage of years; axis Y indicates key words and phrases. Fig. 3a, 3b show the analysis of the drift between 1969 and 2015.

Consolidation of the drift consists in assigning the right key words and phrases on axis Y to dates on axis X. In this way the drift is indicated graphically by points representing key words and phrases and time. The analysis enabled identification of 64 key words and phrases in the justification titles. They show that economists were particularly interested in market, especially in market regulations, market power, market theory, efficient use of resources in the market, structures of market functioning, designing economic and market mechanisms, methods of entering and exiting the market, making economic and political decisions as well as in incentives influencing decisions about the market under asymmetric information. The laureates were also interested in the following issues: rationality of behaviours, economic equilibrium, analysis of interdependence between economic, social and institutional phenomena, economic growth and development in developing countries, including economic fluctuations, labour market, welfare and consumption. The analysis also revealed that the laureates concentrated on financial markets, price analysis, fiscal and monetary policies, currency exchange rates, transaction costs, property rights, optimal allocation of resources, monetary theory, game theory and international trade theory. Apart from that, the Nobel Committee awarded economists interested in econometrics, time series with common trends, methods of analysing selective samples, discrete choices, quantitative methods, theory of probability, dynamic models and econometric models used in attempts to explain economic changes.

In the early years of awarding the Nobel Prize in Economic Sciences the distinguished subjects were related with economic growth and development, social and economic structure, including developing countries and approach to technology. Other prize-winning subjects included analyses of financial markets and their relations with money saving and decisions about expenditures, employment, production and prices. Issues concerning economic and political decisions were awarded both in the early and late years. In the middle years of the Nobel Prize in Economic Sciences the awarded subjects were microeconomic analyses of human interactions and behaviours, which involved the use of psychological tests in economics. So far the issues of consumption and welfare have been distinguished a few times at similar time intervals.

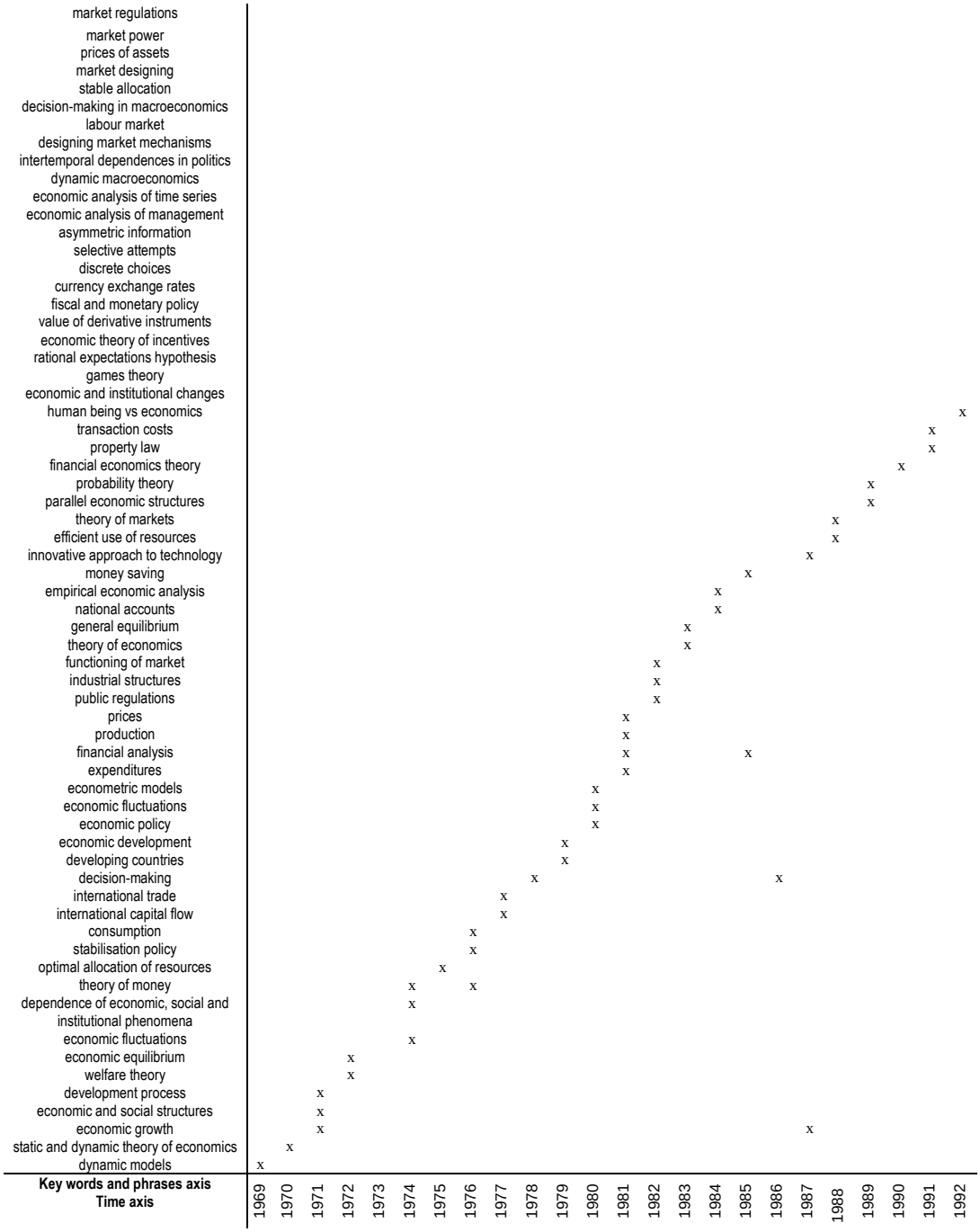

Fig. 3a. The drift of key words and phrases in the subjects of the Nobel Prize in Economic Sciences between 1969 and1992.

Source: Compiled by the authors.

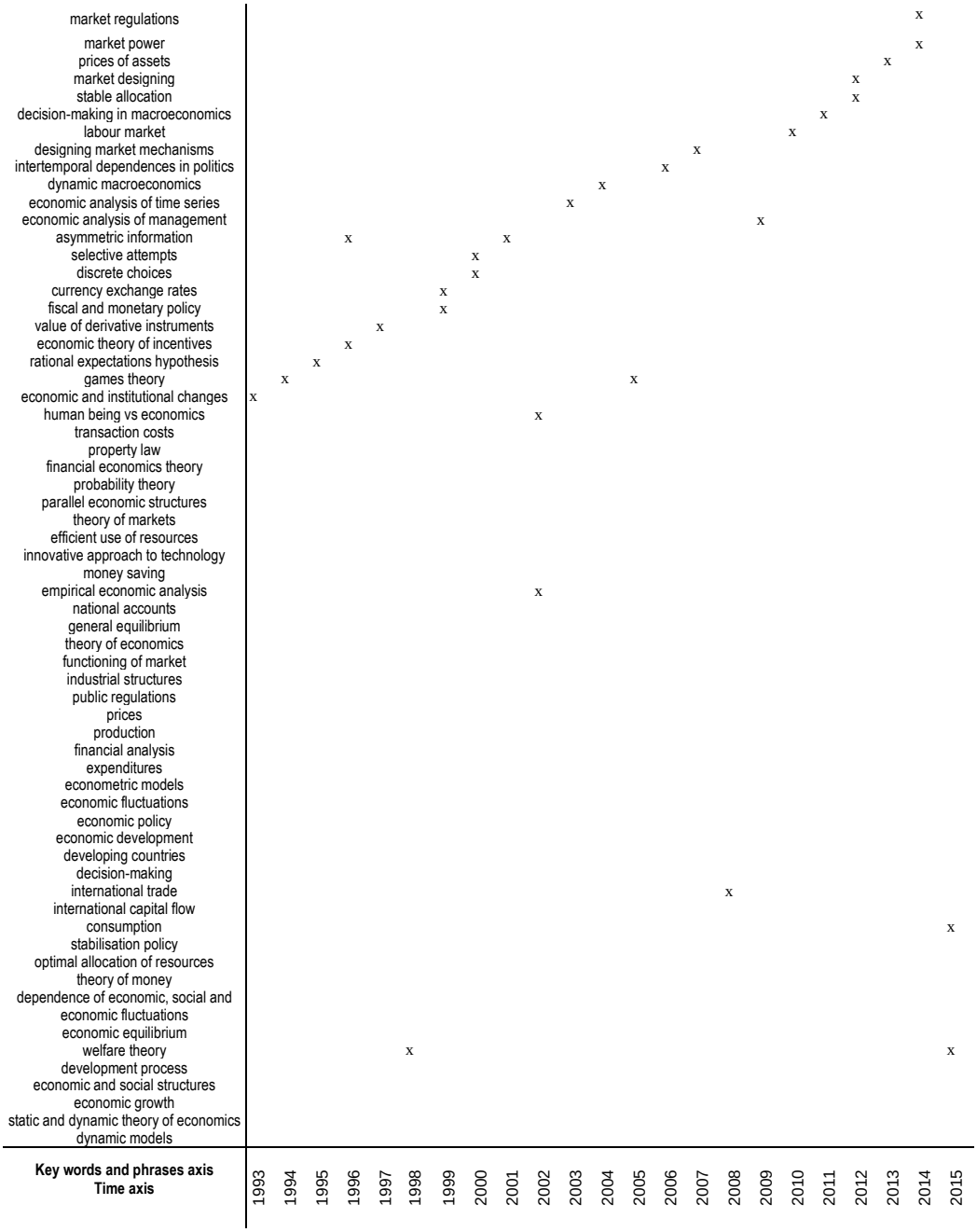

Fig. 3b. The drift of key words and phrases in the subjects of the Nobel Prize in Economic Sciences between 1993 and 2015.

Source: Compiled by the authors.

Periodically, the most frequently awarded issues were those related with the economic theory of incentives under asymmetric information in the market, market power and market regulations, efficient use of resources, the theory of stable allocation and practice of designing economic mechanisms in the market.

Interestingly, two years after the economic crisis in 2008 the subject of labour market was distinguished. In the following years the prize was awarded for market regulations, economic mechanisms in the market, efficient use of resources and the theory of welfare and consumption. This means that the Noble Committee carefully observes current economic phenomena and takes them into consideration to select laureates of the Nobel Prize in Economic Sciences when their scientific accomplishments are related with these issues.

SUMMARY

The article characterises and analyses the Swedish National Bank's Prize in Economic Sciences in Memory of Alfred Nobel. It was established to commemorate the 300th anniversary of the establishment of the Swedish National Bank and it is awarded in memory of Alfred Nobel. The analysis revealed that since the establishment of the Prize it has aroused controversy. American and British scientists have most often been awarded the Prize. One of the most important achievements of this article was the analysis of the development of economic sciences based on the titles of justifications given by the Nobel Committee. The history of titles justifying the Nobel Prize in Economic Sciences enable assessment of the drift in the development of economics in the context of individual achievements of the world's best economists. The analysis of the drift in the development of economics based on key words and phrases confirmed the thesis that the Nobel Committee appreciated scientific works discussing current economic problems and the Nobel Prize in Economic Sciences is awarded for particular contribution to research on the development of economy.

REFERENCES

1. Gertchev N. (2011): The Economic Noble Prize, Libertarian Papers, vol. 3, art. no. 9, 2011,[in] http://libertarianpapers.org/articles/ 2011/lp-3-9.pdf. (accessed on 1 February 2016).
2. http://www.nobelprize.org (accessed on 22 January 2016).
3. Jasiński L. J. (2016): Nobel z ekonomii 1969-2016. Poglądy Laureatów w zarysie, KeyText, Warszawa.
4. Kłobukowska J. (2013): Laureaci Nagrody Nobla w dziedzinie nauk ekonomicznych. Historia i wkład laureatów do współczesnej myśli ekonomicznej, Optimum. Studia Ekonomiczne nr 4 (64) 2013.
5. Laureaci Nagrody Nobla w dziedzinie ekonomii,(1991), Red. Z. Matkowski, Państwowe Wydawnictwo Naukowe, Warszawa.
6. Leksykon PWN. Nagrody Nobla,(2001), Red. B. Tarnowska., Wydawnictwo Naukowe PWN, Warszawa.
7. Michalski T. (2015): Nobel z ekonomii 2015: Angus Deaton został laureatem, http://biznes.pl/swiat/nobel-z-ekonomii-2015-angus-deaton-zostal-laureatem (accessed on 3 February 2016)
8. Nagrody Nobla w dziedzinie ekonomii 1969-2009. (2011). Red. J. Misala, Wyd. Politechnika Radomska, Radom.
9. The Committee for the Prize in Economic Sciences in Memory of Alfred Nobel: Scientific Background on the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2015. Angus Deaton: Consumption, poverty and welfare. http://www.nobelprize.org (accessed on 25 January 2016).

10. The Committee for the Prize in Economic Sciences in Memory of Alfred Nobel: Scientific Background on the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2015. Consumption, great and small. http://www.nobelprize.org (accessed on 25 January 2016).
11. The Medal for The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel. *Nobelprize.org*.http://www.nobelprize.org/nobel_prizes/economic-sciences/medal.html (accessed on 13 February 2016).

Anna Świątek[29]

ORGANIC FARMING - HEALTHY FOOD AND WORK SATISFACTION BASED ON A FARM LOCATED IN THE VILLAGE OF SOBIEN IN OPOCZNO COUNTY

Abstract: Production of healthy food is currently an important topic of economic and social development. People pay growing attention to nutrition and food quality, recognizing their impact on health. Organic farming has experienced a significant growth as a result of this growing demand of modern consumers, who appreciate the benefits of healthy foods. Organic production is carried out on both small and large farms. There are a number of formal requirements to be addressed by farmers in order to receive the appropriate certificate and be able to use farming subsidies. This study examined an organic farm located in village of Sobien (Opoczno County) and described its situation in the light of some of its features. According to the owners, the results of organic farming have been pleasing, bringing satisfaction from managing the land in a natural way, while maintaining a high level of biodiversity.

Keywords: organic food, organic farm, organic farming, Agri-Environmental Program

INTRODUCTION

Healthy food is directly related to safety, which is a multi-faceted issue. Among other things, social, economic and ecological (environmental) safety can be included, each having both local and regional levels. The state is obliged to provide its citizens with the conditions for a better life in a healthy environment, that should be protected, stimulating processes of sustainable development. Caring for the environment is the duty of every citizen, however this concept especially applies to people living in rural areas, which produce food that is then consumed by the whole society. Farmers, through the use of appropriate agricultural treatments, have a direct impact on the state and quality of the environment. The most environmentally safe system is organic farming. "*Organic production is an overall system of farm management and food production that combines best environmental practices, a high degree of biodiversity, protection of natural resources, application of high animal welfare standards and the method of production of certain consumers preferring products produced using natural substances and natural processes* "[The report on the state of ... 2015, p.10]. Sustainable management of agricultural land while protecting the natural environment prevents the degradation of water and soil [Augustyniuk-Kram in 2012]. Crop rotation, among other things, is used in order to increase biological activity and soil fertility. It is a systematic approach based on planning a proper succession for each respective plant. Everything must be adapted to the climate, soil and economic conditions. This technique coupled with appropriate agrotechnical treatments leads to establishing optimum conditions for the development and growth of crops while combining the environmental, socio-economic, ethical-aesthetic and health benefits [Łuczka-Bakuła, 2007]. Organic products, although more expensive, have a higher nutritional value and taste better. According to the research by various authors dealing with this issue, there is a problem with the sale of organic products. This is mostly due to the fact that the development of the organic food market was not as rapid as the development of the organic farming. Therefore, the market of organic food and its distribution are still in the early stages of development [Smoluk-Sikorska, Łuczka 2014].

The aim of the article is to present the structure and functioning of an organic farm in the village of Sobień, and to attempt to find an answer whether the system of ecological management

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will ensure the continued development of the farm. Field studies and direct interviews with the owner and her family have been used as research methods.

ORGANIC FARMING IN THE LODZ REGION AND POLAND

According to the report prepared for the Chief Inspectorate of Trade Quality of Food and Agriculture Products [status report ... 2015 p.19] since Polish accession to the European Union the number of organic agricultural producers in Poland has increased over 9 years, while being able to maintain high geographical diversity. In 2004, the number of farms amounted to only 3.760 [Report on ... 2005] while in 2013, it's number has increased more than sevenfold (27,093). At the end of 2014, the trend reversed. For the first time since the accession, the number of organic farms has decreased (by 6.1%). This was accompanied by a decrease in the total area of agricultural land where organic farming practices have been implemented. The number of ecological processing centers, however, increased by 18.9%. The total area of organic farmland in Poland amounts to 657,902.06 hectares. Most such farms are located in Zachodnio-Pomorskie, Warminsko-Mazurskie and Podlaskie voivodships.

In the Lodz region, overall national trends can be observed. Firstly, reduction in the number of organic producers from 550 in 2013 to 544 in 2014 (1.1% decrease). Secondly, more significantly, the number of organic processing plants increased by 100% at the end of 2014. There were 34 in the whole voivodship. The total area of organic farmland in the voivodship has increased to 11,228.87 ha by the end of 2014. Size structure of the organic farms is dominated by farms with an area of 10-20 hectares (29.1%) and 5-10 hectares (25.2%) [Report on the state ... 2015 s.36,56].

In terms of the production and labelling of organic products EU countries apply Council Regulation (EC) No 834/2007 of 28 June 2007, while the national legal regulation is the Act on organic farming of 25 June 2009, together with the Minister of Agriculture and Rural Development regulations [Report on the state ... 2015]. Environmental policy applies to the rules of production, labelling, fair competition, protection and control. The market of organic products has gained a lot of trust and support. Organic farmers are supported by the national and EU subsidies. New conditions and challenges are transforming farmers into entrepreneurs, including the owner of the described organic farm.

ORGANIC FARM IN THE VILLAGE OF SOBIEŃ

Described farm is situated in the village of Sobień, administratively forming part of the Opoczno county. It is an area dominated by agricultural activity. Agricultural land area of the county is 63,503 ha, of which: 47 939 ha is arable land, 578 hectares are orchards, 10,571 ha grassland and 4,415 ha pastures. At the end of 2010, 10,802 farms existed, with an average area of 4.67 ha [Protection Program ... 2012]. The examined farm is one of 31 organic farms operating in the county that has received money under Measure 214 Agri-environmental Programme - Package 2 Organic farming (RDP 2007-2013), awarding total amount of 1,276,434.84 zł, of which 1.02 million zł came from EU funds.

In terms of physical and geographical aspects, tested area is located across two subprovinces: Malopolska Upland and Mazowiecko-Podlaska Upland. This has influenced its transient climate. Lodz (X) district agro-climate, which includes the test area is characterized by light precipitation from 550 to 600 mm / year. The length of the growing season comes to 217 days. A couple characteristic features are light podzols and large afforestation. The climate is cooler and more humid, which is favorable to agricultural crops [Gumiński 1951]. It is worth noting that different conditions occur, for example, in a forest clearing (microclimate), or within a cultivated field (phytoclimate) [Bac et al., 1993]. This has a direct impact on the vegetation and its root zone.

These are areas with favorable soil conditions, there is here a complex of good wheat, very good, good and weak rye. The area is dominated by light podzolic and pseudopodzolic soils; there

are also fertile alluvial and silty-marsh soils(Fig. 1). Diversity of soil types provides optimal growing conditions for the most and the least demanding plants. Crops are adapted to soil fertility and production capacity. Agricultural suitability of soils plays an important role in organic farming. Among the quality classes VI and V are dominating. Class IV b also has a significant share, which largely depends on the weather conditions [Protection Program ..., 2012]. Occurring here complexes of agricultural suitability of soils according to Sołowiej [1992] are areas optimal for growing brassicas (complex 2 - requires high humidity, therefore depends on the climate) and beets (complex 3 - soil not very concise, with the correct relationship air-water) and carrots (complex 5 and 6 - the smallest soil requirements, light soils with good permeability and humidity).

Organic farm in Sobien is a family farm that includes five people: two working on the farm, one, year-old child, and two people receiving pension. The owner is a graduate of the agricultural college - SGGW in Warsaw who also completed postgraduate studies. She tries to transfer the acquired knowledge into practical action and explained that her agricultural education and family traditions determined the ecological specialization of the farm. The farm takes vacationers and provides them with farm fresh food.

This approach represents true "authentic farm" experience, combining ecological approach in various aspects of its operation.

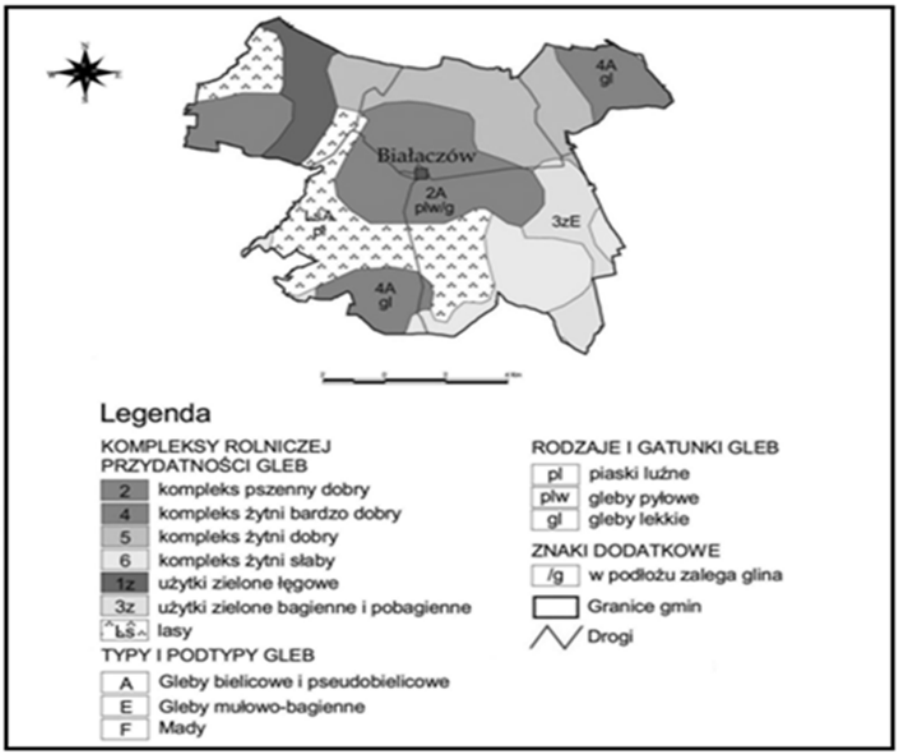


Fig. 1. Soil and agriculture map of Białaczów province. Source: Own calculations based on data from IUNG.

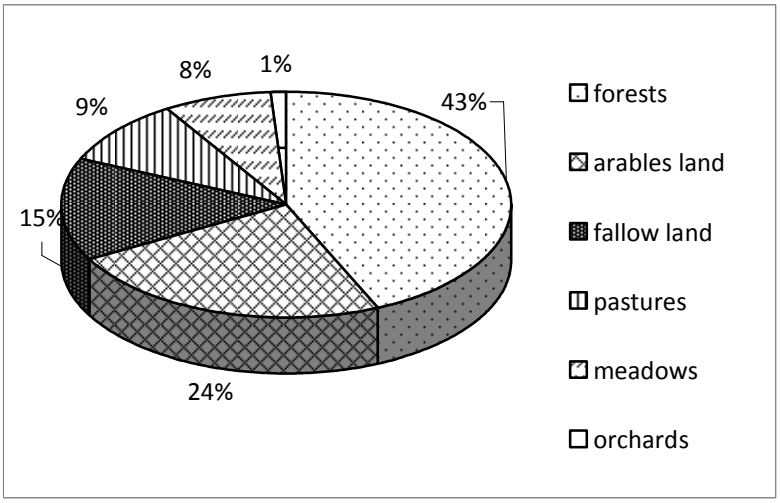


Fig. 2. The structure of land use in the studied farm (own development).

The farm includes 75 hectares (including 32.5 ha of forests, which are not eligible for subsidies). The remaining 42.50 ha consist of: arable land (17.75 ha), orchards (0.75 ha), fallow land (11 ha), meadows (6 ha) and pastures (7 ha). The owner believes that farm size is still too small and insufficient. If there is such a possibility, the farm will be expanded through the purchase of land (spatial concentration). The farm includes 13 parcels, ranging in size from 0.5 to 11 hectares each, which were previously consolidated (organizational and economic concentration) [Klepacki 1998]. The size of this farm exceeds the average size of an organic farm both in the Lodz region (19.13 ha), and in Poland (25.50 ha) (Fig. 2).

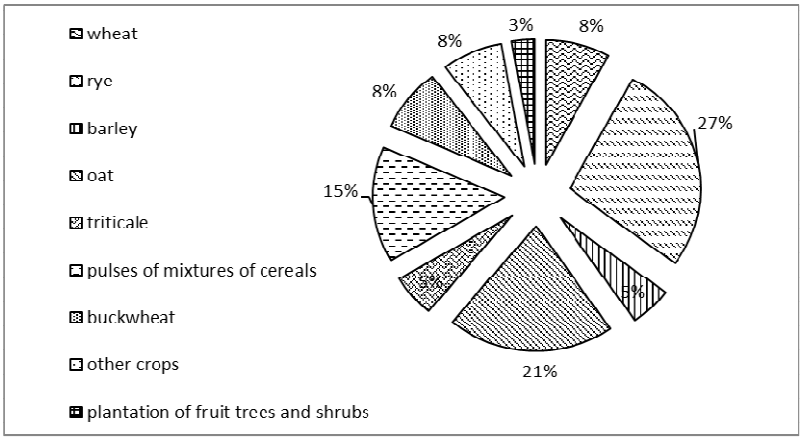
The farm is located in the middle of the forest (Pic. 1) with a paved forest road leading up to it. The closest neighbors are located about one kilometer away. Peace, quiet and unpolluted air create an undisturbed feeling of balance with nature. Neighborhood assistance is required to run the farm. 80% of Sobien residents depend on farm work, and are most helpful during seasonal work, mostly during harvest time. Besides breeding cattle and sheep, the farm has an apiary and fish ponds. Plants grown are mainly cereals (only from their own grain), fruit and vegetables - apples, pears (0.51 ha). More fertile soil is seeded with wheat (1.45 ha), barley (0.94 ha) and triticale (1 ha), while less fertile soils with rye (4.98 ha) and oats (3.76 ha). For the purpose of cultivating bees, buckwheat (1.49 ha) is also seeded, pollinated by bees that produce tasty and healthy honey. One bee family is able to produce (with appropriate conditions) about 10 liters of honey per year, harvested twice - in late spring and autumn. It is harvested with a combine which is already part of the farm's equipment. Sowing of vegetables (carrot, parsley, beets, red beetroot, pumpkins, squash, tomatoes, cucumbers) on the surface of 1.37 ha occurs in early spring (Fig. 3). In case of too little rain during the growing season self irrigation is required. Crops are stored in the basement and serve the needs of its residents and visitors.

Pic.1. Village of Sobien location in the forest landscape

Source: http://www.geoportal.gov.pl/

Additionally, the farm offers additional activities in form of agrotourism. Tourists from all over Poland come here to stay, among them regulars. The farm serves meals prepared with organic products, however it also has a separate kitchen which allows visitors to prepare their own, if necessary. About 20 tourists are admitted in the spring and summer, with a break for the harvest. The farm has a water supply, but no sewage system.

Since 2004 the farm has been supported by the EU in the form of: direct payments, LFA and agri-environmental program. Availability of these resources, personal and farm development, as well as economic considerations has prompted the owner to draw on them. In their acquisition, the owner has initially benefited from consulting ODR, municipalities, agricultural organizations, and the press. In the near future the owner intends to acquire another new farm equipment. These and similar investments are funded by both subsidies and own funds. EU aid allows farmers to carry out larger scale projects. Agricultural activity is profitable, and therefore will continue in the near future.



Dig. 3. Crop structure in the farm (own development).

The farm switched to organic production in 2005. The farm has always been organic, however this needed to be formally confirmed. Parental support, promotion of ecology at the university, economic reasons (subsidies), environmental awareness, as well as favorable natural conditions (location surrounded by forest) were all supporting reasons in favor of organic certification that now covers the entire farm (without wooded areas). Organic products produced by the farm are: cereals used for their feed and straw, honey, eggs, milk and livestock. Only natural fertilizers are used in the production, including liquid manure or mineral (lime). Every year in the period between harvests, the farm is controlled by the Agency for Restructuring and Modernisation of Agriculture, Quality Inspection of Food and Agriculture and Food and an organic farming certification agency. Animal welfare is subject to control, as well as soil samples are taken to check if they contain any banned compounds.

While examining the farm it is worth paying attention to its economic size, that is viability, expressed in the ESU units (European Size Unit). The value of the ESU is created based on the "Regional coefficients Standard Surplus Direct - SGM" 2000 "(SGM - Standard Gross Margin) for the plant and animal products. Łódź Voivodeship qualified for the third agricultural macro-region Mazowsze and Podlasie. The calculations, which are made in a spreadsheet, are based on the type of business, i.e. crop production (ha) and livestock. The farm has an ESU value of 8, 72, which qualifies it as a household with an average economic viability. in this new perspective, the RDP 2014-2020 factor ESU will be replaced with an indicator SO.

Organic food is free of impurities, contains more vitamins and minerals, less nitrates and pesticide residues while conventionally grown products contain substances harmful to the body that are reflected by growing number of allergies, lowered immune system function and increased number of diseases such as cancer.

Despite the high demands, workload and financial outlays associated with organic farming, the farm's owner claims that she would not go to the conventional methods. She is also committed to promoting organic farming methods among friends and neighbors. It is a difficult task, as many farmers have preconceived ideas and nothing is able to change them.

Working on an organic farm brings satisfaction and joy. Everything that is grown can be consumed without having to worry about the quality and health of the products. "I know what I eat" is an important rule. Additionally, knowing that organic farming cannot harm people around, and is beneficial to the environment, serves as a significant motivator. The owner gladly recommends this form of management to young, ambitious people who want to change the environment, starting with themselves.

Lack of sewage system is one the problems faced by the organic farm. They have pay to export the waste in a tanker. It is tiring, uncomfortable and expensive, especially in summer time. Another reason for concern is the problem with selling organic products. The farm has to constantly seek new customers. There are no nearby places where you can sell the products. Local shops are not interested in buying organic products, and if a sale is made, it is only at a price of conventional products. People living in rural areas are not yet convinced by the benefits of organic food. Some simply do not believe in them, others prefer to buy cheaper vegetables. As the farmed area grows, finding people to work can also be challenging.

SUMMARY

Organic farming can be considered as an attempt to stop the ever progressive degradation of the natural environment. To change this situation, people must, first and foremost, change their approach to nature from being focused on exploiting to cooperating. Running an organic farms is not an easy feat. Despite publicizing these issues, in rural areas there is still a belief that without the

use of chemical fertilizers nothing will grow. More knowledge, experience and love of nature is needed to change this mindset.

Young, educated lady farmer from the village of Sobien has reconciled these facts and for the last 10 years has been a satisfied owner of an organic farm. She understands and manages the farm guided by both science and intuition, supported by knowledge she received from her parents and some flexibility in adapting to nature. Development should rely on the support of good, not the fight against evil. Development should be associated with economic, ecological and aesthetic factors. Human activity should be adapted to the nature and respectful of its laws.

So far, farmers do not fully exploit the possibilities of producing organically. Food produced that way, as the owners of organic farms say, require more time and work, but is healthier and better quality, which is reflected by higher prices for products of this type. One can only appeal to the farmers to take up the challenge to switch over their production to organic as not everyone understands this subject.

Conventionally-grown foods are full of chemicals, additives, preservatives, sweeteners and artificial flavors, impacting human health in a very negative way. Due to lower prices, they are, still however purchased by the majority of consumers. Healthier, pesticide free, organic foods are still undervalued. This situation will certainly change for the better with increasing health consciousness of consumers, who will impact an increase in the supply of organic products. The pressure of health-conscious consumers and appropriate agricultural policy should change the attitude of farmers' production and result in faster development of the market for organic and healthy foods.

REFERENCES

1. Augustyniuk – Kram A. (2012), Rolnictwo ekologiczne a właściwości gleby i jej różnorodność biologiczna, Studia Ecologiae et Bioethicae, T. 10, 2012/1, Warszawa, UKSW
2. Bac S., Koźmiński C., Rojek M. (1993), Agrometeorologia, Warszawa, PWN
3. Geoportal 2 http://www.geoportal.gov.pl/ dostęp 07.12.2015 r. g. 18.00
4. Graczyk A., Mazurek-Łopacińska K. (2009), Badanie rozwoju rynków produktów rolnictwa ekologicznego i żywności ekologicznej w Polsce, Wrocław, Wyd. Uniwersytetu Ekonomicznego we Wrocławiu
5. Gumiński R. (1951), Meteorologia i klimatologia dla rolników, Warszawa, Państwowe Wyd. Rolnicze i Leśne
6. Klepacki B. (1998), Ekonomika i organizacja rolnictwa, Warszawa, WSiP
7. Łuczka-Bakuła W. (2007), Rynek żywności ekologicznej. Wyznaczniki i uwarunkowania rozwoju, Warszawa, PWE
8. Program Ochrony Środowiska dla Powiatu Opoczyńskiego na lata 2012-2015 z uwzględnieniem lat 2016-2019. (2012), Opoczno
9. Ramowy Plan Działań dla Żywności i Rolnictwa Ekologicznego w Polsce na lata 2014-2020, Ministerstwo Rolnictwa i Rozwoju Wsi (2014), Warszawa
10. 1Raport o stanie rolnictwa ekologicznego w Polsce w 2004 roku, (2005), Warszawa, IJHARS
11. Raport o stanie rolnictwa ekologicznego w Polsce w latach 2013-2014, (2015), Warszawa, IJHARS
12. Smoluk- Sikorska J., Łuczka W. (2014), Uwarunkowania handlu detalicznego żywnością ekologiczną, Warszawa, Wyd. Difin
13. Sołowiej D. (1992)Podstawy metodyki oceny środowiska przyrodniczego człowieka, Poznań, Wyd. UAM

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FLEXIBLE MANUFACTURING SYSTEMS IN WOOD INDUSTRY ENTERPRISES

Abstract: The paper discusses decisive factors for the implementation of flexible manufacturing systems in industrial enterprises. The basic characteristics of flexible production systems are presented, the functional structure of these systems is given and their organisational forms are shown. Advantages and drawbacks of flexible manufacturing systems are discussed in comparison to conventional manufacturing processes.

Key words: Flexible Manufacturing System, the functional structure of a flexible production system, organisational forms of FMS, wood industry enterprises

INTRODUCTION

Wood industry enterprises, particularly furniture enterprises, increasingly often face market demand requiring final products to be manufactured in small batches. At the same time, commissioned orders suggest short execution times. Moreover, the range of products is frequently changed in successive orders. New varieties and final options as well as novel design solutions are expected. Conventional production systems such as work centres and production lines may sometimes fail to meet such market needs. For classical systems a barrier impossible to overcome is most typically connected with their insufficient efficiency and inadequate profitability of production or no profits generated in these systems, when working in accordance with new market requirements.

Highly efficient manufacturing systems applied to date, such as production lines, generate high costs if types of products manufactured on these lines are often changed. Moreover, lines are usually dedicated (Dedicated Manufacturing Lines – DML) and the potential to produce various types of products is limited to a narrow range, typically a family of parts with a small number of variants. A primary advantage of production lines is connected with manufacturing identical parts in large or very large batches. Each change in the assortment requires changeovers of several and occasionally all work stations constituting a production line. It is time-consuming and thus also costly as a result of idle time of lines during changeovers, leading to high depreciation costs and labour costs not covered by production to be sold. In turn, the other type of production systems, i.e. work centres, is better adapted to manufacturing variable assortments of products, but the efficiency is too low. They have too long production cycles in relation to the required delivery times of finished products. Moreover, in these production units manufacturing costs of products are also too high in comparison to market expectations.

Since the early 1960's competition has been growing dynamically, particularly between main producers of complex machine industry products. The market has been increasingly more complicated and next to low costs and high quality of products, prompt delivery has become a key advantage, providing a marketing edge to win new customers. A response to such challenges has been connected with attempts to adapt novel manufacturing solutions, first of all by leading enterprises of the machine industry. They were defined as flexible manufacturing systems (FMS). FMS was called flexible or elastic, since it makes it possible to manufacture various types of products simultaneously on process equipment, while the volume of production may be regulated according to the changing short-term demand. Flexibility of a system is made possible by

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automation and integration of all operations performed in this system. The first such system, fully automated, was patented in the USA in 1965 by Theo Williamson [Khare 2010]. That system was composed of 8 machine tools and drilling machines together with auxiliary equipment as well as the computer system supervising their operation.

Initially implementation of flexible production systems faced numerous problems. It gained momentum only in the late 1980's thanks to the development of information technology and robotics. The FMS approach was first introduced by large enterprises in the USA, Japan and West Germany. For most enterprises, potentially interested in these systems, a barrier for its implementation was related with high investment outlays, which in that period, depending on the extent and complexity of FMS, ranged from 2 to 20 million US dollars. Table 1 presents an estimated increase in the number of FMS applied worldwide in the years 1970-1988. It is estimated that worldwide by 1989 approx. 1200 FMS were implemented, composed of two or more Computerized Numerical Control (CNC) machine tools together with service systems and controlled by a central computer.

Table 1.The estimated number of flexible production systems installed worldwide in the years 1970-1988

Years	Western Europe	United States	Japan	Word
1970	0	5	3	8
1975	2	8	25	48
1980	27	28	71	163
1985	208	90	166	553
1988	410-460	170-190	190-210	1000

Source:Ellinor Ehrnberg and Statlan Jacobsson. „Technological Discotinuities, Industry Structure, and Firm Strategy – The Case of Machine Tools and Flexible Manufacturing Systems." Unpublished paper. Chalmers University of Technology. Goteborg. Sweden 1991.

In the next decades economic efficiency of flexible manufacturing systems was considered to improve, although the calculations included only quantifiable factors. In the first decade of the 21st century an example of an enthusiastic approach to FMS efficiency was provided by the board of a leading car manufacturer, Ford Motor Co., which saw considerable savings in the implementation of flexible manufacturing. In 2004 a reporter of Automotive News, Richard Truett, cited Bill Russo, Ford's director of manufacturing, vehicle operations, who estimated that the implementation of FMS in five plants of the company would make it possible to save approx. 2.5 billion US dollars [Truett 2004]. He also predicted that by 2010 80% Ford plants would be equipped with FMS. No all such objectives were next realised. However, the direction of changes has been irreversibly set. At present, despite the still relatively high investment costs, flexible production is being implemented in stages also by medium-sized enterprises, including sectors other than the machine industry.

CHARACTERISTICS OF FLEXIBLE PRODUCTION SYSTEMS

A flexible manufacturing system is a concept of manufacturing products, which within the technological potential of process equipment within the system, facilitates production of a large group of various types of parts at a cost comparable to that incurred in mass production. Production flexibility enforces decentralisation of undertaken operating decisions. This transfers planning of production schedules and control over their performance to the lowest management level. However, FMS is first of all a manufacturing technology. According to Krzyżanowski [2005] a flexible manufacturing system may be defined as a system, in which the so-called flexible production means

have been applied, i.e. computer controlled production equipment, characterised by high operation speed and range of changeovers. In this paper a more technical definition of FMS is proposed, as a set of computer controlled machines and technological equipment (process equipment), integrated using a common automated transport and warehousing of manufactured products as well as tools and workshop appliances required in the production process, which facilitates manufacturing of various types of products with common technological characteristics. Variants of flexible manufacturing systems may also be found as Flexible Assembly Systems (FAS) [Sawik 2012].

Basic components of FMS include work stations, automated handling of processed materials and parts as well as the computer control and supervision system. Work stations refer to machining centres, loading and unloading stations, assembly work stations, control stations, sheet metal forming presses, etc. Typically machining centres are Computerized Numerical Control (CNC) machine tools, performing machining operations on families of parts. Automated handling of materials comprises various types of equipment systems, which may be used to transport parts and subassemblies between manufacturing stations. Transport equipment is sometimes given another function of warehousing materials and parts. Figure 1 presents a general diagram of the functional structure of a flexible production system in the system approach.

All auxiliary operations (retooling, transport of materials and parts, waste removal, etc.), performed in the traditional production system by a worker – operator, in FMS are performed by the system automatically, for many hours and without human intervention. Flexible production systems make it possible to run three-shift production at a minimum number of operators required.

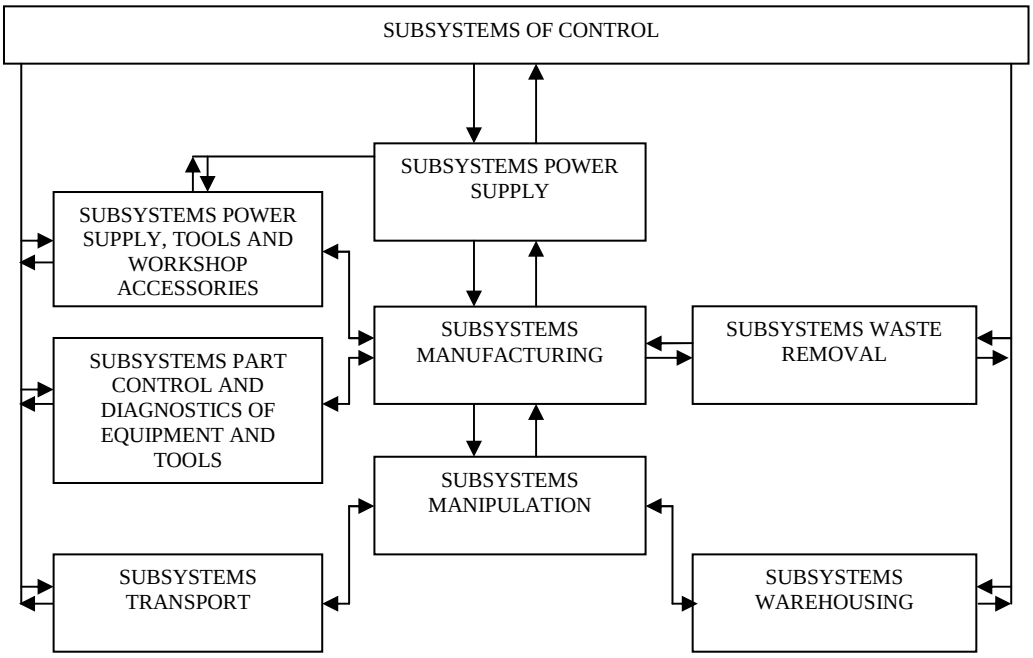

Fig. 1. The structure of a flexible manufacturing system in the systemic approach

Source: Figure modified based on Brzeziński Marek: Organizacja produkcji w przedsiębiorstwie. Wyd. Difin SA, Warszawa 2013.

In FMS manufacturing operations (manufacturing subsystem – see Fig. 1) are controlled by a computer control subsystem. This ensures technical control of subsystem elements and cooperation of all functional subsystems. The manipulation subsystem comprises equipment and technical means (feeding devices, manipulators, industrial robots), facilitating transfer of materials, finished parts, pallets and tools between power supply, manufacturing, transport and warehousing subsystems.

Manipulation equipment is characterised by high accuracy of object positioning and movement repeatability. In the warehousing subsystem equipment and technical means (one- and two-row racks, warehouse robots, etc.) are used to store materials, parts after machining, stock in progress, pallets, tools and tooling. The transport subsystem comprises equipment and technical means (rail or wheeled vehicles, conveyors, transporters, trolleys, lifts, etc.), using which materials, finished parts, pallets as well as tools and tooling are transported between the power supply, manufacturing and warehousing subsystems. The subsystem of tools and workshop accessories controls the exchange of porters, pallets, tools and workshop accessories used in the manufacturing subsystem. The basic components of this subsystem include equipment for automatic exchange of tools and workshop accessories as well as automated tool stores.

The subsystem of control and diagnostics takes measurements of manufactured parts in order to verify their quality and diagnoses the condition of equipment and technical means of the system. Automatic control of dimensions and shape of semi-finished products takes place at the input and output stage. Moreover, the position of the machined part in the working space of the machine is controlled. The condition of machine mechanisms and all the other equipment of the system is monitored. The last subsystem is composed of equipment and technical means removing post-production waste. In the course of mechanical processing of parts the most common wastes are chips, removed from the working space, crushed and ground. Elements of machining and transport equipment are cleaned of fine waste residue using compressed air or cutting fluid.

Flexible manufacturing systems are found within several organisational forms, which developed in the course of their evolutionary development. We distinguish the following forms [Brzeziński 2013, Palchevskyi and others 2015]:

1. A flexible production module (automatic machining station) – composed of a CNC machine tool equipped with devices for replacement of tools and manufactured parts. Most typically tools and pallets with parts are replaced by specialist manipulation robots. A module is an independent production station, which may work for many hours with no human supervision. It is adapted to being incorporated into higher rank flexible production systems.
2. A flexible work centre – it is a set of production modules dedicated to a specific type of products or technological process. Modules are integrated by transport and warehousing of parts and as a result of computer control. Different technological routes may be applied for each type of machined parts. In this way considerable flexibility is provided, as manifested in the potential to manufacture a large number of various types of specific products.
3. Flexible production line – is composed of a set of specialist machines arranged in the order of processing, along the transport route. Each operation may be conducted only on one machine, analogously as it is the case at the automatic production line in the direct line production system. However, machines constituting a flexible line are adapted to frequent and rapid changeovers so that the line may be used to manufacture various types of parts. On such a line it is not possible to change the order of operations for these machines.

4. A flexible production network – it is composed of several combined modules and work centres. This facilitates full production of a specific assortment of products. It is found at the level of a manufacturing department. It requires efficient means of transport including autonomic transport trolleys, carousel conveyors, pallet changers, automated storage and retrieval systems and automated overhead cranes. In this way flexible production sections may be created or even in the future production departments and plants.

STRUCTURE OF FLEXIBLE MANUFACTURING SYSTEMS

Flexible manufacturing systems vary in their structure depending on the arrangement of process equipment and used means of transport. We distinguish four basic structures of flexible manufacturing systems [Krzyżanowski 2005]:

– linear – process equipment is arranged along both sides of a transport line,
– circular – transport conveyors move over a closed oval or rectangular route,
– plane (work centre) – process equipment is randomly arranged on the shopfloor considering technological requirements,
– ladder – pallets travel over a conveyor to process equipment and at the buffer section they wait for free machine tools.

Linear and circular structures are characterised by good use of production area as a result of their compact structure. They may be easily extended by elongating a transport line. However, a drawback of both structures is hindered access to equipment during maintenance operations or removal of system failure. The work centre structure is characterised by free access to stations and potential for easy development. However, it occupies a considerable production area and it needs long transport routes. In the ladder structure access to equipment is hindered, since each machine tool is surrounded by a transport system.

In terms of the method of the flow of materials and machined parts we distinguish three types of structures in flexible production systems:

– no transport links between production stations,
– with direct transport links between production stations,
– with indirect transport links between stations – through a central warehouse.

Figure 2 presents a diagram of FMS with central transport between stations (Fig. 2a) and with a central warehouse (Fig. 2b).

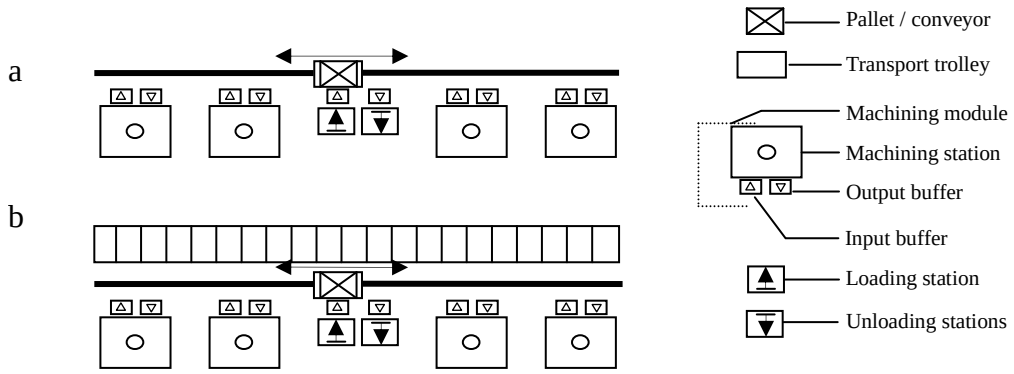

Fig. 2. Diagram of a flexible manufacturing system with central transport between stations (a) and with a central production warehouse (b)

Source: Figure modified based on Lis S., Santarek K., Strzelczak S.: Organizacja elastycznych systemów produkcyjnych. Wydawnictwa Naukowe PWN, Warszawa 1984.

If between stations there are no transport links facilitating flow of materials and parts, each station may perform machining independently on many alternating products. Such a single-station FMS is composed of machining centres or autonomic machining centres.

In the case of systems with direct transport links between stations, we distinguish systems with a linear or work centre structure, in which individual stations are interconnected by transport or a central transport system. Machined parts are stored at warehouses (buffers) next to stations or on transport conveyors.

In the third FMS type the FMS the flow of materials and parts between stations is executed through a central production warehouse. Materials are transported from a warehouse to a station and after the execution of machining operations parts are transferred back to the warehouse. From there they are transferred to the next station in order to perform the next technological operation required in the process. After finished parts pass through all operations they are placed in a central production warehouse. We distinguish static and dynamic warehouses. A static warehouse is composed of high frame shelves and a computer control storage and retrieval system. A dynamic warehouse is typically a floor or suspended conveyor. Parts before and after machining are stored there.

CONCLUSIONS

The application of FMS in an enterprise has many advantages. The most frequently mentioned include:

– shortening of time required to change production assortment, required by market demand,
– shortening of production cycles, i.e. reduction of total execution time for production orders,
– increase in efficiency,# improved quality of manufactured products,
– reduction of direct labour costs,
– increased utilisation of fixed assets,
– reduction of stocks of work in progress,# increased resistance of the production process to external disturbances.

Rapid response to changes in demand for specific types of products ensures a short time of production order execution. The time of their execution is to a considerable extent determined by the time of expectation for machining for a given part. In FMS this time is much shorter than in the traditional production system, as a result of execution of rapid equipment changeover and continuity of manufacture for many hours, with no need for idle time within 24-h periods. Shortening of time of production cycles by 50 up to70% provides an increase in production efficiency and productivity by 200 up to 400% [Gola 2010].

Improvement of quality of manufactured products results from high accuracy of machining and repeatability of production in flexible systems. Moreover, key quality parameters of produced parts are automatically controlled by the system on the on-going basis. Automatic supervision over all system components radically reduces demand for operator handling. Application of modern methods of planning, scheduling and on-going production control leads to minimisation of idle time of machine tools and improved utilisation of the other fixed assets by 30 up to 70% in relation to traditional organisation of production systems [Gola 2010].

A drawback of conventional manufacturing processes, leading to an extension of waiting time for the execution of production orders, is connected with the necessity to warehouse semi-finished products. A large volume of production in progress presents considerable economic value, while it also increases the number of pallets, holders, warehouses, etc. required in the production process. FMS facilitates a significant reduction of the volume of stocks of production in progress, thus reducing costs of freezing financial current assets in these stocks. Automatic supervision and control of operations for all elements of the system increases its resistance to external disturbances.

Installation of FMS is a highly costly enterprise due to the degree of complexity of this system and innovativeness of used equipment. Moreover, following its implementation these systems generate considerable operating costs. This is connected with the necessity to incur increasing repair costs in case of failure than in conventional manufacturing systems. Particularly high costs are generated if flexibility of the system has not been adequately adapted to current and future needs. The level of production flexibility in FMS determines the scope of machining potential for equipment [Brzeziński 2002]. Determination of an adequate profile of flexibility requires the application of several complex tools and design procedures [Stamirowski 2012]. The higher flexibility of a manufacturing system is assumed, the greater design and manufacturing costs need to be faced in this system. The principle concept is thus "to manufacture in a flexible system, but in potentially the simplest and cheapest manner" [Honczarenko 2000].

In the machine industry the predominant field of application for FMS is connected with production involving machining (over 50% implementations). The other installations of this system concern plastic working, welding and fusion welding as well as coat spraying [Zawadzka 2002]. In Polish enterprises a small number of flexible production systems have been implemented. They are first of all flexible production modules, less frequently flexible work centres or flexible production lines.

In wood industry enterprises no flexible production system has been implemented to date. However, there are important indications for such implementations to be introduced in the near future. First of all we observe a very high diversity of manufactured variants and types of products. Depending on the sector and type of enterprise this diversity may be several hundred up to more than ten thousand products. Particularly high diversification of manufactured products is found in enterprises producing kitchen furniture, pallets, construction joinery (doors and windows) as well as frame furniture (mainly chairs). Moreover, there is considerable pressure of demand for rapid delivery of products and delivery in small batches. Technologically and technically, in terms of types of equipment, the wood industry resembles the machine industry. In both cases machining is of significant importance.

In many wood industry enterprises CNC machine tools are used, performing various types of machining operations (milling, drilling, planing, turning, etc.). From the point of view of development of production systems such equipment is the last stage before transition to flexible production modules. In the wood industry in terms of manufacturing technology we may distinguish two basic series of processes: machining of solid wood and machining of wood-based boards (particleboards, fibreboards and plywood). In both these processes product manufacture is based on machining. On the basis of the above-mentioned principles we may expect in the nearest future in the largest enterprises of the wood industry attempts to implement flexible production systems, initially as production modules characterised by the lowest degree of complexity and the lowest system implementation costs.

REFERENCES

1. Brzeziński M. (red): Organizacja i sterowanie produkcją. Projektowanie systemów produkcyjnych i procesów sterowania produkcją. Wyd. PLACET, Warszawa 2002.
2. Brzeziński M.: Organizacja produkcji w przedsiębiorstwie. Wyd. Difin SA, Warszawa 2013.
3. Ehrnberg E., Jacobsson S.: Technological Discontinuities, Industry Structure, and Firm Strategy – The Case of Machine Tools and Flexible Manufacturing Systems. Unpublished paper. Chalmers University of Technology. Goteborg. Sweden 1991.
4. Gola A.: Metodyka doboru podsystemu obrabiarek w elastycznym systemie produkcyjnym części klasy korpus. Rozprawa doktorska, Politechnika Lubelska, Lublin 2010. http://bc.pollub.pl/Content/661/metodyka.pdf (access 20.08.2016).

5. Honczarenko J.: Elastyczna automatyzacja wytwarzania. Obrabiarki i systemy obróbkowe. WNT, Warszawa 2000.
6. Khare A.: Flexible manufacturing system. Shri Ramdeobabba College of Engineering and Management, 2010. http://www.slideshare.net/anandkhare/flexible-manufacturing-system-24793372 (access 20.08.2016).
7. Krzyżanowski J.: Wprowadzenie do elastycznych systemów wytwórczych. Wyd. Politechniki Wrocławskiej, Wrocław 2005.
8. Palchevskyi B., Świć A., Pavlysh V., Banaszak Z., Gola A., Kretianpol A., Lozynskyi V.: Komputerowo zintegrowane projektowanie elastycznych systemów produkcyjnych. Monografie. Wyd. Politechnika Lubelska, Lublin 2015.
9. Stamirowski J.: Wprowadzenie do projektowania elastycznych systemów produkcji w kontekście zmienności produkcji. Technologia i Automatyzacja Montażu nr 1/2012, s. 37-40, http://www.uwm.edu.pl/pro-edu/upload/file/podreczniki/Zad.2/Zintegrowane%20systemy%20wytwarzania.pdf (access 20.08.2016).
10. Truett R.: Ford sees big savings from flexible manufacturing. Automotive News 02.08.2004.
11. Sawik T.: Production Planning and Scheduling in Flexible Assembly Systems. Springer Science & Business Media, 2012.
12. Zawadzka L.: Modele optymalizacji wielokryterialnej. Przykłady aplikacji, [w:] L. Zawadzka: Inżynieria systemów zarządzania. Wyd. Politechniki Gdańskiej, Gdańsk 2002.
13. Zdanowicz R.: Modelowanie i symulacja procesów wytwarzania Wyd. Politechniki Śląskiej, Gliwice 2007.

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IMPACT OF SELECTED DIMENSIONAL AND QUALITATIVE FACTORS ON MATERIAL EFFICIENCY OF CONIFEROUS WOOD CONVERSION

Abstract**:** Production rationality in a crucial way is influenced by technological factors and material efficiency characteristic for them. Processing wood into solid goods and prefabricates is mainly related to the dimensional and qualitative structure of roundwood. Of significant importance is also the impact of a wide range of obtained products which on one hand allows for a better usage of the material but on the other increases the volume of by-products and the number of extra processing operations. In traditional technological processes which prevail in small plants, an important asset is a wide variety of products which meet the requirements of local markets. The article provides the analysis of factors influencing material efficiency of softwood processing, verifies research hypothesis that theoretical efficiency indicators are higher than actual figures and determines the reasons for the demonstrated deviations.

Key words**:** roundwood, sawnwood**,** efficiency

INTRODUCTION

Material efficiency is directly influenced by the type of processed material (wood species, its size and quality) technological level, product flexibility, linked to the size of the plant and the available technological possibilities of processing certain types of roundwood.

The number of sawmills is currently estimated at over 8 000. However, it is still changing, hence a precise determination of both the number of plants, as well as the volume of processing within them is difficult.

The available analysis and literature sources [Czemko 2011, Ratajczak, Szostak, Bidzińska 2001; Ratajczak 2001; Szostak, Bidzińska, Ratajczak 2006 Mikołajczak 2012, Hruzki 2003] most frequently, based on the annual volume of processed wood, distinguish the following groups of companies:

- small, with an annual output below 10 000 m^3 – 20 000 m^3 (25 000 m^3) of roundwood; they constitute around 90% of the overall number of enterprises within this sector of industry and 65% of them are units annually milling less than 1 000 m3 of wood,
- medium, annually processing between 20 000 m^3 (25 000 m^3) up to about 100 000 m^3 which constitute around 8 %,
- large, processing over 100 000 m^3 of roundwood, within this group there are only a few enterprises, which are characterized by the highest utilization of material, 90% of which comes from the main supplier that is National Forests.

Production assortment is linked to technologies and machinery used by companies. Small and medium size companies often use traditional woodworking machines, sash saws, circular saws, chipper edgers, planers and a whole variety of auxiliary devices. In companies with a significant manufacture capabilities there is a wide application of technologies of aggregated wood processing.

The example of optimizing the use of material is set by the sawmills focused on the production with high level of processing where unprocessed material which does not meet the criteria for the main product is prefabricated for the elements of wood joinery, garden furniture and other versatile

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solid products. Semi-finished products are often side boards as well as products which do not meet the requirements for the structural wood, furniture production and so on. [Krzosek 2003, Rynek Drzewny 2015]. Among those types of enterprises there are mainly, due to a high product flexibility (high level of material utilization), sawmills with medium level of wood processing. It justifies the selection of the representative of this group of enterprises for the verification of adopted research hypothesis that theoretical efficiency indicators, published in the available literature are higher than real values obtained in industrial conditions.

The aim of study was also the analysis of material dimensional factors influencing material efficiency of softwood processing, as well as determining the causes affecting the demonstrated deviations in ratios of theoretical and actual efficiency.

MATERIAL EFFICIENCY

The term material efficiency embraces quantitative material efficiency (V_i), qualitative (V_j), and assortment (V_s), where „material efficiency means the proportion of the volume of the obtained products with the given level of processing or the given level of processing and a certain feature to the volume of material in one of the stages preceding that processing. Material efficiency allows for the evaluation of the volume of the material that needs to be used to obtain a given product" [Korczewski, Krzysik, Szmit 1970, Buchholz 1990].

Volume efficiency (ratio of wood usage) it is the proportion of volume of the product to the volume of the wood being processed in order to manufacture that product. It is calculated for the logs, converted material and semi-finished products.

Logs volume efficiency (W_{ik}) the proportion of volume of logs (V_k) to the volume of boles (V_d):

$$W_{ik} = \frac{V_k}{V_d}$$

Volume efficiency of processed wood – volume efficiency of sawn goods (W_{it}) is the quotient of sawn goods volume V_t to the volume of logs V_k, from which it has been obtained or to the volume of boles V_d.

$$W_{it} = \frac{V_t}{V_k}$$

$$W_{\frac{it}{d}} = \frac{V_t}{V_d}$$

The ratio of volume efficiency of sawn goods is influenced by:

- the diameter of sawn logs,
- the type of conversion,
- the dimensions of variety of products
- the means of slashing side boards using cut-off saw and edgers [Korczewski, Krzysik, Szmit 1970, Buchholz 1990],
- volume of processed sawnwood.

Volume efficiency of prefabricates may be calculated as follows*:*[Korczewski, Krzysik, Szmit 1970]:

$$W_{ip} = \frac{V_p}{V_t}$$

where:
V_p – Volume of prefabricates [m^3],
V_t – Volume of sawnwood [m^3],

According to Korczewski, Krzysik, Szmit (1970) „qualitative material efficiency" called in short qualitative efficiency means the proportion of the volume of products of a given level of processing and certain quality to the volume of products in one of the stages preceding their processing. Qualitative efficiency is calculated for the logs, sawn goods and other semi-finished products". This efficiency [Hruzik 2006] is the result of the relations between qualitative and dimensional features of the processed material and the type and quality of the obtained products.

Obtaining high quality sawn logs of superior quality depends on the knowledge about the location of defect in timber in roundwood material and on the impact of those defects on the quality of obtained sawn goods. [Korczewski, Krzysik, Szmit 1970].

Based on the research on material efficiency of sawmilling carried out in the sawmills using coniferous assortment (with domineering pine wood) of varied diameter and quality. [Hruzik 1979,1993,2006; master thesis 2000-2013], the average volume efficiency ratios of all-purpose sawnwood have been established:

- within diameter range between 14 and 19 cm (1 thickness class: 14-24 cm) – from 45% to 55%,
- within diameter range between 20 do 29 cm (2 thickness class: 25-34cm) – from 55% to 65%,
- within diameter range above 30 cm (3 thickness class above 35 cm) – from 65% to 75%.

Material efficiency available at optimum and maximum processing is determined based on couplings of sawing adapted individually for a given type and diameter of the material being used. Final products efficiency requiers taking into account further prefabrication processes utilizing adequate excess for processing.

In case of coniferous roundwood processing for structural sawnwood this efficiency equals 66 to 70%.

Study concerning processing for ***garden programme elements*** [Hruzik1979, 1993, 2006; master thesis 2000-2013] allows to determine volume efficiency within the range of 33% to 53% using material with diameter between 12 and 20 cm.

Based on the results of the study on material efficiency of conversion one may state that the efficiency increases along with the increase in diameter measured half way down the log that is being sawn ($d_{1/2}$). It is mainly influenced by the amount of side material. Average material efficiency oscillates between 55% to 62% and depends on the material being used, means of sawing and expected assortment. For example: material efficiency of cutting logs into battens amounts to about 60%, material efficiency in the process of obtaining coniferous prefabricates from sawnwood that was not slabbed may reach 80%, while efficiency at all levels of planing usually amounts to about 75 %.

METHODIC

The study was carried out in an enterprise categorized as medium size enterprise. Its annual conversion equals about 30 000 m^3. The enterprise under analysis is characterized with basic level of equipment and standard technology of sawing. The study embraced coniferous material: pine, spruce and larch processed into sawn materials and prefabricates. The analysis concentrated on the period of five years (2011-2015) based on the statistics of sawing made available by the enterprise. The volume of sawing in the subsequent months of the period in question was averaged in order to eliminate the impact of demand and seasonality of production on the type of assortment being produced.

Based on the established volume of sawing the ratios of efficiency of roundwood processing have been determined and analysed. Subsequently the influence of used raw material thickness on the available efficiency was examined.

Apart from the simple way of evaluating efficiency ratios that constitutes their comparison in time the obtained results were also juxtaposed with:

1. the results of studies by other authors [Hruzik 1979,1993,2006; master thesis 2000-2013], that were carried out within similar enterprises (annually processing 20-30 thousands m^3 of roundwood with basic equipment and standard technology), they were subsequently referred to as baseline,
2. the range of average ratios quoted in literature for the purpose of this article called theoretical ratios, and the reasons for deviations and their financial impact on the operations of the enterprise under analysis.

RESULTS AND ANALYSIS

The analysis of sales of sawmill raw material showed that the share of individual qualitative and dimensional classes of wood in the subsequent years of the period in question are at a similar level (table 1), while the enterprise's sawmilling operations are mainly dominated by big-size raw material class WC02 (31,89% to 36,66%) and WC01 (18,71% – 23,53%). While thickness classification (table 2) indicates downward trend of processed material towards lower classes of thickness.

Table 1. Qualitative overview of purchased coniferous wood (pine, spruce and larch) between 2011 and 2015

Share of individual qualitative and dimensional classes in the volume of wood in:						
Qualitative and dimensional classes	2011	2012	2013	2014	2015	Average
	[%]					
WA1 3	0,00	0,00	0,04	0,00	0,01	0,01
WB1 1	0,06	0,06	0,04	0,11	0,02	0,06
WB1 2	2,71	1,48	0,66	2,05	1,21	1,62
WB1 3	3,26	1,18	0,43	0,93	1,55	1,47
WA0 2	3,29	3,76	3,23	2,83	0,68	2,76
WA0 3	3,58	3,35	2,79	2,33	2,01	2,81
WB0 1	2,00	2,46	1,74	2,18	2,12	2,10
WB0 2	12,96	13,55	15,03	14,11	13,80	13,89
WB0 3	4,24	4,05	5,07	4,42	5,20	4,60
WC0 1	18,71	22,54	22,36	19,12	23,53	21,25
WC0 2	35,78	31,89	34,67	36,66	33,28	34,46
WC0 3	9,85	8,62	8,72	11,39	11,28	9,97
WD 1	0,81	1,58	1,24	0,53	1,27	1,09
WD2	1,98	3,14	2,69	1,75	2,33	2,38
WD 3	0,77	1,22	1,01	0,98	0,88	0,97
S2A	0,00	0.00	0,00	0,00	0,00	0,00
S2B	0.00	1,11	0,28	0,61	0,84	0,57

Source: own-elaboration based on enterprise data

Table 2. The share of individual classes of thickness of sawn softwood (pine, spruce and larch) between 2011 – 2015

Dimensional classes	Years					
	2011	2012	2013	2014	2015	Average
	Share [%]					
W 1	22.00	27.00	25.00	22.00	27.00	24,50
W 2	56,72	53,82	56,28	57,40	51,30	55,10
W 3	21,70	18,42	18,06	20,05	20,93	19,83
S 2	0/00	1,11	0,28	0,61	0,84	0,57

Source: own-elaboration based on enterprise data

Based on enterprise data on the volume of material being processed into sawn goods using available technological park the volume of logs assigned for sawing as well as the volume of obtained sawnwood in individual months of the period under the study (table 3).

Table 3. List of volume of conversion and sawnwood production between 2011 and 2015 [m^3]

Month	2011		2012		2013		2014		2015	
	Volume of conversion	Sawnwood production	Volume of conversion	Sawnwood production	Volume of conversion	Sawnwood production	Volume of conversion	Sawnwood production	Volume of conversion	Sawnwood production
I	1 265	2 316	1 316	2 363	1 298	2 121	1 365	2 306	1 207	2 179
II	1 157	2 095	1 312	2 220	1 311	2 192	1 496	2 801	1 510	2 506
III	1 643	2 909	1 774	3 347	1 706	2 931	1 597	2 782	1 412	2 418
IV	1 514	2 714	1 466	2 646	1 062	1 990	1 812	3 025	1 490	2 439
V	1 798	3 149	1 443	2 559	1 203	2 212	1 347	2 241	1 578	2 613
VI	1 752	3 209	1 585	2 835	1 234	2 138	1 631	2 928	1 688	2 808
VII	856	1 573	1 361	2 401	1 389	2 446	1 409	2 498	1 397	2 371
VIII	1 565	2 804	1 611	2 736	1 348	2 327	1 557	2 780	1 544	2 639
IX	1 466	2 751	1 553	2 530	1 244	2 014	1 477	2 751	1 465	2 611
X	1 599	2 825	1 587	2 614	1 599	2 661	1 531	2 793	1 518	2 651
XI	1 386	2 544	1 383	2 317	1 523	2 547	1 411	2 363	1 399	2 243
XII	1 093	1 941	1 007	1 773	1 204	2 091	1 250	2 108	1 239	2 001
Total	17 094	30 830	17 398	30 339	16 123	27 670	17 882	31 376	17 446	29 478

Source: own-elaboration based on enterprise data

Based on the data presented in table 3 quantitative material efficiency for the individual months of the period under analysis was calculated as the weighted average (accounting for the volume of the processed material) in the following years. The obtained results were presented in table 4 and figure 1.

The analysis of efficiency ratios shows their successive improvement in the subsequent years of the period under study, which is confirmed by the weighted average illustrated in the figure 1. It indicates that the executive authorities of the enterprise have adopted an adequate strategy of managing the production process. Only in 2014 one might notice a deviation from this rule caused by the need to adjust the conversion level to the lower than previously estimated number of recipients. It resulted in the deterioration of the utilization of the purchased raw material.

The impact of the thickness of the processed material on the obtained efficiency was shown in table 5. The presented numbers indicate that the highest efficiency is reached when converting timber with thickness class 3.

Table 4. General material efficiency of roundwood processing between 2011-2015 [%]

Month	Year				
	2011	2012	2013	2014	2015
I	54,6	55,7	61,2	59,2	55,4
II	55,2	59,1	59,8	53,4	60,2
III	56,5	53,0	58,2	57,4	58,4
IV	55,8	55,4	53,4	59,9	61,1
V	57,1	56,4	54,4	60,1	60,4
VI	54,6	55,9	57,7	55,7	60,1
VII	54,4	56,7	56,8	56,4	55,2
VIII	55,8	58,9	57,9	56,0	57,4
IX	53,3	61,4	61,8	53,7	58,3
X	56,6	60,7	60,1	54,8	58,4
XI	54,5	59,7	59,8	59,7	61,9
XII	56,3	56,8	57,6	59,3	64,9

Source: own-elaboration

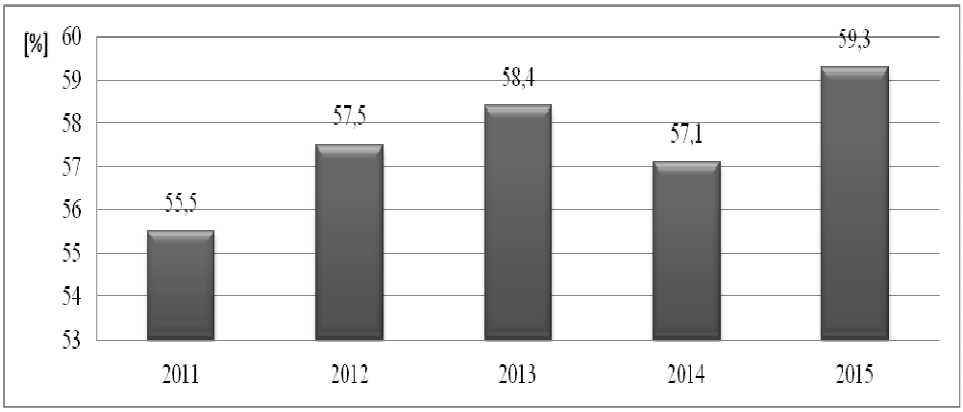

Figure 1. The weighted average of material efficiency of processing roundwood between 2011 and 2015

Source: own-elaboration

The obtained results were compared with the results of earlier studies by other authors adapting the following baseline numbers for the individual diameter ranges of the processed roundwood:

- 1 thickness class (W 1) – 50% (study: Hruzik 1979, 1993, 2006, 2013; master thesis 2000-2014, theoretical data: 45-55%),
- 2 thickness class (W 2) – 60% (study: Hruzik 1979, 1993, 2006, 2013; master thesis 2000-2014, theoretical data: 55-65%)
- 3 thickness class (W 3) – 70% (study: Hruzik 1979, 1993, 2006, 2013; master thesis 2000-2014, theoretical data: 65-75%),
- Medium-size timber (S 2) – 45% (study: Hruzik 1979, 1993, 2006, 2013; master thesis 2000-2014, theoretical data: 33-53%)

and they have been verified with the theoretical data.

The comparison has shown that at the enterprise embraced by the study material efficiency in the first class of thickness remains within the range of theoretical indicators and only slightly exceeds average baseline ratios. In the remaining thickness classes of large timber the results achieved by the enterprise are worse.

Table 5. Material efficiency for the individual classes of thickness of softwood (pine, spruce and lurch) [%]

Thickness classes	Years					Baseline efficiency	Theoretical efficiency
	2011	2012	2013	2014	2015		
W 1	50,0	50,5	52,0	50,0	51,0	50	45-55
W 2	54,5	58,0	59,0	58,0	60,0	60	55-65
W 3	63,5	67,0	66,0	63,0	69,0	70	65-75
S	0,0	47,0	45,0	46,0	50,0	45	33-53

Source: own-elaboration based on enterprise data

Multidimensional analysis taking into account also the enterprise resources provides evidence that justifies the statement that the average efficiency of coniferous raw material conversion for the unit under study should oscillate around 60%.

Lower efficiency ratios will mean suboptimal usage of timber material in the process of conversion (np.: for example inadequate means of conversion, wrong set-up and so on)

In the next phase of the analysis, the volume of the produced sawn goods established based on the documents was verified against baseline figures. Subsequently hypothetical differences in volume that occurred within the period under analysis (figure 2).

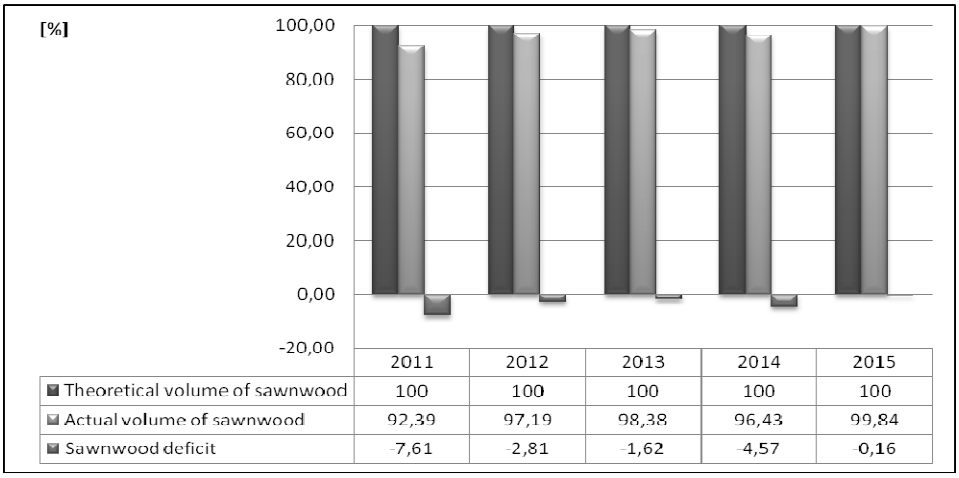

Figure 2. Comparative diagram of the volume of sawn softwood between 2011 and 2015 accounting for baseline efficiency.

Source: own-elaboration

The diagrams shown in figure 2 indicate that each year of the period under analysis there were differences between the volume of the sawnwood produced and the volume expected in accordance with baseline data. Especially high deficit [7,61%] was seen in 2014. In the remaining years those differences fluctuated between 0,16% and 4,57%.

The last phase of the analysis allowed to establish the potential financial loss of the enterprise being the result of not achieving the highest sawnwood efficiency ratio within the period under the study at the level of 59,3 %, that was reached in 2015. Assuming that in the previous years, lower ratios were the result of factors dependant on the company the resultant generated loss was estimated as a percentage or volume (m^3) efficiency of sawnwood in the individual years (m^3). In order to do this the volume of obtained sawnwood between 2011 and 2014 was juxtaposed with the model (100%) conversion from year 2015.

Based on undertaken verification it has been established that between 2011 and 2014 potential loss in the production of sawnwood amounted to almost 2% to 6.5% (table 6). Total deficit of sawnwood within that period reached around 4 707 m^3. Assuming that an average price of sawn pinewood was then 800 zł/m^3, this deficit equals the lost company income amounting to 3.8 million zł.

Table 6. Estimated loss of sawnwood volume between 2011 and 2014 (calculated based on an average efficiency of 59,3%) in respect to year 2015

2011	2012	2013	2014	2015
Volume of sawnwood generated at conversion [%]				
Reported volume [%]				Baseline volume [%]
93,50	96,70	98,26	96,11	100,00
Sawnwood deficyt [%]				
6,50	3,30	1,74	3,89	0,00
Sawnwood deficyt [m^3]				
2003,95	1001,19	481,46	1220,53	0,00

Source: own-elaboration

CONCLUSION

1. Basic ratios of material efficiency constitute an important information about rational usage of wood material
2. In medium-size companies converting 20-30 thousands of m^3 of coniferous roundwood, efficiency of obtaining sawn goods in case of production balanced for the needs of both domestic and foreign markets oscillates around 60%. Those ratios concern basic types of sawnwood of a low level of conversion, which relates to both low costs of labour as well as the lower value of the products.
3. Qualitative an dimensional composition is dominated by third class of quality, while the company is determined to obtain and use wood of first class of thickness (14-24 cm), due to its lower price and technological possibilities of converting such material.
4. Verification of efficiency ratios within the period under analysis indicates the improvement of strategy in managing the production process, which results in the increase of rationality and profitability of the company.
5. The highest efficiency is reached when converting wood of third class of thickness. The comparison that was carried out showed that in the enterprise where the study was done material efficiency of large wood with the first class of thickness stays within the limits of theoretical

ratios and slightly exceeds average baseline ratios. Similar results were obtained for a small share of medium-size wood. In the remaining thickness classes of large wood efficiency was lower than average baseline figures, but it stayed within a wide range of material efficiency determined by available literature. Whereas referring obtained efficiency ratios to the average baseline level – 60% indicates worse company results within the whole period under analysis. It proves that in real terms changeability of the factors determining the effect of conversion results in lowering actual ratios.

The highest efficiency ratio of sawnwood within the period under the study, namely 59.3% the company obtained in 2015. Potential loss being the result of not maintaining material efficiency on a similar level in the previous years (2011-2014) in total amounted to about 4 707 m^3 of sawnwood which equals loss of income amounting to 3.8 million zł

REFERENCES

1. Bidzińska G., Ratajczak E. (2003): Tartacznictwo w liczbach. Rynek Drzewny, nr 4.
2. Buchholz J. (1990): Technologia tartacznictwa. Skrypty AR w Poznaniu: 7.
3. Czemko B. (2011): Gospodarcze i społeczne znaczenie drewna jako materiału. Materiały konferencyjne. Puszczykowo 2011.
4. Hruzik G.J. (1993): Technologiczna optymalizacja przerobu drewna na materiały tarte i półfabrykaty przeznaczeniowe. Roczniki AR w Poznaniu. Rozprawy naukowe. 236, s.8.
5. Hruzik G.J. (2006): Zużycie surowca i materiałów drzewnych w wyrobach przemysłu tartacznego. Drewno - Wood 2006, vol. 49. 175, s. 25-44.
6. Hruzik J.G. (1979): Jakość sosnowego surowca tartacznego jako kryterium optymalizacji produkcji elementów przeznaczeniowych. Fol. Forest Polonica, zeszyt 13.
7. Hruzik J.G.(2001): „Efektywność przerobu tartacznego iglastego drewna wielkowymiarowego", Intercathedra 17, ISSN 1640-3622, s. 58-64, Poznań 2001.
8. Korczewski A.O., Krzysik F., Szmit J.M. (1970): Tartacznictwo (wydanie II poprawione). Warszawa, s. 50.
9. Krzosek Sławomir (2012): Przegląd technik tartacznych stosowanych w halach przetarcia w polskich tartakach. Rynek Drzewny. Biuletyn Polskiej Izby Gospodarczej Przemysłu Drzewnego, nr 1/2012, s. 9 –11.
10. Mikołajczak E., Mydlarz K. Popyk W. (2012): Analysis of processing wooden by ‑ products into energy. Intercathedra 2012 No 28. S. 51-55.
11. Prace inżynierskie zrealizowane w Katedrze Mechanicznej Technologii Drewna w latach 2000-2013.
12. Prace magisterskie zrealizowane w Katedrze Mechanicznej Technologii Drewna w latach 2000-2013.
13. Ratajczak E. (2001): Rynek drzewny. Analiza struktur przedmiotowych. Wydawnictwo Instytutu Technologii Drewna, Poznań.
14. Ratajczak E., Bidzińska G., Szostak A. (2011): Foresight w drzewnictwie Polska 2020. Obszar badawczy: Ekonomika drzewnictwa. Wydawca Instytut Technologii Drewna Poznań.
15. Rynek Drzewny 2015: Tartacznictwo w liczbach.
16. Szostak A., Bidzińska G., Ratajczak E. (2006): Prognoza zapotrzebowania na surowiec drzewny w Polsce do 2013 roku w podstawowych kierunkach jego zużycia. Instytut Technologii Drewna, Poznań.

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TOWARDS A HOLISTIC APPROACH TO THE SUSTAINABLE DEVELOPMENT OF INDUSTRY

Abstract: The paper attempts to analyse the motivations of industrial actors to network for sustainable development. In order to answer this question two sets of modern industrial approaches have been considered i.e. industrial ecology and industrial network approach. Both of them understand industry as a systematic network of interrelated nodes and flows. Their contributions to the sustainable industrial network have been analysed. The review of the theories led to the assumption that the incentives for business to network for sustainable development are exogenous. But networking for sustainable development depends finally on long term relationships which are negotiated as independent business deals. Those relationships are established only if they are expected to be mutually beneficial for business partners considering sustainable outcomes.

Keywords: sustainability, sustainable industrial network, industrial ecology, industrial networks.

INTRODUCTION

In the modern economy sustainability is the most important challenge for industry all over the world. One may consider narrow and broad notion of sustainability. The narrow is about the sustainable growth meaning the long-lasting competitive advantage. The broad is about the sustainable development which enables not only continuity of economic unit, but preventing their ecosystems i.e. environmental and social lifecycle from destruction. "*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."* [Brundtland Commission 1987]. This perspective clearly shows that sustainable development of industry requires that economic dimensions are being considered at the same time as social and ecological dimensions. It acknowledges the interdependency of three dimensions in industrial strategies. Therefore, it highlights transformation of the correct understanding of industrial sustainable development from a one-dimensional "making profit for the shareholder" approach to an integrating three-dimensional sustainability that requires the development "from shareholder to stakeholder" approach [Kakabadse, Rozuel, and Lee-Davies 2005, p. 279].

According to the sustainability, firms can survive only when their activities meet the expectations of stakeholders and social norms **[**Lee and Carroll, 2011, p. 117]. Indeed, stakeholders are commonly treated as a link between the organization's goals and the society's expectations [Iivonen and Moisander 2014]. According to R.E. Freeman, a stakeholder is "any group or individual who can affect, or is affected by, the achievement of a corporation's purpose" [Freeman 1984, p. 53]. A general definition of stakeholders refers to shareholders, customers, partners, employees, unions, local community, society, government, non-governmental organizations, associations, competitors, investors and suppliers. The sustainable development can only be realized by demanded a new way of thinking not only for firms, but also for contract inter-firms relationships and noncontract relationships with all of the stakeholders [Baraldi, Gregori, Perna 2010].

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For industry, the notion of sustainability necessity means stepping out of narrow confines of what an industry does, and thinking beyond economic considerations. The concept of sustainability adopted for industry has generally the four features:

- recognition of the widespread interdependence of species and ecosystems,
- involvement of systems beyond the immediate focal organization,
- understanding the presence of longer-term effects in addition to immediate short-term gains,
- multiple dimensions of performance beyond simple economic profits, e.g. social performance and cultural sustainability [Porter and Derry 2012].

This paper aims at analysing motivations of industrial actors to network for sustainable development. For that reason, two sets of theoretical approaches have been considered i.e. industrial ecology and industrial network approach. Both of them understand industry as a systematic network of interrelated nodes and flows. The paper use descriptive and comparative methods of systematic literature review for discussing the state of the art and the importance of modern industrial theories for sustainable development of industry. The paper is organized as follows. In the first part the backgrounds of industrial ecology literature have been presented, i.e. the insights into main concepts and methods applied within the discussed approach. The second part reviews the main achievements, assumptions and models of industrial networks. In the last, but not least part of the paper the juxtaposition of genesis, system and structural orientations, paradigms and ideas, empirical methods and practices of both approaches has been presented to discuss the contribution of both of the approaches into the sustainable development of industry.

INDUSTRIAL ECOLOGY

The industrial ecology approach has changed the attitude of each industry theory towards the ways of its sustainable development. It has entered the world of industrial development and business strategy in the 70s. The history of industrial ecology begun with the statement that: "*The industrial systems impact on the environment would be naturally reduced. To lessen the burden the industrial ecosystem would function as an analogue of biological ecosystems. An ideal industrial ecosystem may never be attained in practice, but both manufacturers and consumers must change their habits to approach it more closely if the industrialized world is to maintain its standard of living and the developing nations are to rise to a similar level without adversely affecting the environment. Developing nations will have to leapfrog older, less ecologically sound technologies and adopt new methods more compatible with the ecosystem approach.*"[Frosch and Gallopoulos 1989, p.144]. Nowadays, industrial ecology is at a critical stage in its evolution [Ehrenfeld 2004, p. 825].

In defining industrial ecology important attributes in connection to the industrial systems are being considered. They are:

- a systems view of the interactions between industrial and ecological systems,
- a change from linear (open) processes to cyclical (closed) processes,
- integrating industrial activity into ecological systems,
- making industrial systems emulate more efficient and sustainable natural systems [Garner and Keoleian 1995, p.4].

The main assumption of industrial ecology is that industries which share and/or exchange inputs and outputs (e.g. raw materials, products, process wastes, or water) constitute together an industrial ecosystem. The industrial ecology uses the links among industry subjects to define the industry ecosystem (biosystem). Industrial ecology is the study of the physical, chemical, and biological interactions and interrelationships both within and between industrial and ecological systems. One of the goals of industrial ecology is to change the linear nature of industrial system to a cyclical system where the wastes are reused as energy or raw materials for another product or processes [Garner and Keoleian 1995, p.2].

New ideas of industrial ecology serve for: process and product design, defining industrial development, establishing new hybrid forms of cooperation, organizing material recycling in loop-closing systems, analyzing industrial interdependencies, and creating holistic communities [Ayres and Ayres 2002]. The industrial ecology defines interactions and relationships in industrial ecosystems. When interacting industries are collocated, then the industrial ecosystem is referred to as an eco-industrial park or industrial symbiosis. The latter is often referred to as an industrial symbiosis complex. The model of industrial ecology was first fully realized in the eco-industrial park at Kalundborg in Denmark. The primary partners in Kalundborg, an oil refinery, power station, gypsum board facility, pharmaceutical plant, and the City of Kalundborg, literally share ground water, surface water and waste water, steam and electricity, and also exchange a variety of residues that become feedstock in other processes [Chertow 2000, pp. 315-316]. Since that, many industrial eco-parks have been developed all over the world.

Various strategies are used by individuals, firms, and governments to reduce the environmental impacts of industry. Each activity takes place at a specific systems level. Strategies related to industrial ecology comprise:

- pollution prevention (the use of materials, processes, or practices that reduce or eliminate the creation of pollutants at the source)
- waste minimization (the reduction, to the extent feasible, of hazardous waste that is generated or subsequently treated, sorted, or disposed of)
- Total Quality Environmental Management (TQEM) is used to monitor, control, and improve a firm's environmental performance within individual firms [Garner and Keoleian 1995, p.12].

Up till now, the industrial ecology has developed many analytical tools for interconnected industrial actors, such as: design for the environment, life cycle design, environmental accounting, and pollution prevention. Resource conservation and waste minimization have been major concerns in the process industry. Tracing flows of energy and materials through various systems is fundamental to industrial ecology. By quantifying resource inputs and the generation of residuals and their fate, industry and others, stakeholders can attempt to minimize the environmental burdens and optimize the resource efficiency of material and energy use within the industrial system. By tracing material and energy flows and performing mass balances, industrial actors could identify inefficient products and processes that result in industrial waste and pollution, as well as determine steps to reduce them. In the result, the waste produced by one company would be used as resources by another one and no waste would leave the industrial system or negatively impact the environment [Garner and Keoleian 1995, p.3].

Industrial ecology ideas are realized on the facility or firm level, at the inter-firm level, and at the regional or global level (Figure1). Industrial symbiosis occurs at the inter-firm level because it includes exchange options among several organizations. The interacting industries may be collocated in a formal industrial parks or in informal industrial park i.e. cooperate without any element of common management. In industrial ecology, one focus on (or object of study are) the interrelationships among firms, as well as among their products and processes, at the local, regional, national, and global system levels.

The inter-firm physical relationships are naturally suitable to be transformed into a network structure. The latest research conclude the existence of industrial symbiosis networks which emerge as a series of symbiotic relationships between and among regional activities and involve physical exchanges or material and energy carriers as well as the exchange of knowledge, human or technical resources, concurrently providing environmental and competitive benefits [Li and Shi 2015; Schiller, Penn and Basson 2014; Posch 2010]. In the latest research on industrial symbiosis three patterns of network cooperation have been observed:

- resource recovery networks without common investment,

- resource recovery networks with common investment,
- energy cascading networks as a specific form of inter-company cooperation with common investment [Schiller, Penn and Basson 2014, p. 5].

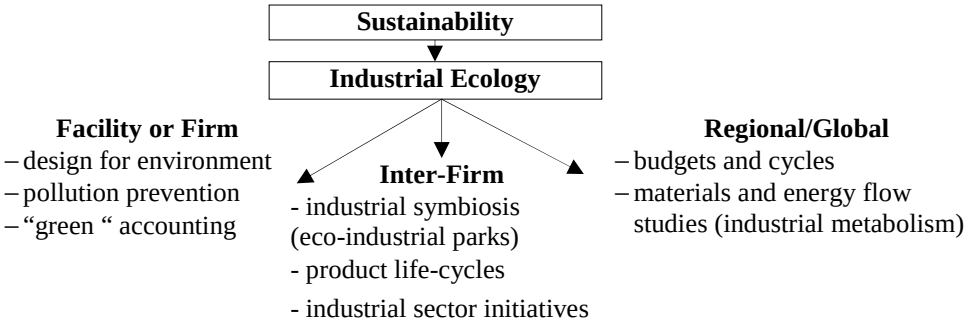

Figure 1. Industrial ecology operates at three levels

Source: M.R. Chertow [2000]

To sum up, the industrial symbiosis and creation of industrial ecosystem show the way of reaching sustainable development nowadays. Today industrial ecology not only turns from the study of the physical, chemical, and biological interactions and interrelationships both within and between industrial and ecological systems. Recent studies in the field of industrial ecology draw more attention from technological and metabolic relationships in industrial symbiosis towards new social, spatial, and business inter-firm relationships in regional or even in global space. Their outcomes show that only the ability to mobilize decisive managers is crucial for delivering industrial symbiosis. They need real incentives to enter eco-industrial parks and industrial symbiosis.

INDUSTRIAL NETWORK

An industrial network is one of the modern industrial approaches in industrial organization economics. For this approach the most important subject is the relationship between firms in the industry. The theory assumes that the whole activity and each change of the activity of the firm takes place in the relationship and those relationships are a central feature of business and organizational landscape of modern industries. Since the early 70s the Industrial Marketing and Purchasing Group (the IMP Group) has been concerned with the understanding of the content and shape of business relationships. This approach known as industrial network or just network approach exemplifies that an economic world consists of networks of business relationships. The approach has prevailed idea that atomistic companies are doing business in the world of anonymous suppliers and anonymous consumers. The main phenomena observable in networks are cooperation, competition, interactions, business relationships, movement, relatedness, and exchange.

The main feature of business is interaction which, according to D. Ford and H. Håkansson, [2006], has several key characteristics: time, interdependence, relativity, jointness, and subjective interpretation. The interaction that takes place between single actors is always the outcome of their previous interactions, as well as of their current interactions with others and their anticipation of future interactions of others. Therefore, business interaction is embedded in past, current and future time. The inherent characteristics of interacted network structures are interdependencies. In networks they are built mainly on technological, economic and resource dimensions. These interdependencies bring different kinds of organizational, social, strategic, logistical consequences

as well as effect on production structure, product development and economic effectiveness. The observable phenomenon shows that efficiency of resources evolves together with exploitation of considered interdependencies by the network partners. Since interaction always takes place in relation to others, there are no simple or stable rules as well as everything is time relative. The next key characteristic of business interaction, i.e. jointness develops in many aspects: combined intentions, specific investments, mutual commitment, and common aims of network partners. The last, but not least characteristics - the subjective interpretation means that all actors have their individual interpretations of the actions of others and their interactions are based on those interpretations [Ford and Håkansson 2006, pp. 7-16].

The interactions evolve into temporal relationship with specific features typical for business. H. Håkansson and I. Snehota [1995] distinguished two main kinds of characteristics for business relationship. They are: structural characteristics, as follows: continuity, complexity, symmetry and informality and process characteristics, as follows: adaptations, cooperation and conflict, social interaction and rutinization [Håkansson and Snehota 1995]. Major customer and supplier relationships of company show continuity and relative stability. The long-run relationships are precondition for change and development in the network. Business relationships are complex in many ways, e.g. number, type, contact pattern. Typical business relationships appear symmetrical in terms of resources and initiative of the parties involved. They often have a low degree of formalization. Mutual adaptations are a prerequisite of the development and continued existence of relationship between two companies. Elements of cooperation and conflict coexist in business relationships. Despite business relationships being essentially about business-specific behaviors – subjective values – the personal bonds and convictions that are always present, play an important role in formation of a relationship. While business relationships are often complex and informal, they tend to become institutionalized over time [Håkansson and Snehota 1995, pp. 9-10].

Regardless of the type of industry, a company always operates within a texture of interdependencies that affects its development. A few are repeatedly encountered in various business relationships, i.e.: technology, knowledge, social relations, administrative routines, systems and legal ties [Håkansson and Snehota 1995, p. 12-13]. In networks technical development within one company and in its relationships is dependent on other companies' technologies. It is facilitated or constrained not only by those with whom the company maintains direct relationships but also by the technology of other third parties. In the same way, the know-how of the company reflects not only the knowledge of its personnel but also that of the other companies and organizations to which it is connected through business relationships. The solutions adopted in one (or several) relationship(s) will affect what is possible or necessary to do in some other relationships. The legal texture is of interest as it can connect different business units with privileged ties. This applies especially to different forms of ownership control or other forms of agreements. Social bonds that arise among individuals in the two companies are important for mutual trust and confidence in interaction between individuals.

H. Håkansson and I. Snehota (1995) introduced a broad analytical scheme to identify where and what effects are likely to occur as business relationship evolves. It includes the immanent independencies between organizations involved in the network. The network scheme consists of three characteristics (the layers): activities, resources and actors. It is known as the ARA Model (Figure 2). This analytical scheme is used to identify where and what effects are likely to occur as a relationship is established, evolves or is interrupted. In the model there are three distinct columns: company, relationship and network. The authors consider that it can be used in analyzing business relationships and three types of effects: the direct effect changing the potential of the relationship (column 2), on the companies and their cost-revenue payments (column 1), and effects in the overall network (column 3). Companies have its own activity structure, organizational structure and

resource collection. They develop relationships with other companies as activity links, resource ties and actor bonds. The companies influence the development of relationships and the development of relationships influences the companies. There reciprocal conditioning exists. The relationship effects spreads among other companies and creates network as an aggregation of actors with activity pattern, web of actors and resource constellation. The relationships influence the network and again the network influences the relationships. Also, the relationship layers representing activities, actors and resources interplay as activity links, actor bonds and resource ties.

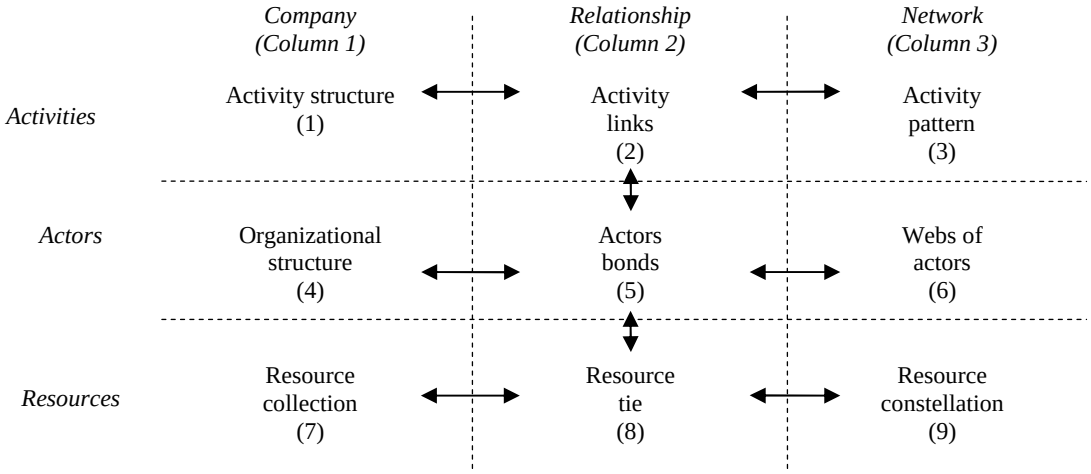

Figure 2. Scheme of analysis of development effects of business relationships

Source: H.Håkansson and I.Snehota (1995)

To sum up, a business network is a specific quasi-organization with a specific structure of interactions and interdependencies and specific economic, technical, and social dimensions. Nowadays, industry networks are the main feature of the business landscapes. Within the frames of network approach a general model of business relationships has been developed in terms of activities, resources and actors. Up till now, the model has been widely used for different kinds of analyses, e.g. on network innovation, network evolution, network performance effects. It also seems suitable for widely treatment of sustainable development of the industry.

CONTRIBUTION TO THE SUSTAINABLE DEVELOPMENT OF INDUSTRY

Industrial ecology and industrial networks are pretty heterogeneous in their approaches and practices as well as in the areas covered. Both take their roots from industrial economy, but instead of the common way of viewing individual actors (atomized) as loosely coordinated by price signals in a market, they both established systems orientation of bounded actors closely related to each other, tied by different relationships. In their worlds of specific relationships the most important are movements, flows and changes which take place among tied actors. In the current forms the industrial ecology and industrial networks may be considered as two different interaction models. Nevertheless, they may be well considered sticking together in the context of requirements of the sustainable development of industry. Contributions of both approaches into sustainable development of industry includes as follows (Table 1).

Table 1. Contributions of industrial ecology and industrial networks to sustainable development of industry

Categories	Industrial Ecology	Industrial Networks
Genesis	-Pioneering works in 1970s -Journal of Industrial Ecology founded in 1997 -International Society for Industrial Ecology (ISIE) in 2000 by the New York Academy of Science	-Pioneering works 1970s -In 1976 the first joint research project of the Industrial Marketing and Purchasing Group (IMP Group) -2006 first issue of the IMP Journal
Systems orientations	-Industry ecosystem with materials and energy flowing through a myriad of interconnected production processes contributed to the close cycle of economy	-Industry network with different modes which are related to each other by specific interactions and non-linear flow of goods, services, and knowledge
Structural orientations	-Industrial ecosystem is comprised of interconnected actors which are recycling materials and energy with no waste (close loops)	-Economic world is comprised of networks of interconnected relationships between independent companies (open loops)
Paradigms	-Flow is a process between companies which changes and transforms wastes into an energy or raw materials for another product or processes	-Interaction is a process between companies which changes and transforms resources, activities, and the companies themselves
Ideas	-Industrial metabolism -Industrial symbiosis	-Business interdependence -Business relationships
Empirical methods	-Case studies -An aggregate and organizational studies -Material and energy flow studies	-Case studies -An aggregate and organizational studies -Flow, point and sequential mapping
Practices	-Material Flow Accounting -Substances Flow Analysis -Life Cycle Analysis -Life Cycle Design -Design for the Environment -Total Quality Environmental Management	-Flow and visual mapping -Process perspective -Pattern matching -Grounded theorizing -Network strategy -Management of supply networks

Source: own elaboration based on the subject literature

The first and the most important is that in both concepts the main driver of interaction is sustainable development, high efficiency and high effectiveness. But the difference is that industrial ecology models drive towards eco-efficiency achieved by the delivery of competitively priced biomasses and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life-cycle to a level at least in line with the earth's estimated carrying capacity [Lehni 2000, p.11]. Industrial network models drive towards relation-efficiency achieved by the stable relationship with other business units [Håkanson and Snehota 1995, p.45]. In the relational model environmental standards are being negotiated by business partners with established investments [Håkansson and Waluszewski 2002].

Nowadays, developing green industry (product) is a complex process and often requires combining technologies from several industries. Therefore, it is relevant to view creation of eco-sustainable solutions from an industrial network, interactive perspective [Baraldi, Gregori and Perna 2010]. What the IMP literature stress, and what is missing in the industrial ecology literature is the differences among the actors approaches especially with the established investments. In the

industrial ecology all investments are made for the reason of improving an industrial biosystem (ecosystem). In industrial networks all investments are made in relationships with other actors. If both approaches consider they attitudes towards investment, the more holistic approach could be taught.

Economic structures are in both concepts determined by the relationships. In industry ecosystems the circulation of flows is closed as in natural systems. Contrary, in business networks, the relationships are open for direct and indirect expansion. The paradigms of industrial networks and industrial ecology underline changes and transformations towards more efficient and more sustainable development. In industrial networks the most important is efficiency of resources, activities and companies themselves. In industrial ecology the most important is reduction of wastes and loses.

The main paradigms of both approaches underline that in the economic world the most important are processes which take place between companies. They are flows and interactions. Therefore, the main coming ideas say about interrelatedness of industrial and business processes, with related episodes in a process of development that comprises a life cycle consisting of a number of different stages (metabolism, symbiosis, interdependence, relationships). Both supply-chain management and industrial ecology foster links between various types of enterprises across all manufacturing and processing industries. Theoretical concepts of industrial ecology and industrial networks shift academic and business practices towards planning and strategizing in relationship with other actors.

Both of the concepts use sociologic and anthropologic studies to understand rules of social interaction. They apply such social characteristics of inter-personal relations as: communication, trust, motivation, commitment, reciprocity, and many other morphological and interpersonal characteristics of social relationship. The interaction includes both inter-personal communication and interaction through delivery of physical products and services, information, knowledge and payments. Social and material dimensions are interdependent and dynamic. Notwithstanding, both industrial ecology and industrial networks aim at other than sociological studies of inter-personal relationships. They neglect the inter-personal relationships and merely focus on the connectedness. They focus on build-up perspective on network flows and processes producing a growth instead of structural holes and different degrees of separation, on resource interdependency instead of synergy, on comprehensive analysis of relations between organizations and surroundings than exclusive focus on inter-personal relationships [Goduscheit 2007, p. 8; Schiller, Penn, Basson 2014, p.5].

Empirical researches in both discussed approaches are based on qualitative methods, mainly case studies. The level of analysis is on aggregate, organizational level and not on an inter-personal level. The focus is on a wider structure, not on individual relationships. They aim at qualitative understanding of the content, shape and the effects of the relationships among companies. In industrial ecology the aim is the high quality of material and energy flow measured by ecological efficiency. In industrial network the aim is the high quality of co-evolution of business activities, resources and actors measured by economic efficiency and effectiveness.

Nowadays, industrial ecology has been identified as a strategy for promoting industrial sustainability. The perspective of industrial organization and especially of industrial networks should be considered while identifying and implementing strategies to reduce the environmental impacts of products and processes associated with industrial systems, with an ultimate goal of sustainable development. Recently, the industrial ecology is more and more often recognized as the study of the effects of the material and energy flows not only on the environment, but also on the economic, political, regulatory and social factors as well as the reverse influence of these factors on the industrial flows. The social network analysis has being used for studying of self-organizing industrial symbiosis with the assumption of the embeddedness of industrial networks in industrial

ecology. It is evident that industrial nodes can be connected by various types of ties including material and energy flows, financial transactions, information, and social interaction. Despite industrial ecology's primary interest in the functional ties that establish metabolism of the network, it also needs to consider indirect social influences, e.g. research institutes spreading knowledge, banks handing out loans or regulators introducing new regulations. New models of social analysis of material flows initiate the discussion on metabolic relationships in time and space which are produced and reproduced by social relationships [Schiller, Penn and Basson 2014, p. 2, Velenturf and Jensen 2015].

Publications on environmental impacts of industry traditionally focused on the technology aspects. Nowadays the view shifts away from the technology approach toward holistic approach to "green industry" dealing with the social and economic aspects, as well as the complexity of "greening supply chains" [Dornfeld 2012]. When sustainable development is the goal, the design process is affected by external and internal factors like: government policies and regulations, consumer demands and preferences, the state of the economy, competition, current scientific understanding and public perception, as well as corporate policies and the companies' mission, product performance measures, product strategies, and resource availability.

Today the aspiration of broadening the concept of industrial symbiosis towards social and structural dimensions lay in:

- the fact that environmental protection is more than the recycling of materials (in fact, recycling is an end of the pipe activity and therefore counts only as a second-best solution, it does not aim at avoid or reduce the negative outcome of production processes),
- sustainable development is more than environmental protection (it implies three dimensions: economic prosperity, environmental quality, and social justice),
- transition towards sustainability requires the involvement of all relevant actors (region, industry, regulators, consumers, households, interest groups, and so on) [Posch 2010, p.246].

CONCLUSIONS

Nowadays, the concept of industrial ecology is being developed towards a holistic approach recognized namely as an industrial sustainability. This broadening of industrial symbiosis requires new models of social relationships, finance flows, state regulations, and so on. For industrial ecology building an industrial biosystem (ecosystem) is much wider activity than just building a business network. The juxtaposition of industrial ecology approach and industrial network approach also shows different rationalities among economic actors in industrial ecology and in industrial network. Industrial ecology shows the way how business in networks may change the disadvantage of being involved in the environmental debate into advantage of totally new business encouraged to look for ecological advantages by ecological approach. Both discussed approaches are connected by the main and new view of industry, in which the most important lays in between companies. It is imperative to implement the network approach and its accomplishments of business interactions and business relationships. This is the way to link interactions to technical and organizational changes proposed by industrial ecology as well as to link strategies formed and developed not within a single company, but between interconnected companies.

To create a new economy for sustainable development these two subfields of industrial economy should work together more effectively on incorporating their achievements into common practice. More has to be done to explicate their structural and system aspects in common such as interdependence, closed-loop, community, or locality. The coalescence of all industrial knowledge into a unified whole is needed as well as more work is demanded to demonstrate the benefits of bringing industrial ecology into network practices. Up to day results, in form of the supply chain protocols for large-product oriented companies, required that suppliers to these companies carry out

evaluation of environmental burdens associated with a product, process, or activity, are quite weak as for the long history of both approaches. To strengthen and to accelerate the results of sustainable development joint academic and practical efforts should be undertaken within the frames of both considered approaches.

REFERENCES

1. Ayres R.U. and Ayres L.W. (Ed.) (2002), *A handbook of industrial ecology*. Edward Elgar, Cheltenham.
2. Brundtland Commission (1987), *Our Common Future*. United Nation World Comission on Environment and Development, Oxford University Press, Oxford.
3. Freeman R.E. (1984). *Strategic Management: A Stakeholder Approach*, Pitman Publishing, Boston, MA.
4. Iivonen K. and Moisander J. (2014), Rhetorical construction of narcissistic CSR orientation. *Journal of Business Ethics*, 131(3), 649-664.
5. Kakabadse N.K., Rozuel C., and Lee-Davies L. (2005), Corporate Social Responsibility and stakeholder approach: a conceptual review, *International Journal of Business Governance and Ethics*, 1(4), pp. 277-302.
6. Lee S. Y. and Carroll C. E. (2011), The emergence, variation, and evolution of corporate social responsibility in the public sphere, 1980-2004: the exposure of firms to public debate. *Journal of Business Ethics*, 104 (1), pp. 115—131.
7. Porter T., Derry R. (2012), Sustainability and business in a complex world, *Business and Society Review*, 117(1), pp. 33-53.
8. Baraldi E., Gregori G.L. and Perna A. (2010), Developing and embedding eco-sustainable solutions: the evolution of the Leaf House network. 26th IMP-conference in Budapest, Hungary.
9. Ehrenfeld J. (2004), Industrial ecology: a new field or only a metaphor? Journal of Cleaner Production, 12 (8-10), pp.825-831.
10. Garner A. and Keoleian G. A. (1995), *Industrial Ecology: An Introduction*. National Pollution Prevention Center for Higher Education, University of Michigan, Michigan.
11. Frosch R.A. and Gallopoulos N.E. (1989), Strategies for Manufacturing, *Scientific American*, 261(3), pp.144-152.
12. Chertow M. R. (2000), Industrial symbiosis: Literature and taxonomy. *Annual Review of Energy and Environment*, 25, pp. 313–337.
13. Li Y. and Shi L. (2015), The Resilience of Interdependent Industrial Symbiosis Networks. A Case of Yixing Economic and Technological Development Zone. *Journal of Industrial Ecology*, 19 (2), pp. 264-273.
14. Schiller F., Penn A. S., Basson L. (2014), Analyzing networks in industrial ecology - a review of Social-Material Network Analyses. *Journal of Cleaner Production*, 76, pp. 1-11.
15. Posch A. (2010), Industrial Recycling Networks as Starting Points for Broader Sustainability-Oriented Cooperation? *Journal of Industrial Ecology*, 14(2), pp. 242-257.
16. Ford D. and Håkansson H. (2006), The Idea of Business Interaction. *The IMP Journal*, 1(1), pp. 4-20.
17. Håkansson H. and Snehota I. (Ed.) (1995), *Developing Relationships in Business Networks*. Routledge, London and New York.
18. Lehni M. (2000). *Eco-efficiency creating more value with less impact*, WBCSD, Geneva.
19. Håkansson H. and Waluszewski A. (2002), *Managing Technological Development, IKEA, the Environment and Technology*. Routlege, London.

20. Goduscheit R. C. (2007), *Networks and Networks – Social network theory vs. the IMP tradition.* Paper presented at New Directions for Marketing: Interactions and Partnerships, Moscow, Russian Federation.
21. Velenturf A.P.M. and Jensen P.D. (2015), Promoting Industrial Symbiosis. Using the Concept of Proximity to Explore Social Network Development. *Journal of Industrial Ecology*, online version, pp. 1-10.
22. Dornfeld D.A. (Ed.) (2012), *Green Manufacturing, Fundamentals and Applications.* Springer, New York.

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INLAND WATER TRANSPORT POLICY DEVELOPMENT OF TRAS-EUROPEAN TRANSPORT NETWORK TEN-T POLISH AND EUROPEAN EXPERIENCES

Abstract: Policy development of the Trans-European transport network TEN-T is one of the best-defined areas of the EU's common transport policy. Obtaining funds for the development of the TEN-T is a way of overcoming the financial barriers to the development of transport infrastructure.

In Poland, inland waterway transport has a marginal role in the transport system of the country. This is a consequence of limited funds for maintenance, development and modernization of waterways.

Polish waterways are not included in the TEN-T network because of the non-compliance of international technical standards. It can be assumed that this will have far-reaching negative effects on the functioning of inland waterway and for the realization of transport policy in Poland in accordance with European guidelines. As a consequence, it negatively affects the competitiveness of the economy, especially in regions with access to the waterway.

Keywords: Trans-European transport network, TEN-T, inland water transport, transport policy

INTRODUCTION

Trans-European transport network TEN-T is a political program, by which the European Commission aims to create a system of transport connections. This system will provide spatial coherence of the EU area, it offers the right conditions for increasing the mobility of people, goods exchange, solve the problem of congestion and will promote environmental protection [Załoga 2009].

Trans-European transport network policy development is one of the best-defined areas of the EU's common transport policy. Raising funds for the development of the TEN-T is a way of overcoming the financial barriers to the development of transport infrastructure.

POLICY OF DEVELOPMENT OF TRANS-EUROPEAN TRANSPORT NETWORK TEN-T

Since mid-80s, within the trans-European transport network policy, have been defined assumptions for the infrastructure development strategy. These assumptions are designed to ensure the efficient operation of the internal market, to provide economic, social and territorial cohesion and improved accessibility across the European Union.

The legal basis for the trans-European transport network was created in 1992 by the Treaty of Maastricht. In 1994 during the European Council meeting in Essen was adopted a list of 14 major projects. In line with the already implemented by the EU's sustainable development strategy, most of the projects were related to rail and combined transport. The development of highways was planned only in three, relatively economically weaker EU countries, which was Portugal, Spain and Greece.

Financial principles of trans-European transport network development were identified in 1995 by Council Regulation (EC) No 2236/95. In these regulation were also defined EU assistance conditions and procedure within projects of common interest realization. In general assumption, Community aid could not exceed 10% of the total capital cost of the project. For implementation of

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the regulation EU secured amount of 2.35 billion ECU for the years 1995-1999, while the estimated value of the investment 14 projects amounted to 97 billion ECU. By that fact European Commission gave the signal that the share of the EU budget in the implementation will be limited.

In 1996, the European Parliament and the Council adopted the first guidelines defining the TEN-T policy and infrastructure planning [Decision No 1692/96/EC]. In 2004 these guidelines was amended, taking into account EU enlargement and the expected changes in the course of cargo flows [Decision No 884/2004/EC]. To facilitate the implementation of projects, was adopted a number of financial and non-financial instruments. These include the financial regulation on TEN [Regulation (EC) No 680/2007], Cohesion Fund, European Regional Development Fund (ERDF), the loans granted by the European Investment Bank, as well as initiatives coordinated by the Commission.

A major challenge for policy revision of the TEN-T was the Lisbon Strategy in 2000. The policy of infrastructure development was revised striving to achieve its objectives.

In 2003, a group chaired by Karel Van Miert (which included representatives of the EU candidate countries) assessed the progress of the projects of the TEN-T, identified the investment priorities for the enlarged EU (EU 25), classified it according to the time horizon and identified as cohesion projects.

Finally, a list of 29 priority projects of TEN-T network was adopted by the European Parliament and the EU Council in April 2004. Three of the priority projects runs by Poland in a latitudinal orientation (No. 23,25,25), two of them connect Gdańsk and southern Europe, and the third project will create axle railway "Rail Baltica" from Warsaw via the Baltic countries to Helsinki.

Until 2007 was realized five of 30 of TEN-T network priority projects. Implementation of 30 priority projects requires investment of about 340 billion euros.

In the years 1993-2006 expenditures for the implementation of all TEN-T projects incurred 458 billion euros, including 163 billion from the Community budget and 295 billion euros from the budgets of EU Member States. Expenditures planned for the years 2007-2013 incurred 337 billion euros, including 157 billion euros from the EU budget. Sources of funding priorities of the TEN-T are shown in Table 1.

Table 1. Financing of TEN-T priority projects (billion euro)

Trans-European Transport Network TEN-T	**1993/1996–1999 EU 15**	**2000–2006 EU 27**	**2007–2013 EU 27**
Expenditures on a total of 30 priority projects	32,65	93,7	154,0
– TEN-T Found	1,35	2.80	5,4
– Cohesion Found	3,83	7.0	12,3
– European Regional Development Fund (ERDF)			
– loans and guarantees from the European Investment Bank	1,46 9,78	4,81 16,1	4,7 25,0
Other sources of funding (national)	16,23	63,0	106,6

Source: TEN-T Funding in Figures. Transport infrastructures- EU funding for TEN-T, www.ec.europa.eu (15.05.2013)

Despite so many potential sources, the main burden of financing the trans-European transport network rests on the budgets of a member states. The results of studies of recent years indicate that

the level of investment in transport infrastructure in all EU countries is very low and it is smaller than 1% of GDP.

The majority of EU investment funds dedicated to the TEN-T are spent on rail projects (railways and ERTMS) - 61%, and only 4% for road projects. However, the Cohesion Fund are directed primarily to investments in roads (50% of total investment in transport are intended to roads and air transport projects).

So far, the principles of financing of the trans-European transport network in the EU have not been very effective. The priority projects are not implemented at the same rate and scope, as expected. The European Commission undertakes many activities aimed at achieving significant progress in the implementation of the TEN-T.

25 October 2006 was established Executive Agency of Trans-European Transport Network, headquartered in Brussels. Agency was established for the period from 1.11.2006 to 31.12.2008. It manages Community action in the field of TEN-T, coordinates financial instruments, provide any administrative and technical support requested by the European Commission. Agency is also responsible for collecting, analyzing and reporting to the Commission all information required for implementation of the TEN-T. It take supplementary measures to contribute to the effectiveness of the TEN-T program, in particular promote the program to all stakeholders and increase its visibility to citizen [Commission Decision 2007/60/EC].

In July 2005 the European Commission appointed six European coordinators and entrusted them task of support implementation of five priority projects and the implementation of the European Rail Traffic Management System (ERTMS). In 2007 published regulation amending the general rules for the granting of Community financial aid in the field of the trans-European transport and energy networks [Regulation (EC) No 680/2007].

However, the main source of Community support for TEN-T is still the Structural Funds and the Cohesion Fund. Countries of Central and Eastern Europe, as counties which have access to cohesion policy instruments, should be the biggest beneficiary of such organization. The incentive from the Cohesion Fund (85%), as recognized by the European Commission, can facilitate the financing of priority projects in poorer EU countries.

In 2010. The European Parliament and the Council adopted Decision No 661/2010/EU, which recast the Union guidelines for the development of the trans-European transport network [Decision No 661/2010/EU]. First of all, decision amended the current perception of infrastructure. It defined network range, which consists of the transport infrastructure, traffic management systems and systems for positioning and navigation.

In 2011, based on challenges defined in the White Paper "Roadmap to a homogeneous European Transport Area – Towards a competitive and resource efficient transport system" [COM/2011/0144 final], was defined long-term strategy of the TEN-T guidelines for the years 2030/2050 [COM (2011) 650 final]. Special attention was given to the contribution of infrastructure investment in reducing carbon dioxide emissions. A new approach to planning the development of the transport network in the EU was introduced- the concept of two-layer development, of the comprehensive network and the core network. The comprehensive network constitutes the basic layer of the TEN-T. It consists of all existing and planned infrastructure meeting the requirements of the Guidelines. The comprehensive network should be realized until 31 December 2050. The core network overlays the comprehensive network and consists of its strategically most important parts. It constitutes the "backbone of the multi-modal mobility network". The core network should be in place by 31 December 2030.

Rail freight corridors will provide the framework instrument for the coordinated implementation of the core network. In terms of scope, the core network corridors will in principle

cover three transport modes and cross at least three Member States. The core network has been designed in accordance with the following two-step methodology:

- the first step was the identification of main nodes (urban, ports and airports, border crossing points),
- the second step consisted in connecting these main nodes by multimodal links.

For the implementation of the TEN-T policy development was created a new financial instrument - the fund "Connecting Europe Facility". 10 billion euro of fund will go to Member States eligible to receive assistance under the requirements laid down for the Cohesion Fund.

In 2012, during monitoring progress of implementing the priorities of the TEN-T has been shown that past actions were ineffective, especially taking into account the expected duration of projects. Some projects have a chance to finish if it will be financed from the EU budget.

Of the 30 priority projects (as of November 2012) 52% has been completed, 18% are in progress, investment in 16% of projects was started in 2012-2013, and 14% projects will be implemented after 2013. The biggest progress has been achieved in road investments (completed 80% of planned projects), smaller progress has been achieved in rail corridors (about 50%).

In the literature, are raised the objections to the criteria for selection of projects for funding. Research conducted by Stef Proost revealed that only 12 out of the 22 priority projects of the TEN-T met the basic test performance (5 percent social discount rate). He proved also that a minority of selected projects has any real European added value in terms of the benefits of local investments to other countries. They would be certainly more effective if they were invested in the poorer regions of the EU.

Transport infrastructure network in the overall concept of TENs (transport, energy, telecommunications) proved to be the segment with the highest barriers to development. The reason is the wide range of investment, high labor- and capital-intensive, legal and organizational barriers, the requirement to considering EU environmental legislation, as well as coordination of national and regional investment plans taking into account the EU priorities. Experience in the implementation of TEN-T program shows that this political vision, in spite of compelling targets, will be difficult to implement. The primary barrier is the limitation of public finances, insufficient coordination of priority projects and the lack of compatibility of the interests of member states in the implementation of cross-border sections.

INLAND WATER TRANSPORT IN POLICY OF DEVELOPMENT OF TRAS-EUROPEAN TRANSPORT NETWORK TEN-T IN POLAND AND EUROPE

The spatial arrangement and utilization of waterways is essential for the effectiveness of inland waterway transport and demand for inland waterway transport. This is a result of tendency to increase the size of river vessels and profitable scale of container transport on waterways with high technical parameters.

The prerequisite for the development of infrastructure of waterways and river ports are increasing needs of the EU economy in area of condition and capacity of transport infrastructure. Existing policies and instruments for their implementation are adapted to upcoming challenges related to mobility within the EU, care for the environment and the problems of congestion.

Unbalanced spatial distribution of waterways and the diversity of inland water transport development is a feature of the current system of inland waterway transport in Europe. The creation of an Agreement on Main Inland Waterways of International Importance (AGN) is an attempt to impart cohesive qualities to international network of waterways. AGN is an international agreement adopted in 1996 by the Inland Transport Committee of UNECE. Agreement is classified waterways, aiming to create a network of waterways available for self-propelled vessels with dimensions of length. 85 m width. 9.5 m., draft 2.5-4.5 capacity 1 250 - 2 500 t. The agreement sets

out the priority investments on the waterways - bottlenecks and missing links. It came into force in 1999 and was ratified by 18 Member States of UNECE.

Equally important for the development and cohesion of the network of waterways is inclusion inland waterways in the trans-European transport network. In accordance with the guidelines set out in the "Connecting Europe Facility", waterways parameters class IV and above are part of the core network of TEN-T. Core network consists of nine transport corridors. Inland waterway transport is part of the seven multimodal transport corridors [http://ec.europa.eu/transport/themes/infrastructure/ten-t-guidelines/corridors/index_en.htm (14.12.2015)]:

- The **North Sea-Baltic Corridor** connects the ports of the Eastern shore of the Baltic Sea with the ports of the North Sea. The corridor will connect Finland with Estonia by ferry, provide modern road and rail transport links between the three Baltic States on the one hand and Poland, Germany, the Netherlands and Belgium on the other. Between the Odra River and German, Dutch and Flemish ports, it also include inland waterways, such as the "Mittelland-Kanal". The most important project is "Rail Baltic", a European standard gauge railway between Tallinn, Riga, Kaunas and North-Eastern Poland.
- The **North Sea-Mediterranean** Corridor stretches from Ireland and the north of UK through the Netherlands, Belgium and Luxembourg to the Mediterranean Sea in the south of France. This multimodal corridor, comprising inland waterways in Benelux and France, aims not only at offering better multimodal services between the North Sea ports, the Maas, Rhine, Scheldt, Seine, Saone and Rhone river basins and the ports of Fos-sur-Mer and Marseille, but also better interconnecting the British Isles with continental Europe.
- The **Orient/East-Med** Corridor connects the maritime interfaces of the North, Baltic, Black and Mediterranean Seas, allowing optimising the use of the ports concerned and the related Motorways of the Sea. Including Elbe as inland waterway, it will improve the multimodal connections between Northern Germany, the Czech Republic, the Pannonian region and Southeast Europe. It extends, across the sea, from Greece to Cyprus.
- The **Rhine-Alpine Corridor** constitutes one of the busiest freight routes of Europe, connecting the North Sea ports of Rotterdam and Antwerp to the Mediterranean basin in Genoa, via Switzerland and some of the major economic centers in the Rhein-Ruhr, the Rhein-Main-Neckar, regions and the agglomeration of Milan in Northern Italy. This multimodal corridor includes the Rhine as inland waterway. Key projects are the base tunnels, partly already completed, in Switzerland and their access routes in Germany and Italy.
- The **Atlantic Corridor** links the Western part of the Iberian Peninsula and the ports of Le Havre and Rouen to Paris and further to Mannheim/Strasbourg, with high speed rail lines and parallel conventional ones, including also the Seine as inland waterway. The maritime dimension plays a crucial role in this corridor.
- The **Rhine-Danube Corridor**, with the Main and Danube waterway as its backbone, connects the central regions around Strasbourg and Frankfurt via Southern Germany to Vienna, Bratislava, Budapest and finally the Black Sea, with an important branch from Munich to Prague, Zilina, Kosice and the Ukrainian border.
- The **Mediterranean Corridor** links the Iberian Peninsula with the Hungarian-Ukrainian border. It follows the Mediterranean coastlines of Spain and France, crosses the Alps towards the east through Northern Italy, leaving the Adriatic coast in Slovenia and Croatia towards Hungary. Apart from the Po River and some other canals in Northern Italy, it consists of road and rail. Key railway projects along this corridor are the links Lyon – Turin and the section Venice – Ljubljana.

Currently, have been taken steps towards the construction of the canal Seine - Northern Europe (Paris - Amsterdam) and Saône - Moselle and Saone - Rhine (SMSR) in central France. Both projects will be a very important link in a network of waterways in Western Europe [Mialocq, Chaban-Delmas 2012, pp. 37-40].

Canal Seine - Northern Europe will have a length of 106 km and will be available for ships with a capacity of up to 4 400 t. Canal will connect Paris region with Rhine and Germany (through Belgium), creating a 20.000 km of new routes of inland waterway transport in Europe. This canal is to be opened in 2017. Voies navigables de France, predicts that by 2020 this canal will be transported 15 million tons of cargo [*Medium and long time perspectives,* pp.193]. This corridor is on the list of 30 priority TEN-T corridors. It will have great importance for the economy of the European Union.

Canals Saône - Moselle and Saône - Rhine (SMSR) allow water connection of Germany and Southern Europe (through France). It will connect Rhine - Moselle - Saone - Rhone - Mediterranean. After passing the above-mentioned canals, loads will be transported by sea from the port of Marseille to North Africa and Asia.

Both canals will have a total length of approx. 220 km, total width of 70 m and a width useful for vessels of 36 meters. Height difference will be equal 300 meters. Canals of such dimensions can be used by barge with a length up to 185 m and draft of 4.5 m. In financing of the construction of canals SMSR will participate eight regions of France and three German Länder. Construction of the above-mentioned canals was undertaken by the management of inland canals in France - Voies Navigables de France - VNF[Mialocq, Chaban-Delmas 2012, pp. 37-40].

With the additional budget dedicated to trans-European transport networks is possible more efficient elimination of the missing links and bottlenecks in European network of waterways. In the financial perspective 2007-2013 the European Commission allocated 11.5% of the budget of the TEN-T, it is 610 million EUR, to the project No. 18 (Rhine-Main-Danube) and No. 30 (Seine-Scheldt). In addition, 66 million EUR was allocated to support smaller projects in inland waterway transport carried out on the river Po, Moselle, in the port of Cologne on the Inland Canal in Germany and the Oder-Havel Canal [*Medium and long time perspectives,* pp.193]. The main beneficiaries of the TEN-T in inland waterway transport in the 2007-2013 financial perspective was Germany.

As part of the priority project Seine-Scheldt, in 2013. Belgium received from the TEN-T budget 5 million EUR for investment projects divided into 3 stages. The first stage concerns the reconstruction of two bridges, which will allow the transport of three layers of containers from the French border to the River Moselle. The second stage involves conceptual work that will allow for investments in infrastructure eliminating bottlenecks on Seine and Scheldt. The third stage of the project involves upgrading canal Brussels - Scheldt to a depth of 9.5 m and a minimum width of 55 meters, allowing the transport of using vessels with a capacity of 10 000 t [Press Release Executive Agency, http://tentea.ec.europa.eu (28.07.2013)].

In Poland from the TEN-T budget was funded pilot project to implement RIS on Lower Oder. The project was implemented by the Office of Inland Navigation in Szczecin. It includes 97.3 km of the Oder River on international parameters, which imposed an obligation to implement RIS. In 2013, the Inland Waterways Authority in Szczecin began work on the project "Full implementation of RIS Lower Oder - preparatory work". System will be expanded territorially by the distance from the village Ognica to the village Hohensaaten, ie. 30 km [www.ris-odra.pl (25.07.2015)].

Lack of international parameters of waterways in Poland with minimum class IV navigability was the cause of their rejection by the European Commission as waterways that could create the TEN-T network. In the network is only the lower section of the Oder holding a class IV waterway (Widuchowa Szczecin / Świnoujście). This decision will have resounding consequences for the

economic development of regions. It means the loss of benefits from the transit of goods through Poland, the loss of potential jobs, losses for Polish seaports and loss benefits of cooperation with neighboring countries. Lack of inclusion of the Oder waterway to the TEN-T will also hamper the implementation of Oder - Danube – Elbe Canal.

It is worth noting, that as a result of the revision of the TEN-T, to core network was included competitive corridor in the following course: Berlin Magdeburg - Hannover - Inland Canal - West German Canal System – Rhine [http://ec.europa.eu/transport/themes/infrastructure/ten-t-guidelines (03.23.2015)]. Germany investing in port in Schwedt providing transport services in Berlin by water. This project was realized despite unfavorable waterways development policy in eastern Germany and prioritize the development of this mode of transport in the Rhine.

Huge delays in adjusting Polish waterways to European requirements caused losses for shipping companies and water management. Reversing these changes require expenditures that are impossible to realize in a short time.

It can be assumed that the omission of the interests of inland waterways regarding their inclusion in the TEN-T network will have far-reaching negative effects on the functioning of this mode of transport and for the implementation of transport policy in Poland in accordance with European guidelines. In consequence it affects adversely the competitiveness of the economy, in particular in regions with access to the waterway.

CONCLUSION

The political program trans-European transport networks outline priorities for expansion and modernization of selected transport corridors in Europe. The inclusion of infrastructure projects into TEN-T provides promotion and political support for their implementation, and constitutes an important source of investment financing.

The use of opportunities arising from the integration of waterways TEN-T could contribute to achieve international parameters of waterways in Poland. It would contribute to obtaining of cohesion of the waterways network, improving intermodal competitiveness of inland waterway transport, ensuring conditions for development and investment for shipping companies and the growing interest in the Polish market of foreign shipowners.

To enable Polish waterways to the trans-European transport network in the next revision of the TEN-T network they must have a minimum IV navigability class. From the requirements of the European Commission indicates that the inclusion of Polish rivers to the TEN-T will also be possible if there will be create a comprehensive program adjusting waterways to international class (at least IV navigability class), feasibility study and the necessary strategic environmental impact assessment. Required is also a decision on implementation of the project, for example, after the establishment of this program by law.

REFERENCES

1. Commission Decision 2007/60/EC of 26 October 2006 establishing the Trans-European Network Executive Agency pursuant to Council Regulation (EC) No 58/2003.
2. Decision No 1692/96/EC of the European Parliament and of the Council of 23 July 1996 on Community guidelines for the development of the trans-European transport network.
3. Decision No 661/2010/EU of the European Parliament and of the Council of 7 July 2010 on Union guidelines for the development of the trans-European transport network (recast)
4. Decision No 884/2004/EC of the European Parliament and of the Council of 29 April 2004 amending Decision No 1692/96/EC on Community guidelines for the development of the trans-European transport network.
5. *Medium and Long Term Perspectives of IWT in the European Union, Executive Summary Report*, CE Delft, Planco, MDS Transmodal, viadonau, NEA, 2011.

6. Mialocq G., Chaban-Delmas J.-J.: Towards a sustainable transport system, *"Internationales Verkehrswesen"* 2012, No 5.
7. Press Release Executive Agency. Trans-European Transport Networks of the European Commission of 28 January 2013. http://tentea.ec.europa.eu (28.07.2013)
8. Proposal for a regulation of the European Parliament and of the Council of 19 December 2011 on Union guidelines for the development of the Trans-European Transport Network COM (2011) 650 final.
9. Regulation (EC) No 680/2007 of the European Parliament and of the Council of 20 June 2007 laying down general rules for the granting of Community financial aid in the field of the trans-European transport and energy networks.
10. Regulation (EC) No 680/2007 of the European Parliament and of the Council of 20 June 2007 laying down general rules for the granting of Community financial aid in the field of the trans-European transport and energy networks.
11. The website of DG. Mobility and Transport at the European Commission: http://ec.europa.eu/transport/themes/infrastructure/ten-t-guidelines (03.23.2015)
12. The website of DG. Mobility and Transport at the European Commission: http://ec.europa.eu/transport/themes/infrastructure/ten-t-guidelines/corridors/index_en.htm (14.12.2015)
13. The website of the Pilot program for the implementation of RIS on the Dolna Odra www.ris-odra.pl (25.07.2015)
14. White Paper. Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system COM/2011/0144 final
15. Załoga E. (2009), The trans-European transport network (TEN-T) – Planning and financing of development, Scientific Journal of the University of Szczecin No. 535, Economic Problems of Services No. 32, Edited by E. Załoga, Szczecin University Press, p. 525.