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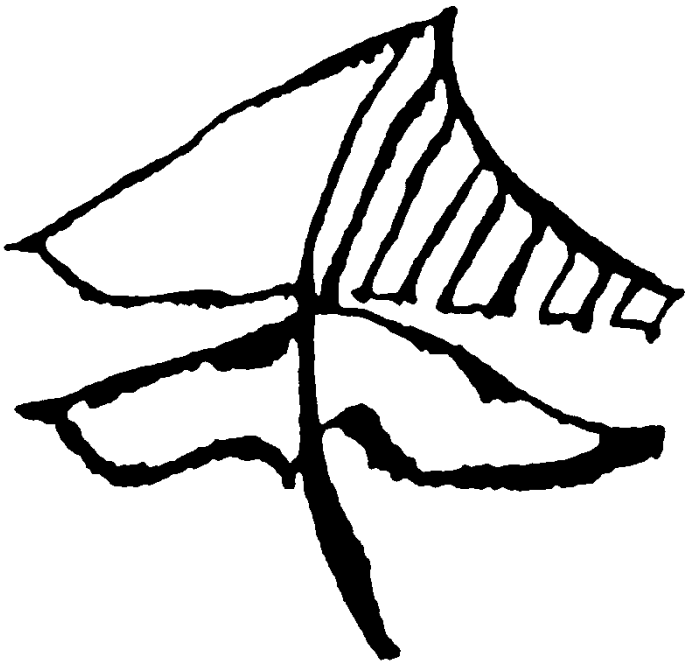

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Dear Readers!

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

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

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

This edition marked as 28/3 includes, inter alia, papers that were presented at international scientific conferences: the Economic Forum 2012 in Laski and InterEconoMIX in Poznań.

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

We cordially invite you to read this volume.

Wojciech Lis

Katarzyna Bolimowska[1]

URBAN ROAD NETWORK. THE REALIZATION OF THE VARIOUS FUNCTIONS OF PUBLIC SPACE

Abstract: The sustainable development of a town is mainly the management of public space. The streets of the city, unlike the roads out of town, are not only a transport network. This is public good with many features. The subject of research is the use of street space and defining the needs of its users. The following analysis of the subject discusses the status of the network of streets of Poznan, selected functions of the road, the dynamics of the needs of road users. The urban street is becoming increasingly a place for meetings, events. Expectations as to the status of aesthetics, technical features and equipment of roads are growing. In some areas some people are going to slow down traffic, and even close streets for vehicles, while at the same time there is an ongoing fight against traffic congestion. The increase in complexity of urban road functions tends to redefine the network of streets towards public space.

Keywords: Public space, public roads, a network of streets, urban roads, functions of urban roads.

INTRODUCTION

The The aim of basic research in this field is the need to redefine the network of urban streets. The author tries to sort out, check the events that take place within the street space and determine the needs of its users. In the framework of the research carried out in the Department of Spatial and Environmental Economics at the University of Economics in Poznan, the author attempted to answer the question: how to fulfil the many functions of public space that constitute a network of urban streets?

By this study the author is hoping to achieve both cognitive aims and the aim of applicability. While it is important to emphasize the theoretical issues arising from the problem, it is also worth to obtain results that can be applied in practice, in the management of public roads in Poznan that we are facing today.

In Poland, public roads are divided into four categories: those under national, provincial, district and municipal authorities. The administrator of the national roads is the General Director of National Roads and Motorways, while district and municipal roads remain under the responsibility of local governments. Within the limits of county cities (cities with powiat rights) the administrator of all public roads, with the exception of motorways and expressways, is the mayor of the city. Public roads known as "urban" represent 17 per cent of the entire network of public roads in Poland [6].

Only a selected group of management dilemmas have been presented in the case studies of actions undertaken in the field of management of roads.. The study analyses the phenomena and events taking place over the years 2008 to 2012.

The study of spatial-economic features, implemented into the framework of spatial economy, is moving towards the observation and measurement of interactions between the environment and people. The implementation aspect of cognitive interactions, relationships and processes has to identify possible solutions to various problems in the local area.

The methodology of research used in this paper is the empirical model, in terms of empirical and inductive methods [11]. Being at the stage of analysing empirical data (organizing knowledge and facts) the author plans her implementation of the next steps. While defining the aims of research, it was considered that those are needed and in fact initially defined, which is the fundamental hypothesis of the research. Cartographic, statistical and other methods have been used to complete they verification of the hypothesis [5, 11].

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DEFINITION OF THE SUBJECT

In In accordance with the Polish Act on Public Roads as of 21st March 1985 the duties of the road manager, in terms of tasks related to the development of the road network, should include, inter alia, draft plans for the development of the road network, plans to finance the construction, reconstruction, repair, maintenance and conservation of roads. The introduction of the concept of management refers in turn to the definition of spatial economy. Wikipedia [16] defines this concept on the basis of available literature, i.e. Domański: Spatial economy: theoretical basics [4], Parysek: Introduction to spatial management [9]. The definition therefore includes all activities of passive and active entities and items associated with the use the space of streets [4], [9].

In Poznan there are 1927 public roads with a total length of 1040 km and a total surface of 781,7 ha. The financial resources allocated to network management are more than 360 000 000 zł per year, representing approximately 12 per cent of the total budget of the city [17]. However, this multi-million estate of streets requires increasing investment for its development, maintenance and damage prevention. In order to actively shape social relations, a civic debate in July 2011 has been carried out on behalf of the Consortium of the Office of MPK Poznan Sp. z o.o., Euro 2012 Sp. z o.o., Infrastructure 2012 Sp. z o.o. and Aquanet S.A. The subject of the debate also touched on the issue of public roads. It should be noted that during the debate the area "of public roads and lighting" has been indicated as the area that should be spared any spending cuts, arguing: "this is an area for the development of the city", "this is an area that has an impact on the safety of residents" and that "the quality of the roads affects the quality of life of all inhabitants" [15].

The basic, generally recognized functions of streets network have been reduced to providing transport and communication. The subject of this research struggles to show features beyond transport, which also create a source of management dilemmas. Management is the implementation of functions and purposes. In the limited space, which a network of urban streets is, a contradiction of needs may easily occur. The general objectives of transport are: travel (time, distance, access, and elimination of exclusion), as well as the elimination of barriers for all users [2]. In order to organize the concepts we should further ask the question as to what is space, public space? An explanation to the question above may be found in The Charter of Public Space. There it is considered that public space must be defined in terms of socio-economics, and that it is jointly used and intentionally shaped by people, in accordance with their social principles and values – to meet the needs of local communities and supra. The public nature of space is determined by the corporate way in which it is used [7]. This thesis is based on the assumption that urban street network management needs to support a multi-criteria analysis of events, factors influencing events and needs of street space users.

It turns out that not only technical knowledge and expertise are necessary, but also the current study and analysis of the needs of users of urban streets.

The need for involvement of professionals of many industries, authorities, scientific environments in the discussion of the problem seems obvious. In terms of traffic management it is recommended to cooperate with experts from the scientific community. As part of the management of roads in Poznan (understood as the administration and maintenance of roads), in the context of outsourcing, in 1996 the city's authorities launched a cooperation program with the Institute of Civil Engineering of the University of Poznan. Annually, within a system for supporting the management of the network of streets of Poznan, a wide range of data and analysis is prepared in order to advise on management decisions [2].

TECHNICAL ASSESSMENT

Within the framework of specialized cooperation the University of Technology is obliged to assess the condition of the road network. Over the past ten years, despite financial constraints, the city managed to keep the condition of roads at an acceptable level. 21 per cent of all roads are currently in a state described as bad - D (with a 30 per cent decrease); good condition - A: 21 per

cent (an increase by 13 per cent). The values in B - satisfactory, and C - unsatisfactory, remain at a similar, constant level [3, 12].

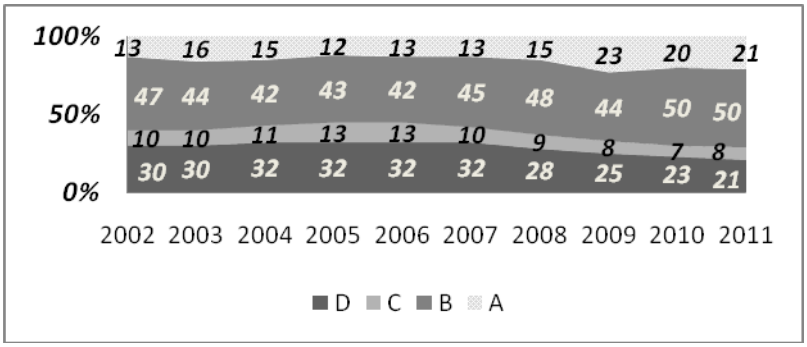

Fig. 1. Results of the evaluation of the condition of roads in Poznan in the years: 2002 -2012 - global index

Source: Own study based on [12]

THE USE OF STREETS SPACE - EXAMPLES OF FUNCTIONS UNRELATED TO TRANSPORT

The scientific community is also involved in preparing analytical tools, inventory, etc. An example of an information tool is the traffic lane module that allows for the preparation of statistics and inference within the broad time horizon [13].

The prepared statistics, which are the result of extensive databases, allow, among others, to recognize how the belt road is being shaped when used for purposes other than transport. By examining the time horizon from 2007 to 2012 we can see an increased use of street space for purposes other than transport. The number and diversity of applications is growing every year. Allowed was an average of 17 events in one district in 2011 (differently for each of the five boroughs). Interesting are the purposes of using the traffic lane: for the purposes of promotion, street art, in various forms, music performance, happenings, erection of memorials and plaques, the celebration of Christmas etc., exhibitions, expositions, artistic installations, implementation of various educational programs, trade, sports events, concerts, fairs, outdoor events, mass events. Frequent street events include performances during the Maltese Theatre Festival , public marathons, celebrations of Street Name Days (e.g. St. Martin Street Name Day), etc. A huge increase in the number of permits to raise objects within the street lane, is evident. In other words, those permits are related to the equipment needed for the implementation of many other municipal tasks, such as the supply of media.

Table 1. Summary of permits for placing equipment not related to road management in the traffic lane

Incorporation of devices	District					Together
	Grunwald	Jeżyce	Nowe Miasto	Stare Miasto	Wilda	
The number of authorisations until 2012 -current	1 746	1 881	2 279	1 734	500	8 140,00
Area occupied device (m^2) 2005-2012	22 478,81	24 354,28	34 328,07	27 245,84	9 234,65	117 641,65
Growth of surface used in the device (m^2) in 2012 (10 months)	902,60	875,64	6 032,13	1 484,85	248,05	9 543,27
Annual revenue (rate at PLN 10 per $1m^2$)	224 788,10	243 542,80	343 280,70	272 458,40	92 346,50	1 176 416,50

Source: Own study based on [17], [13]

Most of the surface is determined by the length of equipment multiplied by 1 meter of width. A total of over 117 kilometres of linear devices have been built. In addition, there are 531 km of rainwater drains and 152 km of mixed sewage drains installed within the roads.

Analysis of the statistics in terms of authorization for the use of the street in a special way indicates the need to broaden our comprehension of the street network (or rather parts of it), as the transport function is now moving towards a public space of many different functions.

THE USE OF STREETS SPACE - EXAMPLES OF THE IMPLEMENTATION OF TRANSPORT FUNCTIONS

One of the actions undertaken in the field of fulfilling the transport function of Poznan roads is the gradual introduction of the TEMPO Zone 30. This zone, thanks to the use of a suitable shaping of the road and its surroundings can prevent accidents and other nuisance by physically preventing unauthorized speed driving and eliminating unwanted traffic transit, thus eliminating certain non-urban street network functions (of course, in areas or on roads which are not intended to serve this function). Reconstruction and modernization of road sections by the urban local government aims to ensure the safe speed of traffic and ease the burden of transportation, this being achieved through: a functional hierarchy of the road traffic system, establishment of speed zones, the introduction of traffic calming measures and the improvement of the quality and aesthetics of public space. Subsequently, lower speed causes less noise and reduced emissions of dangerous gases into the environment [8]. Traditional tools are used: elevated intersection, newly elevated pedestrian crossings, narrow roads, etc. The implementation of the zone is a joint initiative of the Municipal Council, citizens and municipal services. Transport policy includes parking security. The basic strategy for promoting public transport is planning to deploy buffer car parks so as to limit the maximum entry of cars to central areas of the city.

An important source of information on the use of street space for the performance of its functions is to study the supply of and demand for parking on public roads in the city. The total number of places in the zone is 9236, 8670 outside the zone. In total there are 17906 parking places (beyond the outermost areas)around the surveyed area. Filling in the various zones is as follows: zone A - central - 82,2 per cent (during maximum traffic at 12.00-13.00 hrs), zone B - 72,7 per cent (during maximum traffic at 10.00-11.00 hrs) and zone C (during hours of maximum traffic - 13.00-14.00 hrs) - 41,7 per cent. The average filling of parking places - 77,3 per cent - meets the criteria established in the decision of the City Council on required free parking places available [10]. The introduction of paid parking zones on Saturdays, between the hours of 8.00 to 14.00 results in filling oscillating around 81,4 per cent, and in the Central zone - 80,0 per cent. Zone B has reached even 90,4 per cent in hours from 11.00 to 12.00. In zone C - most distant from the center of the city - the filling up is significantly lower on weekends than the filling occurring from Mondays to Fridays. What does this tell us? The established percentage of vacancies is maintained, while there is an observable increase in filling in the hours from 11.00 to 12.00 (and even to 14.00). This situation may suggest a relationship with the opening hours of shops, offices, universities, etc. This may provide a hint for the analysis of the purposes of travel by car, the needs for the use of public space and analysis for the purposes of promoting public transport.

It is therefore necessary to urgently implement policies such as planning construction of underground car parks. This will allow the release of public space, which is the street, from the congestion caused by parked vehicles. Public opinion polls have shown that the effects of expansion of paid parking zones are positively evaluated and further steps are actually expected. But we must remember that the introduction of the zone must (in accordance with the demands of citizens and other organized communities) go hand in hand with the improvement of the technical condition of infrastructure, improvement of environmental values (vegetation, trees), and improved aesthetics of the street as part of public space.

According to the Act on Public Roads as of 21st March 1985 a public road is the road included under the Act to one of the categories of roads, which can be used by anyone, in accordance with its intended use and the limitations and exceptions set out in this Act or any other related provisions. Roads falling under the category of "higher purpose" are primarily serving the needs of transport and communication. To minimize travel time is an essential task of the road manager. Transport congestion causes a decrease in perceived quality of life in the city by limiting the mobility of the population [14]. Time spent travelling is time spent in a street public space.

The analysis of the availability of individual sections of the network of streets is prepared as image isochrones in two versions: from the six starting points lying on the border of the city and in the reverse direction from the starting point in the center. The model is illustrated by travel isochrones in conditions that do not include traffic congestion, taking into account the speed allowed on the streets. The picture shows the shape of travel time in urban areas - perfect, counting from the border to the center, is access within (during daily traffic) 15 minutes. In a completely theoretical model, for the no-load network, this time is less than 10 minutes. In the opposite direction - from the center to the border, in model conditions of travel, the time of average daily traffic is extended to 20 or even 30 minutes. Using isochrones - lines modelling the same time of travel - is just one of the methods of research conducted by the author of the paper.

CONCLUSIONS

In the urban street, being the open road that it is, public space is a public good of non-market interdependencies, specific spatial properties and changing functions. Street network management of city streets is therefore shaping public space. One cannot restrict management actions to those affecting the functioning of the road as a communication system (connecting areas), but one should analyze the road lane as a small-surface and functionally complex area with many different characteristics and relationships. In the stages of urban development, type of change (to determine the dynamics of change) in their "bloodstream", which is the road network.

This should all be taken into account when ensuring an adequate level of financial investment in management of the street network. Modern management must involve a constant search for new sources of funding; generate new socially acceptable products, supporting management processes [1].

The street's condition also affects the attractiveness of the, as an attractive public space generates many values. It is not just about the monetary value, but the value of assets that are valued by the community.

Further detailed studies will aim to determine the spatial and temporal availability of the city's main places (objects) in the light of the need for spatial coherence. It is also necessary, at a later stage, to diagnose the social evaluation of the urban road network as a public space. Finally, the study shall be designed to determine the position of the road in the socio-economic system of the city.

REFERENCES

1. Bolimowska K.: Analiza strategiczna możliwości efektywnego zarządzania pasem drogowym, Studium podyplomowe Akademii Ekonomicznej. Wydział Ekonomii, Poznań 2004.
2. Bolimowska K.: Odpowiedzialni za miasto. Rządzący i rządzeni. Miasto, a w nim sieć ulic miejskich jako przestrzeń publiczna o wielu różnorodnych funkcjach - obserwacje i wybrane przypadki. IV Kongres Urbanistyki Polskiej. Kongres Związku Miast Polskich, Lublin 2012.
3. Bolimowska K., Rydzewski P., Sztukiewicz R.: Ocena stanu technicznego nawierzchni jezdni w systemie wspomagania zarządzania siecią ulic miasta Poznania. 56 Konferencja Naukowa Komitetu Inżynierii Lądowej i Wodnej PAN oraz Komitetu Nauki PZITB, Problemy naukowo-badawcze budownictwa, Wydawnictwo Politechniki Świętokrzyskiej, Kielce-Krynica 2010.
4. Domański R.: Gospodarka przestrzenna: podstawy teoretyczne. PWN Warszawa 2006.

5. Domański R.: Procedura typologiczna w badaniach ekonomiczno-geograficznych. Przegląd geograficzny, z.4, 1964.
6. Karta przestrzeni publicznej. III Kongres Urbanistyki Polskiej, Poznań 2009.
7. Ministerstwo Infrastruktury: Program uspokojenia ruchu dofinansowania z kredytu europejskiego banku inwestycyjnego. Założenia programu. Warszawa 2008.
8. Parysek J.: Wprowadzenie do gospodarki przestrzennej. Wydawnictwo Naukowe UAM, Poznań 2007.
9. Pracownia Inżynierii Komunikacyjnej: Badanie napełnienia w strefie płatnego parkowania w Poznaniu – obszar Centrum, Jeżyce, Grunwald, Wilda – okres wiosenny 2012, Poznań 2012.
10. Runge J.: Metody badań w geografii społeczno – ekonomicznej. Elementy metodologii, wybrane narzędzia badawcze, Wydawnictwo Uniwersytetu Śląskiego, Katowice 2007.
11. Rydzewski P.: Raport nr 2 z realizacji pracy Systemu wspomagania zarządzania siecią ulic miasta Poznania. Instytut Inżynierii Lądowej, Politechnika Poznańska, Poznań 2011.
12. System wspomagania zarządzania siecią ulic miasta Poznania, bazy danych, Moduł zajęcia pasa drogowego. Instytut Inżynierii Lądowej, Politechnika Poznańska, Poznań 2012.
13. Szołtysek J.: Kreowanie mobilności mieszkańców miast. Wolters Kluwer Polska Sp. z o.o., Warszawa 2011.
14. TNS Pentor: Konsultacje społeczne budżetu miasta Poznania na rok 2012. Poznań 2011.
15. Transport - wyniki działalności w 2008 roku. Informacje i opracowania statystyczne. GUS. Warszawa 2009.
16. Zarząd Dróg Miejskich w Poznaniu, Archiwum baz danych 2012.
17. http://pl.wikipedia.org/w/index.php?Title=Gospodarka_przestrzenna&oldid=28980484", (17.08.2012).

Pavol Božek[2]

ROBOT CONTROL SYSTEMS USING HYBRID SENSORS

Abstract: The contribution deals with constructing an inertial navigation system (referred to hereafter INS) which will be used for the calibration of a robotic workplace. It analyses dynamic properties of the sensors of the inertial unit, e.g. gyroscopes and accelerometers. The implementation of the original system of controlling the robot on the basis of autonomous navigation systems is the dominant part of the paper. The calibration is necessary for adapting the simulation of a production device model to real geometric conditions. The goal is to experimentally verify the proposed inertial navigation system in real conditions of an industrial robot operation.
Keywords: Hybrid sensor, control, calibration, robot.

1. INTRODUCTION

Inertial navigation is the navigation based on uninterrupted evaluating of the position of a navigated object through the use of sensors that are sensitive to motion, i.e. gyroscopes and accelerometers, regarded as primary inertial sensors, or other sensors located on the navigated object. The position, orientation, direction and velocity of motion without external sources of information about the motion are constantly determined by means of the navigation computer and data from sensors. The actual position of the object is evaluated on the basis of knowledge of the initial position and subsequent continual measuring of the acceleration and direction of motion in a reference system. The aim of the research is to investigate and develop a new combined inertial navigation system based on electronic gyroscopes, magnetic and barometric sensors. The crucial activity is focused on three basic fields: the first goal is to analyze accelerometric and gyroscopic sensors and their possibilities of utilization for inertial navigation and the simulation of the effect of sensors with different metrological parameters and their effect on the properties of the proposed combined navigation system. The second goal is to optimize a specialized processor system for processing the data from the defined sensors in connection with controlling items of an industrial robot [3]. The author presents a proposal for an algorithm of combined navigation with respect to the used processor system. The third goal is to experimentally verify the proposed inertial navigation system in real conditions of an industrial robot operation.

2. BASIC PRINCIPLE OF AN INERTIAL SYSTEM

The inertial navigation system consists of a measurement unit containing accelerometers and gyroscopes and a navigation computer which evaluates data from measuring devices. In contrast to all the other navigation systems inertial navigation is completely autonomous, self-sustainable and independent of the surrounding environment, i.e. the system is resistant to outside influences such as magnetic disturbances, electronic interference and signal distortion. Computing operations in the inertial navigation system are based on Newton's law of motion.

For the purpose of navigation in a coordinate system it is necessary to keep the direction of motion in the direction of acceleration. This is not possible in practice and therefore sensors – gyroscopes - are used for detecting the rotary motion. Seeing that each free object in space has six degrees of freedom (internally mutually independent variables), the inertial navigation system usually consists of three gyroscopes and three accelerometers, where each pair (gyroscope, accelerometer) is able to record the rotation or acceleration in the direction of one axis that is perpendicular to the others. Of the six degrees there are three linear degrees of freedom, the translation in the X-axis, Y-axis and Z-axis, which indicate the position of the object and three degrees of freedom of rotation which indicate rotating around the X-axis, Y-axis, and Z-axis. Of the

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six degrees there are three linear degrees of freedom (Fig. 1), the translation in the X-axis, Y-axis and Z-axis, which indicate the position of the object and three degrees of freedom of rotation which indicate rotating around the X-axis, Y-axis, and Z-axis.

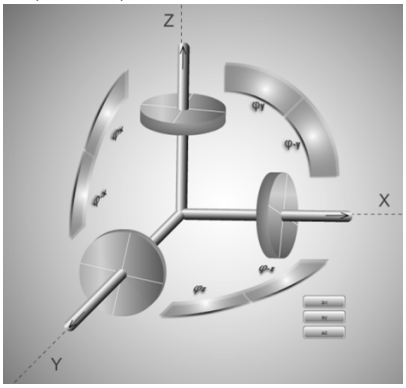

Fig. 1. Basic principle of INS activity

The inertial measurement unit (IMU) is an essential item of every INS. Sensors, whose output is influenced by the motion of the object on which the IMU is placed, are regarded as primary sensors of the IMU. Primary sensors in inertial navigation are sensors of angular velocity whose output signals, when integrated, are used for determining the orientation in space, and accelerometers whose output signals after precise compensation of gravitational acceleration and the Coriolis force can be integrated onto speed and position. Such an inertial measurement unit has six degrees of freedom. This means it enables to measure translational and rotary motion in three orthogonal axes. The accuracy of inertial sensors plays a key role in autonomous navigation. Errors of current inertial sensors have an approximate value of 0.01°/hour for gyroscopes and 100 μg for accelerometers [2]. The mentioned errors are integrated in time and cause the error of determining the position, which is expressed by the non-accuracy of measuring per hour, which is, however, minimal. Such high-power IMU are implemented only into inertial navigation systems for special use.

3. USING AN INERTIAL CONTROL SYSTEM

At the current space requirements and efficient use of space the robot is often forced to work in a cramped environment. The movement of the tool or handling of parts requires high accuracy. This implies great demands on the correct calibration of robotic devices.

When using INS the calibration process is considerably simplified. The benefits of verification and measurement, such as to prevent accidental collisions of robots, will be significant.

3.1 Theory of the Inertial System

The methodology is based on the 1st and 2nd law of Newton, which reflects the change in motion and acceleration vectors for the action of net force F on mass m (1st NL). The acceleration is proportional by direction and size to the vector of net force F (2nd NL):

$$\boldsymbol{F} = \boldsymbol{m} \,.\, \boldsymbol{a} \tag{1}$$

Thus, it is possible to obtain the value of instantaneous speed and to determine the trajectory by integrating over time::

$$v(t) = v_0 + \int_0^t a(t)dt \tag{2}$$

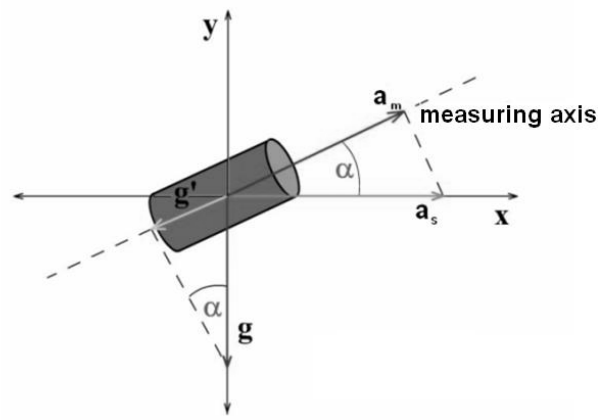

Figure 2. The effect of gravitational acceleration to measurement

$$s(t) = s_0 + \int_0^t a(t)d^2t \quad (3)$$

Because the acceleration vector is needed to capture acceleration in three mutually perpendicular axes, this allows the positioning in XYZ Cartesian coordinate system. During movement the acceleration of gravity also operates on the object and therefore must be eliminated from the measurement (Figure 2).

If the navigation axis (measurement axis of the accelerometer) is identified with the horizontal axis ($\alpha \neq 0$) then:

$$a_m = a_s . \cos\alpha \quad (4)$$

$$g' = g . \sin\alpha \cong g . \propto \text{ for } \alpha \to 0 , \quad (5)$$

where g is gravitational acceleration.

Relationship (5) also defines a single measurement error, which accumulates without compensation by applying relations (2) and (3). It is therefore necessary to measure the actual angle α with a gyro sensor. The requirement of eliminating gravitational acceleration is possible to overcome by the use of a stabilized base, or by using gyroscopes – through what is called an inertial navigation system without shaft.

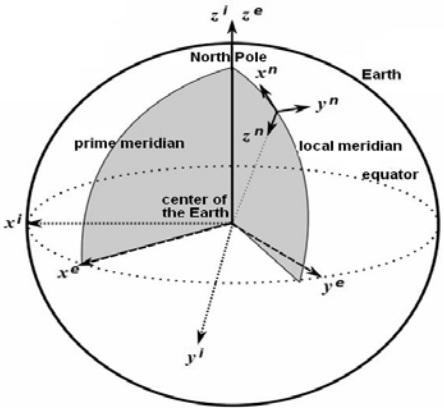

Fig. 3. Coordinate systems: inertial (i), Earth (e) and navigational (n)

Besides the coordinate system shown in (Figure 3), the moving body also has its own coordinate system (xb, yb, zb), whose angular orientation is measured with gyroscopes and the

acceleration is measured with accelerometers. In internal navigation it is therefore necessary to carry out conversions between coordinate systems. There are several useful mathematical methods, e.g.: direction cosine matrix, Euler angles or by using quaternions. When assuming the orientation of the body it is suitable to act compliant with the established guidelines of navigation, which are shown in Figure 4.

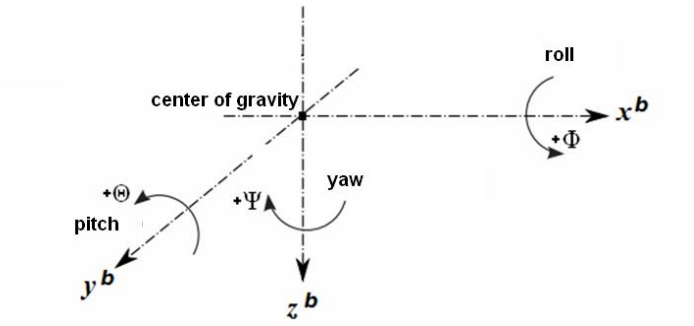

Fig. 4. Body coordination system

It is then possible to express the general rotation R_n^b with three partial rotations Rx, Ry, Rz around axis xb, yb, zb, which is the method of Euler angles:

$$@0\& - \sin(\&\cos(\,)]$$

$$R_y = \begin{bmatrix} \cos\theta & 0 & -\sin\theta \\ 0 & 1 & 0 \\ \sin\theta & 0 & \cos\theta \end{bmatrix} \qquad R_z = \begin{bmatrix} \cos\psi & \sin\psi & 0 \\ -\sin\psi & \cos\psi & 0 \\ 0 & 0 & 1 \end{bmatrix} \qquad (6)$$

$$R_n^b = R_x R_y R_z$$

Equations (6) represent the conversion from the navigation system (n) to the body coordinates (b). The conversion of coordinates of the body to the navigation system is carried out according to equation (7).

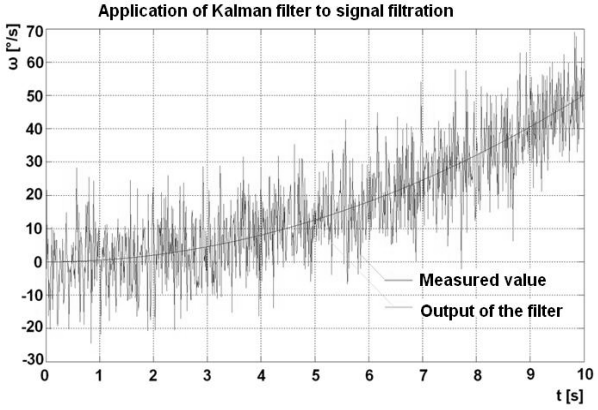

Fig. 5. Kalman filter signal filtration

$$R_b^n = R_n^{b\,T} = R_z^{\,T} R_y^{\,T} R_x^{\,T} \qquad (7)$$

In addition to basic errors resulting from measurement methods , in the process of navigation it is necessary to eliminate errors resulting from measuring accelerometers and gyroscopes and particularly distortion (bias), change the scale and noise. These errors vary depending on the quality (cost) of sensors. Noise of measurement sensors is a serious error to be eliminated in the process of navigation. The theoretical and practical work of navigation is presented by the above application of the Kalman filter (Figure 5) to eliminate this deficiency before processing.

The core of the inertial navigation system, the navigation computer, which processes the measured values of the measuring unit, first pre-processes them, then transforms them into the reference system and carries out the elimination of gravity and the Coriolis acceleration. It also calculates (equation (2) and (3)), based on the initial parameters (position, speed), the position of the navigated object. The contribution of the Coriolis acceleration to the navigation, as a result of the Earth's rotation, is reflected in the long navigation. Although the process of inertial navigation seems simple in principle, it implies solving three differential equations.

4. APPLICATION POSSIBILITIES

In contemporary space requirements and the effective use of space the robot often has to work in confined conditions. Moving a tool or manipulating with parts requires great accuracy. This results in the enormous demands for correct calibration of a robot device.. The calibration will fundamentally be simplified by using the INS in the field of calibration. The contribution to the field of control and measurement, for example, preventing the accidental collisions of robots, will be significant. One may expect further contributions to the original proposal of the algorithm of combined navigation with respect to the applied processor system and its optimization in the use of robotics, as well as in connection to the operation of robots mainly on their safety and economics. The proposed procedures - modern methods, analyses and simulations with the use of modern software tools such as OrCAD, Matlab, Multisim will be used in mentioned fields [5]. The shape of stationary magnetic fields will be investigated on an experimental laboratory model which uses an area positioning system. Possibilities of using magnetoresistance sensors and barometric sensors will be verified within the sensor system [4]. The original own algorithms will be applied in the course of processing the data from the sensors. The solution will use planned experimental verification of the navigation system first on a model robot, and later in real operational conditions of a robot device, together with evaluating all arising uncertainties.

The output will ultimately be the actual original construction of the navigation system applicable in the operation of robots – an elaboration of the study, with the possibility of implementation of inertial navigation for the calibration of robotic workplaces, a system of control with the possibility of avoiding collisions during the operation.

5. CONCLUSION

The possibilities of applying inertial systems are directly proportional to the advance in their development. The ability of precisely measuring the position of the robot mainly in necessarily and regularly repetitive calibration is increased by this. The implemented INS is able to measure acceleration and slewing of an observed point located on the arm and to use this informationfor determining the position of the robotic arm in space [1].

When hardware and software is configured, it will alow for achieving the needed values of measuring the position,even on a 3D surface.

REFERENCES

1. King A.D: Inertial Navigation - Forty Years of Evolution. GEC Review 13, 2010, pp.141, ISSN 0267 9337.
2. Sotak M. et al.: Integration of navigation systems, Košice, 2006, ISBN 80-969619-9-3.

3. Zolotova, I., Flochova, J., Ocelikova, E.: Database Technology and Real Time Industrial Transaction Techniques in Control, Journal of Cybernetics and Informatics, Volume 5, Slovakia, Bratislava (2005), ISSN 1336-4774. pp. 18-23. www.ski.sk/yournal/index.php
4. Nikitin Y.R., Abramov I.V.: Models of information processes of mechatronic systems diagnosis University Review, 2011, pp. 12–16, ISSN 1337-6047.
5. Al-Akkad M. A., Kuchuhanov V. N.: 3D Model construction from two orthogonal photos, High technologies – 2004 international forum: Proceedings of International Scientific-technical Forum, Izhevsk, 2004. pp. 3-12.

Łukasz Bryl[3]

THE INFLUENCE OF CRISIS ON MULTINATIONAL CORPORATIONS IN NEW ECONOMY

Abstract: This paper's discussion focuses on the phenomenon of the global financial crisis impact on the largest multinational corporations from the dominant economic sectors. Based on selected sectors in terms of the largest market capitalization rankings by the Financial Times Global 500, the author attempts to show how the individual values have changed within the period from 2008 to 2012, including: market capitalization, turnover and profit of sectors. Moreover, presented is the correlation between these variables as well as its strength. In addition, in the following paper, the author has isolated sectors which are related with so-called new economy to examine whether these sectors are less prone to the phenomenon of the crisis than the other sectors.
Keywords: new economy, multinational corporations, ICT, crisis.

INTRODUCTION

The aim of this work is to study the impact of the global financial crisis on the market value, turnover and profits of the largest sectors of the global economy in terms of market capitalization, with a particular emphasis on the industries related to the so-called new economy. The author makes such an attempt due to his own research interests focused around the issue of the new economy and its impact on the activities of multinational corporations and because of the topicality of the issue. Observation has prompted the author to seek answers to the question whether there are sectors of modern economy that are susceptible to the crisis (manifested in the decline of market value, turnover and profit) to a lesser extent than others. The inspiration of behind the research problem is the increasing value of the parameters mentioned above in case of the so-called sectors of new technologies. Companies such as Apple and Google can be used for research, as they record above-average growth in the turnover, profits and market capitalization. At the same time among the companies that are experiencing deterioration are firms from the banking sector (responsible for causing the global financial crisis), and producers of oil and gas (due to lower turnover and lower prices for resources, resulting from economic activity reduction).

SCIENTIFIC HYPOTHESIS

The study group included 12 sectors of the global economy. The author has formulated the following research hypothesis:

In the sectors related to the new economy higher market value, turnover and profit than in other sectors have been observed in 2012 (compared to 2008) .

For the purposes of this paper, the author adopts the following definition of the new economy: the new economy is the effect of structural changes in economic activity due to the mass deployment of information technologies including: technical equipment (hardware), software and tools and means of communication [4]. In the literature, the concept of the new economy is often equated with the term knowledge-based economy. This approach is not entirely correct, the new economy is a narrower concept of the term knowledge-based economy because it refers only to the segments of the economy that are formed by information technologies. It should be noted, however, that the term is often treated as synonymous with knowledge-based economy [5]. It should also be added that the new economy forms, in addition to information technologies, communication technologies (telecommunications). In turn, the knowledge based economy (knowledge-driven economy - concept introduced by the OECD) is based on the production, distribution and use of

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knowledge and information (translation added) [9]. Companies involved in the new economy have been of great interest to researchers since the late 80's of the 20th century (information revolution). This interest results from the unique features and innovative management methods. The following features are being mentioned: decreasing average costs and reducing the average prices of goods [1], information as a product and virtuality of actions.

The study presents data (market value, turnover, profit) for 12 sectors of the global economy from two periods of time: 2008 and 2012.

The research hypothesis, based on the analysis of the data does not have territorial restrictions, as part of the selected 12 sectors may be any company, providing that it has sufficiently large market capitalization (the minimum value of market capitalization in the listing of the Financial Times - the last place in the listing in 2012 was Swedbank with the value of 17 942.1 bln USD). However, in reality it is dominated by companies from developed countries (including the newly industrialized Asian countries) and from developing countries (classification of countries according to the guidelines of the International Monetary Fund [8]).

In order to verify the research hypothesis, the Financial Times Global 500 listings for 2008 and 2012 have been used. This listing is compiled annually by the British newspaper Financial Times and includes 500 companies with the largest market capitalization. Moreover four sectors related to new technologies have been identified. Verification of the hypothesis has been conducted in four stages. In the first stage market value, turnover and profits have been calculated for each of the 12 sectors in 2008 and 2012. In the second stage, market value, turnover and profits in 2008 have been compared with the same parameters for 2012. In the third step the correlation analysis between the market value and turnover and profits has been presented. The fourth step is the attempt to answer the question, which of the sectors (and to what extent) have been affected by the global financial crisis, with particular emphasis on the industries related to the new economy.

DETAILED DESCRIPTION OF RESEARCH ISSUE AND RESULTS

In the study, 12 sectors of the global economy with the highest 2012 total market value have been selected, . In the following paper only publicly traded companies are analyzed. The value of the stock market in 2008 has been prepared as of 31st March 2008, while the market value for 2012 refers to the market capitalization made on 30th March 2012. This approach allows to see changes in the world economy that have taken place over the four years in the period 2008-2012. Analysis of the base period pertains to the period preceding the beginning of the global financial crisis (as the beginning of the crisis the author points to the generally accepted date of 15th September 2008 - the bankruptcy of U.S. investment bank Lehman Brothers). In contrast, the final analysis of the current situation (due to the availability of reliable data) has been recognized as of 30th March 2012. However, it should be noted that these dates refer to market value only. Other indicators analyzed: turnover and profits refer to the full year, hence the Financial Times Global 500 listing in year 2008 contains data on turnover and profits for 2007, while a summary of the year 2012 refers to the year 2011. This choice appears to be factually correct and justified to measure the changes that have occurred in the market value, turnover and profits due to the global financial crisis.

Sectors that have been identified for the study are the following: banking, oil and gas producers, pharmaceuticals and biotechnology (in total), technology hardware and equipment, software and computer services (in total), general retailers, mobile telecommunications, mining, automobiles and parts (in total), beverages, fixed line telecommunications and chemicals. The selection of this group is purposeful - it consist of the first 12 largest sectors in terms of market capitalization in 2012, according to the Financial Times Global 500 listing. A detailed list of the number of corporations comprising different sectors has been shown in Table 1.

Table 1. Market value of 12 researched sectors in 2008 and 2012

Sector	Market value 2008 (bln USD)	No. of companies 2008	Market value 2012 (bln USD)	No. of companies 2012	MV Change (%)
Banks	4.115.611,6	71	3,836,035.8	71	-279575,8 (-6,8%)
Oil and gas producers	3.890.165	43	3,272,340.3	43	-617824,9 (-15,9%)
Pharmaceuticals and Biotechnology	1.629.568,7	23	1,629,229.6	22	-339,1 (-0,02%)
Technology Hard-ware and Equipment	1.237.749	18	1,540,460.8	16	+302711,8 (+24,5%)
Software and Computer Services	821.001,6	10	1,140,034.0	13	+319032,4 (+38,9%)
General retailers	597.683,7	12	897,333.8	17	+299650,1 (+50,1%)
Mobile Telecommunications	934.916,8	16	869,618.7	16	-65298,1 (-6,98%)
Mining	943.912,9	13	820,203.3	14	-123709,6 (-13,1%)
Automobiles and parts	594.736,5	10	798,472.9	17	+203736,4 (+34,3%)
Beverages	550.738,4	10	790,707.2	12	+239968,8 (+43,6%)
Fixed line telecommunications	1.101.733,1	19	734,313.2	15	-367419,9 (-33,4%)
Chemicals	622.320,4	15	664,850.5	18	+42530,1 (+6,8%)
Total	17040137,7	260	16993600,1	274	-46537,6 (-0,27%)

Source: Own work based on: Financial Times Global 500 2008 and 2012 [2,3,6,7]

The researched group of corporations included slightly more than half of all businesses in the Financial Times listing (54.8 per cent in 2012) and in terms of total market capitalization accounted for 67.08 per cent (169 93,600.1 bln USD) Market value of different sectors in total has been shown in Figure 1.

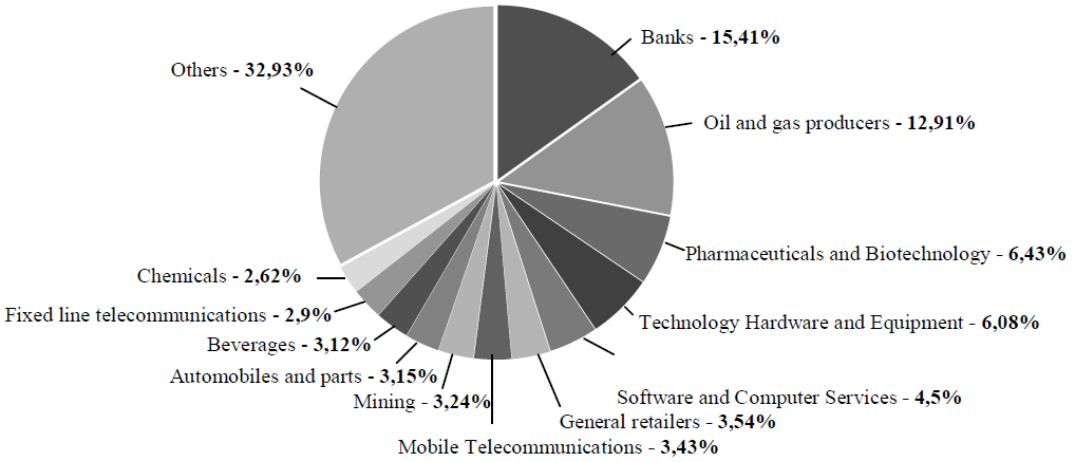

Fig. 1. Market capitalization of researched sectors in total capitalization (Financial Times)

Source: Own work based on Financial Times Global 500 2012 [2,3,6,7]

Corporations associated with the new economy were companies from the following four sectors: technology hardware and equipment, software and computer services, mobile telecommunications and fixed line telecommunications. This group included a total of 63 companies in 2008 and 60 in 2012. In 2012, the total market capitalization amounted to 4,284,426.7 bln USD, which accounted for a substantial proportion of the study group at the level of 25.21 per cent.

Table 2 shows the turnover and profits of companies from each industry sectors and the increase/decrease in turnover and profits in 2012 compared to 2008.

Table 2. Turnover and profit of 12 largest sectors in 2008 and 2012.

Sector	Turnover 2008 (bln USD)	Profit 2008 (bln USD)	Turnover 2012 (bln USD)	Profit 2012 (bln USD)	Turnover Change (%)	Profit Change (%)
Banks	N/R	344340	N/R	319466,6	N/R	-24 873,4 (-7,22%)
Oil and Gas producers	3136483,5	329450,2	4019189	373750,2	+ 882705,5 (+28,1%)	+44 300 (+13,45%)
Pharmaceuticals and Biotechnology	522571,9	97502,8	580101,1	103565,3	+57529,2 (+11,01%)	+6062,5 (+6,22%)
Technology Hardware and Equipment	651833,5	73647,1	752298,7	89924,6	+100465,2 (+15,41%)	+16 277,5 (+22,1%)
Software and Computer Services	221072,9	39977,1	304757,3	71149,3	+8368,4 (+37,85%)	+31172,2 (+77,98%)
General retailers	808067	31911,7	1 030 426,6	45828,6	+222359,6 (+27,52%)	+13 916,9 (+43,61%)
Mobile Telecommunications	347523,2	27034,6	544299,9	66155,2	+196776,7 (+56,62%)	+ 39 120,6 (+144,71%)
Mining	203383,4	51209,3	514636,7	84115,7	+311253,3 (+153,04%)	+32906,4 (+64,26%)
Automobiles and parts	1101745,2	55405,9	1531550,5	101826	+429805,3 (+39,01%)	+46 420,1 (+83,78%)
Beverages	187593,1	26505,3	251018,8	38062	+63425,7 (+33,81%)	+11 556,7 (+43,6%)
Fixed line telecommunications	804814,4	86509,6	693841	35993,7	-110973,4 (-13,79%)	-50 515,9 (-58,39%)
Chemicals	278031,5	41899,9	476603,2	46371,2	+198571,7 (+71,42%)	+4 471,3 (+10,67%)
Total	8263119,6	1205394	10698722, 8	1376208	+2435603 +29,48%	+170814,9 +14,17%

Source: Own work based on: Financial Times Global 500 2008 and 2012 [2,3,6,7]

The market value of all industry sectors in 2012 has decreased compared to 2008 by 46,537.6 bln USD, but the change was almost imperceptible (0.27 per cent). However, distribution of decreases / increases of the market value was very uneven. As a result of further analysis, it was found that in terms of market capitalization over half of the sectors recorded a decrease in value. The largest decreases (in absolute and percentage terms) were oil and gas producers - 617,824.9 bln USD (a decrease of 15.9 per cent compared with the value in 2008). Another sector which has lost most of the value was the telecommunications industry: loss of 367,419.9 bln USD (33.4 per cent). Large losses of market value were also observed in the case of the banking sector: 279,575.8 bln USD (6.8 per cent). Quite a strong drop in the sector was reported by mobile telecommunications, a decrease of 65,298.1 bln USD (6.98 per cent). The last sector with a negative growth rate of the market capitalization were the pharmaceutical and biotechnology industries (decrease by 339.1 bln USD), but in percentage terms the decline was almost negligible and amounted to only 0.02 per cent. However, the sectors that despite the crisis increased the aggregate market value were: technology hardware and equipment (increase of the market value by 302,711.8 bln USD, an increase of 24.5 per cent compared to 2008), software and computer services (increase by 319,032.4 bln USD, 38.9 per cent), general retailers (increase by 299,650.1 bln USD, 50.1%), automobiles and parts (increase by 203,736.4 bln USD, 34.3 per cent), beverages (increase by 239,968,8 bln USD, 43.6 per cent) and chemicals (increase by 42,530.1 bln USD, 6.8 per cent).

Since market capitalization is only one of the indicators of the financial health of companies, a further part of the analysis will be focused on turnover and profits in the surveyed sectors. It was

observed that the aggregate value of the turnover and profits of all surveyed sectors has increased in 2012 compared to 2008 by 2,435,603 bln USD (an increase of 29.48 per cent) and the profits by 170,814.0 bln USD (14.17 per cent increase). Moreover, in all of the sectors increase in turnover and profits, compared to the values from the period before the crisis, was noticed . The exceptions were the fixed line telecommunications sector and the banking sector. The last one was excluded from the analysis of turnover (no data in the Financial Times listing due to write-offs problem). Banks recorded a reduction in total income in 2012 compared to 2008 (a decrease of the level of aggregate income by 344,340 bln USD to 319,466.6 bln USD). At the same time, the average increase in turnover among sectors outside the banking and telecommunications sector amounted to 47.38 per cent, while average profits growth was at 51.04 per cent. Among the sectors of the new economy (four), three of them reported an increase in turnover and profits. Those were: technology hardware and equipment (turnover growth of 15.41 per cent and profit growth of 22.1 per cent), software and computer services (turnover growth by 37.85 per cent, profit growth by 77.98 per cent) and mobile telecommunications (turnover growth by 56.62 per cent, profit growth by 144.71 per cent). The average value of turnover growth in this group was 36.63 per cent, while the average value of profit growth was 81.59 per cent. The only sector related to the new economy in which there was a decline of turnover and profits compared with the period before the crisis was the telecommunications sector (a decrease in turnover by 13.79 per cent, decrease of profits by 58.39 per cent).

Furthermore, in all cases, the increase in turnover resulted in an increase in profits. In the case of the fixed line telecommunications sector turnover decline caused a decrease in profits. In the case of the three sectors (oil and gas producers, pharmaceuticals and biotechnology and chemicals) turnover growth was more than proportional than the increase in profits. In other cases, the opposite situation was observed - an increase in income was more than proportional than the increase in turnover. Based on the analysis, in eight cases a correlation between the increase in turnover (profits) and the increase in stock market value was noted . In one case there was a correlation between the decline in turnover and profits and market value decline. In two cases, the turnover and profit growth caused a decrease in market value. Relations between the market value, turnover and profits has been comprehensively shown in Table 3.

Table 3. The influence of crisis on market value, turnover and profits - by sectors.

Sector / Crisis influence on	Market value	Turnover	Profits
Banks	-	N/R	-
Oil and gas producers	-	+ +	+
Pharmaceuticals and biotechnology	0	+	+
Technology hardware and equipment	+ +	+	++
Software and computer services	+ +	+ +	+++
General retailers	+ + +	+ +	++
Mobile telecommunications	-	+ + +	+ + +
Mining	-	+ + +	+ + +
Automobiles and parts	+ +	+ +	+ + +
Beverages	+ +	+ +	+ +
Fixed line telecommunications	- -	-	- - -
Chemicals	+	+ + +	+

Source: Own work based on Table 1 and 2

Description:
"-" percentage decrease between: 1-20%, "--" percentage decrease between: 21-50%,
"0" - percentage change not larger than 1%, "+" - percentage growth between: 1-20%,
"+ +" - percentage growth between: 21-50%, "+ + +" percentage growth larger than 51%.

The data presented in Table 3 shows that the impact of the global financial crisis on the market value, turnover and profit in the most significant sectors of the world's economy has been uneven. Meanwhile, in a separate group of sectors related to the new economy the following has been noted:

1) in 3 of 4 sectors – an increase of turnover and profits;
2) in 2 of 4 sectors – an increase of the market value;
3) increase of turnover and profits coincides with the general trend in the study group (10 to 12 sectors increased turnover and profits);
4) in 3 of 4 sectors there was a correlation between the change in turnover and profits and the change in market value;
5) in three sectors in which there was an increase in turnover, average turnover growth was less than the average income growth in all sectors in which there was an increase;
6) in three sectors in which there was an increase of profit, average profit growth was higher than the average earnings growth of all industry sectors in which there was an increase.

To sum up, the hypothesis formulated in the work cannot be unambiguously verified.

CONCLUSIONS

The hypothesis could not be unambiguously verified as positive due to different scores in the market value of two of the four sectors related to the new economy. However, turnover and profits of three of the four sectors reported growth, while turnover and profit growth also occurred in most other sectors, so part of the hypothesis, promoting the idea of a different impact of the crisis on sectors related to the new economy than on other sectors, could not be positively verified. Deductive conjecture, based on selected examples of companies (Apple, Google), is not mandatory in the case of other companies, and therefore the sector. It should also be noted that in the sectors related to the new economy there is a vast diversity and the largest differences occurred in the telecommunications sector, which recorded (in contrast to other sectors within the group) a decline of market value, turnover and profits. In addition, the work was not to explain the reasons for the increase or decrease in market value, turnover and profit sectors. The analysis is limited only to a quantitative study.

Despite all this, the paper is an original contribution to the field of science, supported by empirical research. The results may be a valuable contribution to economic policy. The author would also like to note that further analysis could be developed and enhanced by additional sector parameters, such as: number of employees, stock price, the value of assets, dividend, price/earnings ratio, R&D spending.

REFERENCES

1. Cox W.M, Alm R.: The New Paradigm. Federal Reserve Bank of Dallas, 1999 Annual Report, p. 11.
2. Financial Times Global 500, 2008: www.ft.com/intl/cms/889d77f0-4142-11dd-9661-0000779fd2ac.pdf [20.10.2012].
3. Financial Times Global 500, 2012: www.ft.com/intl/cms/a81f853e-ca80-11e1-89f8-00144feabdc0.pdf [20.10.2012].
4. Grudzewski W.M., Hejduk I.K.: Przedsiębiorstwo wirtualne. Difin, Warszawa 2002, p. 24.
5. Kamińska T., Frycy J., Majecka B. (ed.), Efektywność gospodarki opartej na wiedzy. Teoria i praktyka. Wydawnictwo Uniwersytetu Gdańskiego, Gdańsk 2007, p. 22.
6. Market value by sector 2008: www.ft.com/intl/cms/8cb08ab2-4142-11dd-9661-0000779fd2ac.pdf [20.10.2012].
7. Market value by sector 2012 www.ft.com/intl/cms/a858f40e-ca80-11e1-89f8-00144feabdc0.pdf [20.10.2012].
8. Międzynarodowy Fundusz Walutowy www.imf.org/external/pubs/ft/weo/2008/02/weodata/groups.htm#ae [20.10.2012].
9. OECD. Paris 1996: The knowledge-based economy, p.7.

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ANALYSIS OF LIGHTING INTENSITY IN A MANUFACTURING FACTORY DURING PRODUCTION OF AN INNOVATIVE PRODUCT USING THE L.E.S.T. METHOD

Abstract: The topic of this article is to assess the ergonomic parameters of lighting in the production area in the production of innovative products. The objective was to obtain as much information as possible about the issue and also provide a measure for illumination in a manufacturing factory.
Keywords: Lighting Intensity, LEST Method.

INTRODUCTION

For the successful operation of the market, the company has to know the needs of the customers. The innovation ability is now considered as a condition of ultimate competitiveness in all types of businesses. In the manufacturing of a product the most important are the employees and their health. In order to maintain their health it is necessary to provide optimum working conditions. The topic of this article is to assess the ergonomic parameters -of lighting in the production area in the production of innovative products.

CHARACTERISTICS OF PRODUCT

The characteristics of the studied product can be described as a mobile domestic lift. The user simply gets on the platform, presses a button on a remote and thanks to a scissors system coupled with an engine the platform goes up. The maximum height is one meter because users don't need to be lifted higher in a house, and if you add your own height to this, it's sufficient.

The idea is to propose a product which improves the daily life of aged people. The safety tools of the new product include:

- a wheel auto lock (to prevent the product from moving during use),
- a safety chain (to prevent falls),
- a support handle (to increase stability),
- an anti-slip floor (to prevent slipping).

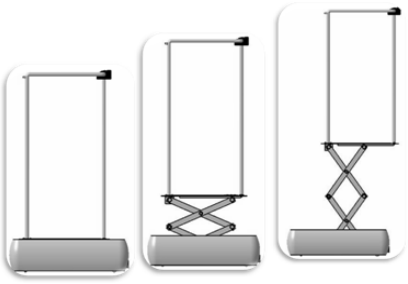

Fig. 1. Product design [own processing]

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The motor's rotation rotates the screw and pushes the floor up thanks to the scissors system.

Fig. 2. Principle product operation [own processing]

Table 1. Manufacturing process

	Quantity	Items involved	Specifications
Cutting machine	2	Bars and handles	The cutting process chosen is a simple one because the cutting part requires a basic process without any complicated phases
Welding machine	2	The body and the handle	The welding process chosen is the MIG process, very extremely suitable for welding aluminium efficiently. The welder will use an aluminium wire to weld each bar together.
Milling and drilling machine	2	The rectangular piece and the body	This process will be used to manufacture the rectangular piece using the milling process, but also to drill and to tap the body. All these processes are fitted on the same machine.
Bending machine	1	Handles	The chosen part of this process will be solely used to bend the handle thanks to a machine equipped functioning with three rollers adapted to the handles' dimensions (curves) ang operating at the same time to bend the handle.

The body is made of standard rectangular bars cut and welded together: first by a cutting machine and then by a welding machine (MIG process).

The handle is made of standard aluminium circular bars bended by a bending machine and then welded and assembled altogether.

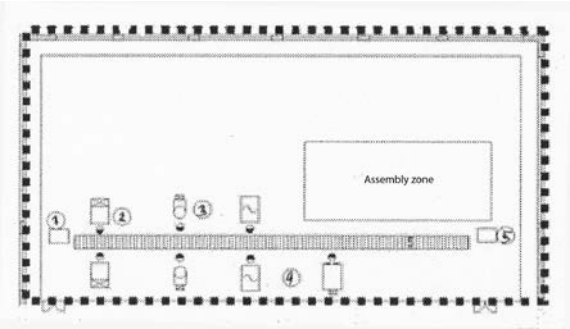
FACTORY LAYOUT

For the layout of the machines, the company has chosen to mix two different systems:

The first one is the functional system. It consists of regrouping similar machines in the same zone of production. This is the first system that the company has used to place the machines in the factory.

The second one is to form a line that is logical in terms of the production process. This system is the second system that is used to place the machines.

The above factory layouts are drawn according to the choices previously made in the manufacturing part.



1. Palette of material
2. Cutting station
3. Milling and drilling machine
4. Welding station and bending machine
5. Roller transporter

Fig. 3. Layout of manufacturing factory

Research work took place in manufacturing factory (identification area). Objectives:

1. Detect the factors that cause visual fatigue in the visual inspection stations.
2. Determine whether conditions of operation in the inspection area are adequate.
3. Find out whether lighting in the inspection area meets the requirements of PC hardware weight reduction.

LIGHTING INTENSITY

Proper lighting intensity can improve the task performance of the operators, the appearance of the area and also positively affect the worker's psychology.

The lighting levels were measured with a Multi-Function Environment Meter in each inspection area in four spots: to the left, to the right, in front of and behind the area where the operator is located.

MEASUREMENT PROCESS

The measurement process covered a complete working day. Visual acuity and chromaticity were measured. Tests were initially performed at six randomly selected stations. These measurements took place from 6:00 a.m. to 9:00 a.m. and from 12:00 p.m. to 15:00 p.m. The room was divided into 21 measurement sections.

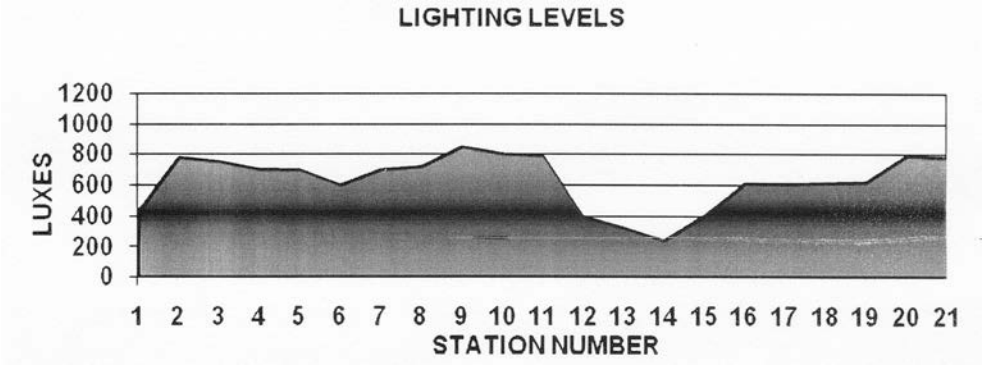


Fig. 4. Measurement results

GLOBAL EVALUATION USING THE L.E.S.T. METHOD [3]

Finally, for performinga general evaluation of the working conditions, the L.E.S.T. method was used. The method presents an evaluation of the working conditions as objective and global as possible, establishing a final diagnose that indicates whether each of the considered situations in the position is satisfactory, unpleasant or harmful.

For the diagnosis of the situation, the method considers 16 variables grouped in five aspects,

as follows: physical environment, physical load, mental charge, psychosocial aspects and working time. The evaluation is based on the scores obtained for each of the considered variables. These variables are:

the lighting level at the working station, the average general lighting, contrast level in the working station, perception level required for the task, the presence of artificial light and the existence of dazzling sources.

Using information obtained through the study and observation in situ, different values are calculated for each variable, which oscillate between 0 and 10, and are then interpreted as follows:

Table 1. Scoring system in the L.E.S.T. method [3]

SCORING SYSTEM	
0, 1, 2	Satisfactory situation
3, 4, 5	Low discomfort
6, 7	Moderate discomfort. Fatigue risk
8, 9	Strong discomfort. Fatigue
10	Harmfulness

The following figure illustrates the values obtained for the factors in different dimensions.

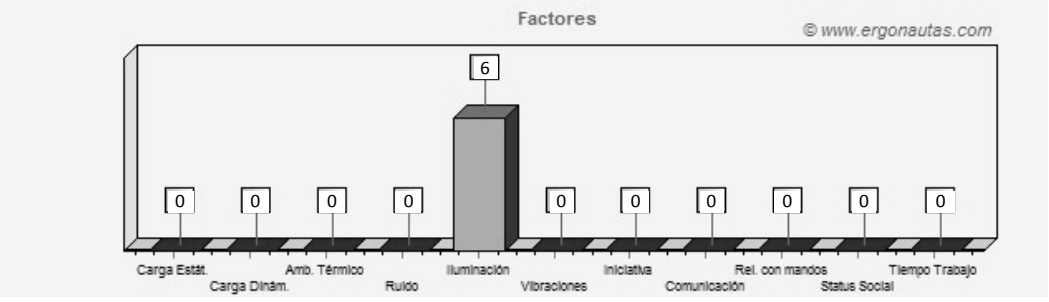


Fig. 5. Results provided by using the L.E.S.T. method [3]

Data was subjected to evaluation with the L.E.S.T. method, resulting in a grade of 6 (Moderate discomfort. Fatigue risk), which means that the lighting conditions can generate moderate to high discomfort and the risk of visual fatigue is present. A relation with factors that present a higher number of errors, less visual acuity and lower capacity to distinguish hues, is evident.

CONCLUSION

In a working place, illumination remains mainly a part of ergonomic guidelines. Besides the fact that light does influence personal well-being and health, it has also a positive impact on workers' motivation and performance. Lighting in the working place is based on ergonomic principles and has to meet safety requirements within the scope of occupational health and safety rules. The appropriate use of daylight and artificial light in a manufacturing factory can have a strong impact on psychic-emotional factors.

REFERENCES

1. Kováč J., Svoboda M., Líška O.: Automatizovaná a pružná montáž. Košice. VIENALA 2000, 190 s., ISBN 80-70999-504-1.

2. Benefits of ergonomic simulation. In: Applied Manufacturing Technologies. www.appliedmfg.com/Downloads/Benefits_of_ergonomic_simulation.pdf
3. Diego-Mas J., Sabina A.: Lest (Laboratorio de Economía y Sociología del Trabajo) www.ergonautas.upv.es/metodos/lest/lest-ayuda.php.
4. Karwowski W., Parsaei H.R., Wilhelm M.R.: Ergonomics of hybrid automated systems.

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Jaroslav Jánský[6]

THE ASSESSMENT OF THE WOODWORKING INDUSTRY DEVELOPMENT IN CONDITIONS OF THE CZECH REPUBLIC

Abstract: The paper analyses the development of the woodworking industry in the Czech Republic from 2005 to 2010. The objective of this paper is to assess the influence of the economic crisis in relation to the development of a reference sector. The assessment of the woodworking industry is based on indicators of industrial production, number of business entities, employment in the sector, revenues, incomes, costs and profit. The paper also analyses indicators of added value, return of investment and foreign trade.
Keywords: woodworking industry, index of industrial production, employment in the woodworking industry, profitability, costs, the Czech Republic.

INTRODUCTION

The wood industry is one of the smaller industrial sectors compared to other manufacturing industries. An undoubted advantage of this sector is its permanently recoverable resource base of local origin, i.e. wood mass. Wood is harvested from forests that extend for 2 657 376 hectares of forest area, which represent more than 33,69 per cent of the country's territory (ISPŽP, 2010). A positive aspect is the reduction of wood mass extraction in Czech forests by 12 per cent, so stocks of wood are constantly increasing. Increment of wood in forests of the Czech Republic is permanent and has been exceeding extraction since the 70's. The Czech Republic has a leading position in Europe in terms of wood production intensity per 1 inhabitant, which is of about 1.4 m^3 and 5.9 m^3 per 1 ha of forest land.

Authors dealing with analysis of the woodworking branch are: Hrubec (2002), Kupčák (2002), Dudík (2002), Dejnožka (2002). The wood industry has a long tradition. At the turn of the century it had undergone a series of changes (from property rights and management through extensive restructuring to entry of foreign capital) as Kalousek, Lenoch, Štork (2007) state. The advantage of the wood industry in the Czech Republic is mainly the fact that it has qualified, skilled and relatively cheap labour force with respect to EU. On the other hand, the negative aspect of the wood industry is the high number of defunct enterprises, those in the process of liquidation or in bankruptcy proceedings (an average of 300 entities).

THE AIM AND METHODOLOGY

The aim of the paper is to assess the development of the woodworking industry in the Czech Republic in the years 2005-2010. Since 2007 the woodworking industry encompasses many disciplines, according to the Classification of Economic Activities CZ-NACE (formerly the Industrial Classification of Economic Activities). The CZ-NACE includes the production of wood, cork, wicker and straw products, except furniture, which fall into the CZ-NACE 16th category, and are divided into:

CZ-NACE	16.1	Sawmilling and plaiting of wood,
	16.10	Sawmilling and plaiting of wood,
CZ-NACE	16.2	Manufacturing of products of wood, cork, straw and plaiting materials,
	16.21	Manufacturing of veneer sheets and wood-based panels,
	16.22	Manufacturing of assembled parquet floors,
	16.23	Manufacturing of other builders' carpentry and joinery,

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16.24 Manufacturing of wooden containers,
16.29 Manufacturing of wood, cork, straw and plaiting materials, except furniture - with the exception of the processing of raw cork.

The analysis of the woodworking industry is based on indicators of revenues, output, sales, costs, personnel costs and profit. Furthermore, added value, profitability, investment and foreign trade are also analysed. The paper also examines the development of an index of industrial production, the number of business entities and employment in the sector.

RESULTS AND DISCUSSION

In order to assess the development of the woodworking industry the period of 2005-2010 is analysed. The woodworking industry is more concentrated in small and medium businesses than any other sector. Their advantage is flexibility and ability to quickly adapt to the requirements of customers to create products in small batches. At the same time, the disadvantage is the highvulnerability of such firms. Those firms are subject to fluctuations on the market and due to their capital inadequacy they are quickly created or destroyed.

Basic characteristics of the production

Since 2005 - 2007 the woodworking industry has been progressively increasing its index of industrial production. In 2008 the index decreased by more than 10 percentage points, mainly due to the global crisis. Since 2009 the index has been increasing again. This index of industrial production is shown in Table 1.

Table 1. Index of industrial production

	Index of industrial production					
	2005	2006	2007	2008	2009	2010
CZ – NACE 16th	106.3	108.1	108.2	97.4	96.6	101.3

Source: Czech Statistical Office

Table 2 describes the development of the number of enterprises in the sector. From this it follows that in 2005 to 2010 the number of registered business units increased by 3.5 per cent, while production of wood, cork, straw, plaiting products (except furniture) decreased by 5 per cent.

Table 3 presents selected employment indicators of the CZ – NACE 16th. The data show that number of employees dropped by about 8,000 people. The number of active entrepreneurs recorded a decrease of 4,000 active entrepreneurs in 2007 compared to 2005. And subsequently it equalized to the initial value in 2005. In the same table we can see that the average wage per employee increased significantly: by 3,636 CZK from 2005 to 2010.

Table 2. Number of business units in sector CZ-NACE 16th

Sector	2005	2006	2007	2008	2009	2010
CZ – NACE 16.1	2,363	2,409	2,449	2,548	2,549	2,520
CZ – NACE 16.2	25,008	24,651	24,870	24,780	25,326	25,804
CZ – NACE 16 in total	27,371	27,060	27,319	27,328	27,875	28,324

Source: Czech Statistical Office

Table 3. Selected employment indicators in sector CZ – NACE 16th

Indicator	2005	2006	2007	2008	2009	2010
Number of employees (in thousands)	69	67	66	66	61	61
thereof:						
Number of active entrepreneurs (in thousands)	24	22	20	21	22	24
Average registered number of employees (in thousands)	45	45	45	44	39	37
Average number of employees per enterprise	3	2	2	2	2	2
Average monthly wage	12,873	13,834	14,721	15,620	15,531	16,512

Source: Czech Statistical Office

BASIC ECONOMIC CHARACTERISTICS

Trends of revenues and costs in the woodworking industry are shown in Table 4 and Graph 1. In the analysed period revenues of the woodworking industry reached their maximum in 2007. In the following two years revenues have decreased due to the economic crisis. A slow increase in revenues of 1.1 per cent occurs in 2010. The revenues in the analysed period are structured to reflect sales of outputs and goods. The sales of outputs and goods are structured to reflect the sales of own products and services and sales of goods.

De facto costs in sector CZ – NACE 16th showed similar trends to revenues. An exception is the year 2010, when the costs dropped below the 2005 level. In the analysed period costs are structured to reflect the costs of goods and services, costs of goods and services sold in the same condition and personnel costs.

Table 4. Selected indicators of economic base CZ – NACE 16th

	2005	2006	2007	2008	2009	2010
	in millions CZK					
Revenues in total	87,879	98,935	105,678	102,795	88,318	89,301
thereof:						
Sales of outputs and services	82,018	92,944	100,696	95,953	83,776	84,688
Sales of own products and services	73,686	83,372	93,678	88,612	76,585	77,598
Sales of goods	8,331	9,572	7,018	7,341	7,191	7,090
Costs in total	82,980	91,678	97,401	96,414	84,380	82,346
thereof:						
Costs of goods and services in total	64,813	72,820	78,982	75,591	65,561	64,048
Costs of goods and services sold in the same condition	7,569	8,520	6,489	6,786	8,475	8,507
Personal costs	9,664	10,398	11,106	11,822	10,874	10,253
Profit	4,899	7,257	8,277	6,381	3,938	6,953

Source: Czech Statistical Office

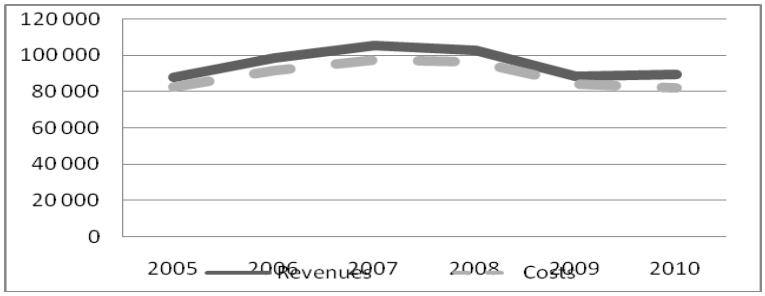

Fig. 1. Costs and revenues of the woodworking industry

Source: Czech Statistical Office

Table 5 presents the sales of own products and services. Development of sales shows a fluctuating trend in the analysed period. The highest level of sales was achieved in 2007, while beyond this year the sales have been declining, reaching their lowest in 2009. It is obvious that sawmilling and wood impregnation (CZ-NACE 16.1) achieve higher levels.

Table 5. Sales of own products and services in c. p.

(in millions CZK)	2005	2006	2007	2008	2009	2010
CZ-NACE 16.1	21,021.7	23,442.3	26,012.6	23,633.1	19,858.4	23,156.0
CZ-NACE 16.2	52,664.6	59,929.3	67,665.0	64,979.1	56,726.7	59,121.5
CZ-NACE in total	73,686.3	83,371.6	93,677.6	88,612.2	76,585.1	82,277.6
index	x	113.1	112.4	94.6	86.4	107.4

Source: Panorama of Czech industry

Table 6 shows the development of personnel costs in current prices. Until 2008 the amount of personnel costs increased to 11,105.6 million CZK and in succeeding years there is a decrease of 18.4 per cent.

Table 6. Personnel costs in current prices

(in millions CZK)	2005	2006	2007	2008	2009	2010
CZ – NACE 16.1	2,414.8	2,379.6	2,551.5	2,645.3	2,455.8	2,094.1
CZ – NACE 16.2	7,249.2	8,018.5	8,554.1	9,176.4	8,418.1	7,549.1
CZ – NACE in total	9,664.0	10,398.1	11,105.6	11,821.7	10,873.9	9,643.2
index	X	107.6	106.8	106.4	92	88.7

Source: Panorama of Czech industry

INDICATORS OF ADDED VALUE

The added value is measured as the difference between output and output consumption. The added value and its development in the analysed period are shown in Table 7 including related performance indicators and output consumption. Output consumption in the CZ-NACE 16th shows a decrease of 18.5 per cent from 2007 to 2009. A slight growth was recorded in 2010 compared to 2009. And it increased by 2.2 per cent. The added value de facto copies the development of output consumption.

Table 7. Indicators of added value CZ – NACE 16th

(in millions CZK)	2005	2006	2007	2008	2009	2010
Output	75,713	85,336	95,636	90,541	77,565	79,321
Output consumption	54,515	60,706	69,610	66,078	56,714	57,963
Added value	21,198	24,630	26,026	24,463	20,851	21,359
thereof:						
trade margin	1,249	1,321	965	1,015	955	1,005

Source: Czech Statistical Office

INDICATORS OF PROFITABILITY IN THE CZ – NACE 16TH

Indicator of added value per employee (see Table 8) increased by 107 thousand CZK during the years 2005 to 2007. In 2008 and 2009 there was a slight decrease of 4.1 per cent and 4.3 per cent. Conversely, in 2010, there is an annual increase of 10.5 per cent. The Return of Assets (ROA) copies the indicator of added value per employee in percentage in the analysed period.

Other types of profitability listed in Table 8 showed a similar development, i.e. Return on Equity, Return on Sales, and Return on Costs.

Cost efficiency (in %) showed a fluctuating trend in the period. In Table 8 the last indicator is the inventory turnover in days and varies in the range from 31 to 37 days.

Table 8. Derived indicators of profitability

	2005	2006	2007	2008	2009	2010
Added value per employee (in thousands)	475	548	582	558	534	590
Return On Assets (ROA) (%)	10.03	13.39	14.47	10.61	7.14	10.49
Return On Equity (ROE) (%)	20.87	27.97	30.02	20.61	15.86	24.21
Return On Sales (ROS) (%)	6.27	7.80	8.36	6.93	4.85	8.21
Return On Costs (%)	6.20	7.91	8.64	6.89	4.82	8.45
Cost efficiency (%)	94.42	92.66	92.17	93.79	95.54	92.21
Inventory turnover (in days)	32	31	32	34	34	37

Source: Czech Statistical Office

Table 9. Annual differences in profitability indicators

Indicators	Difference 2006-2005	Difference 2007-2006	Difference 2008-2007	Difference 2009-2008	Difference 2010-2009
Added value per employee (in thousands)	73	33	-24	-24	56
Return On Assets (ROA) (%)	3.36	1.08	-3.86	-3.47	3.35
Return On Equity (ROE) (%)	7.10	2.06	-9.41	-4.75	8.35
Return On Sales (ROS) (%)	1.53	0.55	-1.43	-2.07	3.36
Return On Costs (%)	1.72	0.73	-1.75	-2.07	3.63
Cost efficiency (%)	-1.76	-0.50	1.62	1.75	-3.33
Inventory turnover (in days)	-1	0	2	0	3

Source: Czech Statistical Office

INVESTMENT

Table 10 describes investments in the woodworking industry. Indicator of Acquisition of fixed assets, indicative of investment of in the woodworking industry, is divided into acquisition of fixed intangible and tangible assets. In Table 10 the acquisition of fixed assets gradually decreases in the analysed period. The lowest level of investment is in 2010 in the amount of 3,991 million CZK.

Table 10. Chosen indicators in the CZ – NACE 16th

(in millions CZK)	2005	2006	2007	2008	2009	2010
Acquisition of fixed assets in total	8,180	4,146	6,836	6,476	4,411	3,991
thereof:						
Acquisition of fixed intangible assets	-57	113	108	135	32	33
Acquisition of fixed tangible assets	8,237	4,033	6,728	6,341	4,379	3,958

Source: Czech Statistical Office

FOREIGN TRADE

Foreign trade of commodities of the woodworking industry showed a positive trade balance in both years (2009 and 2010). It increased by 1,410 million CZK in 2010 compared to the previous year.

Table 11. Foreign trade CZ – NACE 16th in 2009 and 2010

(in millions CZK)	2009			2010		
	Import	Export	Balance	Import	Export	Balance
CZ – NACE 16.1	4,490.0	9,732.7	5,293.7	4,458.0	10,119.8	5,661.8
CZ – NACE 16.2	9,396.3	16,570.9	7,174.6	10,102.3	18,318.5	8,216.2
CZ – NACE in total	13,866.3	26,354.6	12,468.3	14,560.3	28,438.3	13,878.0

Source: Panorama of Czech industry

The Czech woodworking industry exports most of its products to EU member states, mainly to neighbouring Germany and Austria. Delivered are primarily lumber, builders' jointary and pallets.

Table 12. Export territories in 2010

Country	Percentage of export
Germany	37
Other	19
Austria	13
Italy	9
Slovakia	8
Poland	6
Hungary	4
Slovenia	2
Switzerland	2

Source: Czech Statistical Office

Table 13. Import territories in 2010

Country	Percentage of import
Germany	26
Other	20
Austria	15
Slovakia	14
Poland	10
Russia	6
China	4
Hungary	3
Netherland	2

Source: Czech Statistical Office

In 2010 about 79 per cent of products of the CZ-NACE 16th were exported to EU countries. In the Tables 12 and 13 of export and import territories in 2010 we can see that the main import and export territory is Germany, followed by Austria. Another important export territory is Italy and Slovakia. On the contrary, other import territories are Slovakia and Poland.

CONCLUSION

The woodworking industry is a prosperous and integral part of the Czech national economy and is adapted to the conditions of production in the EU. Business entities in the woodworking industry are operational, show good adaptability to new situations. They are able to overcome obstacles relatively quickly. If more structural focus is put on the production of higher added value, the woodworking industry could become an attractive investment area and contribute to the solution of problems of economic and social development of regions.

In the analysed period the surveyed characteristics show a perceptible increase in 2007 and subsequently the effects of the global economic crisis are reflected in this sector of the Czech Republic. This means that in 2008 and 2009 there was a significant reduction in revenues associated with the gradual decline in costs, which represents a decrease in profit. Impacts of the economic crisis are reflected in the decline in employment in this sector. In 2010 a slow growth of basic economic indicators is noticed. Perspectives for the woodworking industry can be seen in the application of new techniques and technologies (investment) and in the application of modern management methods. It will be important to concentrate on the production of larger units, which are better for achieving high productivity.

REFERENCES

1. Czech Statistical Office: economic results of Czech industry. [2012-10-13] http://notes.czso.cz/csu/2012edicniplan.nsf/p/8006-12.
2. Dejnožka F.: The role of trade in wood and wood products and its relation to the development of forestry and woodworking industry in the Czech Republic. Forest – wood sector of the Czech Republic and EU states: Collection of papers of the international conference. Brno: Mendel University of Agriculture and Forestry, Faculty of Forestry and Wood Technologies, 2002.
3. Dudík R.: Forest – wood sector of the Czech Republic and EU states: Collection of papers of the international conference. Brno: Mendel University of Agriculture and Forestry, Faculty of Forestry and Wood Technologies, 2002.
4. Hrubec T.:The development of woodworking industry since 1989. Forest – wood sector of the Czech Republic and EU states: Collection of papers of the international conference. Brno:

Mendel University of Agriculture and Forestry, Faculty of Forestry and Wood Technologies, 2002.
5. Indicators of State Environmental Policy of the Czech Republic 2004-2010: Area of forest in percentage of area of the country 2010 [2012-10-13] http://issar.cenia.cz/issar/page.php?id=187.
6. Kalousek F., Lenoch J., Štork R.: The Economic aspects of the use of wood mass. Edition 1st. Brno: Mendel University of Agriculture and Forestry 2007, 72 s. Folia Universitatis Agriculturae et Silviculturae Mendelianae Brunensis. ISBN 978-80-7375-047-3.
7. Kupčák V.: The Economic and legal relations of forestry and woodworking industry of the Czech Republic: Collection of papers of the international conference. Brno: Mendel University of Agriculture and Forestry, Faculty of Forestry and Wood Technologies, 2002.
8. Panorama of Czech industry. 2011 [2012-10-19] download.mpo.cz/get/45569/51390/586478/priloha001.pdf

Sylwia Klus[7]

THE QUALITY OF BANKING SERVICES AS A SOURCE OF COMPETITIVE ADVANTAGE

Abstract: The quality of banking services is strictly tied with customer satisfaction, since they define a final assessment about its level. A negative opinion is usually related with customer resignation of banking services, which stimulates financial institutions to identify customer needs and undertaking activities so that customers are most satisfied. Knowing the needs and requirements of customers, the bank tries to customize its entire internal organizational structure and define its market strategy. The important role of quality service in building a competitive advantage results from its impact on customer satisfaction.

Keywords: competitive advantage, quality service, customer satisfaction, customer loyalty, product, marketing.

INTRODUCTION

It can be observed nowadays that commercial banks find competition based on product differentiation extremely hard, since banking products have become easy to imitate and are unprotected with patents. As the products become more and more homogenous, price competition becomes fierce, which narrows pricing conditions to a tight range. Therefore quality of service has become an essential element of competitive advantage and its high level can easily be recognized by the market. This implies that investing in quality becomes just as important as the creation of new banking products.

The banking market has experienced intensified competition within the recent decade, which compelled banks to look for new ways of approaching new clients, as well as retaining the existing ones. An intrinsic feature of the banking services' market is the permanent change in expectations of more and more demanding clients.

Whereas electronic banking services, such as online access to bank accounts, are forming a new reality for bank-customer contact, the close distance to a bank post are becoming irrelevant in competing for new clients. That is why nowadays banks that are looking for a factor of enduring competitive advantage over their rivals decide on building a solid base of quality services.

The notion of quality in services has evolved recently and nowadays it's been emphasized that its essence is focused on foreseeing and meeting client's expectations, which implies that high quality service means a continuous process of satisfying customer needs.

The service is in principle the only merchandise which banks have to offer. One of the few resources at the disposal of a bank today, through which it can sufficiently distinguish itself on the market, is the high quality of service. It is the quality that can guarantee profitable business activity and sustainable development, understood as new technologies, new distribution channels and thus new opportunities of meeting customers' needs or even going beyond their expectations. This in turn leads to broadening the base of clients and has a direct impact on their loyalty.

METHODS OF ACHIEVING A SUSTAINABLE COMPETITIVE ADVANTAGE IN THE SERVICES MARKET

In the competitive activity within services market some companies make better results than others. In the competitive activity within services market some companies achieve better results than others. Skills and resources that contribute to better performance are defined as sources of competitive advantage. The sustainability of competitive advantage means a state in which the

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bank's supremacy is resistant to various activities of direct competitors, including imitation of strategy or particular actions. In professional literature we may find the following methods of achieving a sustainable competitive advantage on the services market:

- the economies of scale effect - implementation of new technologies and solutions for servicing and interacting with customers provides a standardization of service processes, which in consequence results in costs reduction and cost advantage;
- the innovative nature of product, service process and company management – a source of competitive advantage might be a product, service or innovative methods of company management - as long as they become exclusive for that company (i.e. secured against duplication with patents, secured with copyrights or classified if possible). The more complex or technical the resources for providing services, the stronger the significance of innovation as a source of competitive advantage;
- brand value of service - the greater the extent of service immateriality or the more features connected to experience and trust it has, the bigger is the role of brand value as a source of competitive advantage;
- customer relations – the significance of customer relations as a source of competitive advantage increases when provision of services requires a certain level of company experience and customers' trust;
- corporate culture – the quality of corporate culture in a service sector company is a strong source of competitive advantage for services markets where a significant role is played by staff;
- location of service points – the significance of the feature rises along with the decentralization of the service delivery processes.

The choice of a convenient way of gaining a sustainable competitive advantage requires an in-depth analysis of the particular service branch so as to determine, which of the above presented activities might have a chance of implementation within a particular market.

THE QUALITY SERVICE AS A FACTOR OF THE BANK'S COMPETITIVE ADVANTAGE

The important role of quality in building competitive advantage results from its influence on the level of customer satisfaction, which is always subjective. Therefore, having their own preferences, buyers are satisfied with a service that is adjusted to their individual needs and capabilities. Sometimes it happens that a customer might be satisfied in general from a lower quality service, because it matches their financial capabilities. Therefore a higher quality service might not necessarily deliver greater satisfaction since it might exceed the customer's financial budget.

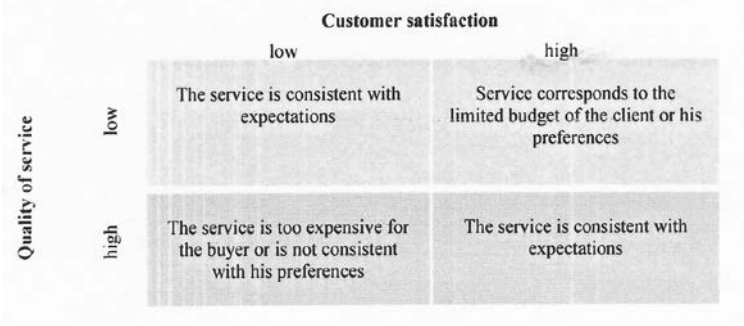

Fig. 1. The relationship between quality of service and customer satisfaction

Jakość w usługach bankowych i jej rola w zwiększaniu efektywności i konkurencyjności banku. [2]

Providing service of the highest level results in a rising customer retention rate and helps in acquiring new prospects. Compliance with high quality service is based upon good understanding of

and meeting customer requirements. A bank that treats its customers subjectively may rest assured that such customers will be using its products for a long time. Therefore the major determinant of banking quality service is customer trust and loyalty.

Increase in loyalty leads to lowering customer service costs, which allows for reduction of marketing expenses and increase in the bank's operating income. Moreover, it turns out that it's not new products, but maintaining high quality service that significantly contributes to a bank's increase in profits.

A loyal customer of a bank might be described as a person who:

- makes regular purchases, represents an emotional attitude towards the bank and its offer,
- uses a full range of products offered by the bank,
- spreads positive information about the bank,
- is resistant to commercial activities of other competitive banks.

A bank that wants to obtain customer trust must meet a number of their expectations connected with the previously mentioned determinants of quality service. The expectations relate particularly to:

- reliability - resulting in the exact fulfillment of promises and compliance of delivered financial services with the bank's offer,
- sensitivity - which refers to precise and eager service,
- appearance - which refers both to bank posts and their workers,
- accessibility - customers want that services and bank personnel was available at the required place and time,
- competence - bank workers should be professional, having complex knowledge in terms of financial services,
- politeness - clients must be treated friendly and respectfully,
- transparency - bank workers must communicate with clients in a comprehensible manner.

Customer dissatisfaction and poor loyalty contribute to high rotation of consumers, which further entails the necessity of additional expenditures for acquiring new clients. It is estimated that the acquisition cost of a new client is fivefold higher than the cost of maintaining an existing one. Increased spending on service and acquiring clients leads to a decrease in profits and reduces the possibilities of investing in improving the quality of services.

Poor quality of services also affects employees. Lack of objective possibilities for improvement, as well as regular contact with dissatisfied customers, weakens employee motivation for additional efforts and effective work. Low commitment of workers and the dissatisfying effects of their work cause management reaction in the form of numerous controls and recommendations. Constant supervision becomes in turn a reason of workers dissatisfaction and ultimately results in resignation from work. New employees require time and trainings in order to learn their job and customer needs, which initially make quality of their work low and results in low quality service.

The basic costs and losses incurred by an enterprise due to the low quality of services include:

1) costs associated with the provision of services:
   - costs of repairing or recurrent service (which often reach up to 50 per cent of total company activity costs),
   - costs of detecting errors (all efforts and expenses incurred to discover the causes of poor quality of service),
   - costs of protection (expenses incurred in order to identify and neutralize the factors affecting the deterioration of the quality of services),
   - costs of performance (expenses incurred to perform the service right at the first time);
2) costs associated with loss of customers:
   - cost of acquiring new customers in order to replace those who resigned from the services of the company,
   - lost revenues from customers who resigned from the services of the company,

- costs of lost opportunities (the scale of potential profits the company will not gain due to bad reviews; the losses are caused primarily by disappointed customers who discourage others interested in using the services of the company).

Even a small improvement in the quality of services causes positive reactions. The most visible consequence is an increase in customer loyalty and lower rotation, which reduces amounts spent on attracting new customers. Consumer loyalty is manifested not only through the constant use of company services, but also in spontaneous recommendation of these services to their friends. Additionally, some satisfied customers are willing to pay a higher price for the offered service and in spite of price increases continue to use the company's offer.

Enhancing customer loyalty and gaining their trust are not limited to the benefits of providing good quality in services. Other advantages of high quality services include:

- cost reduction and increase in company profitability,
- achievement of a strong market position (particularly when imitation of good quality becomes hard),
- higher flexibility in conducting pricing policy, achieved due to the positive image of the company and the group of loyal customers,
- attracting new customers (company's positive image and word of mouth advertising),
- increase in personnel satisfaction, commitment and loyalty (reduced turnover of staff),
- improvement of company reputation as an employer, which leads to attracting more qualified and skilled workers,
- improvement of internal cooperation between different departments,
- good quality becomes an advertising tool, which might lead to reduction of marketing expenses.

There are three areas in which positive effects of taking care of quality can be seen. Investing in quality services not only brings benefits to a service company, but also to the external environment, and above all, to the customers.

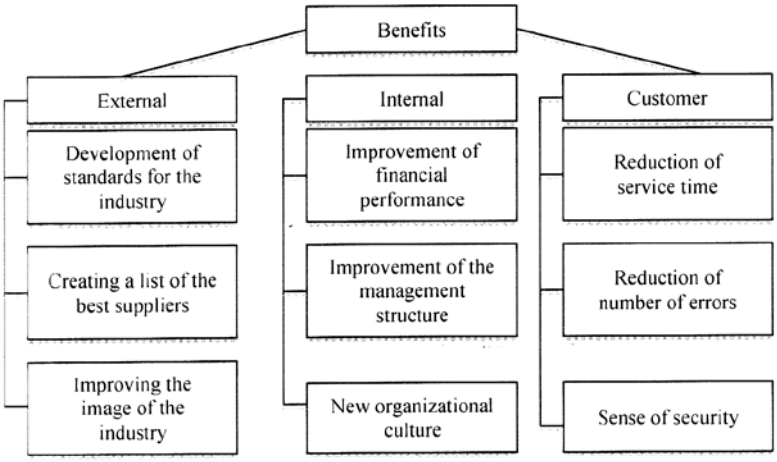

Fig. 2. The benefits of improving the quality of service

Source: Jakość a wzrost efektywności oddziałów bankowych. [3]

HUMAN CAPITAL AS A SOURCE OF QUALITY

Human capital plays a key role in building long lasting relationship with customers, which translates into an increase in the efficiency and competitiveness of the bank.

Values of human capital are:

- commitment, efficiency, diligence,
- identification of people following the bank's mission statement,
- mobility and availability,
- willingness and ability to work in teams,
- positive attitude to the bank's hierarchy of values.

The above mentioned features have a huge impact on relations between bank and customer and on the environment. This, in turn, is reflected in the bank's economic condition and efficiency, as well as the bank's image and reputation.

The progressive specialization and diversification of banking services often appears to be complicated and hard to understand by present customers and future ones. In such circumstances they might expect help in their decision-making processes, especially from staff of initial contact.

CONCEPT OF THE MARKETING-MIX IN BANKS

Specific competitive conditions on the financial services market are determined by the following factors:

- the leading role of the corporate image and availability of services in the structure of the marketing mix,
- the relative importance of personnel and personalization as a component of the marketing mix (the concept of "5P"),
- the dominance of relational marketing and building of loyalty systems (CRM),
- a strong substitution of mass and simple financial services,
- development of dependent and independent financial advisory.

A characteristic feature of the financial services marketing mix is the relative similarity (standardization) of offer and propensity to imitation. Financial institutions are characterized by a similar organization of work, offer, level of costs. Thus it is difficult to find or create a leading and sustainable competitive advantage, which is essential in the construction of a marketing mix. An important task of marketing is assigning distinctive features to the financial products, which are related to a symbolic "product package". "The package" is created by: people (most importantly), name of product, visual identification system, product and financial institution brand, manners of advertising, access to services, range of products, art of sales, elasticity in service, innovation and other components of a marketing mix. Confidence building and creating the company's image is one of the primary functions of financial institutions' marketing activity, such as stimulating loyalty programs, e.g. the Customer Relationship Management system.

In the marketing activity it is important to establish and stimulate permanent customer relationships (transactional marketing is replaced by relational marketing), create a positive image of the institution and gain customer trust.

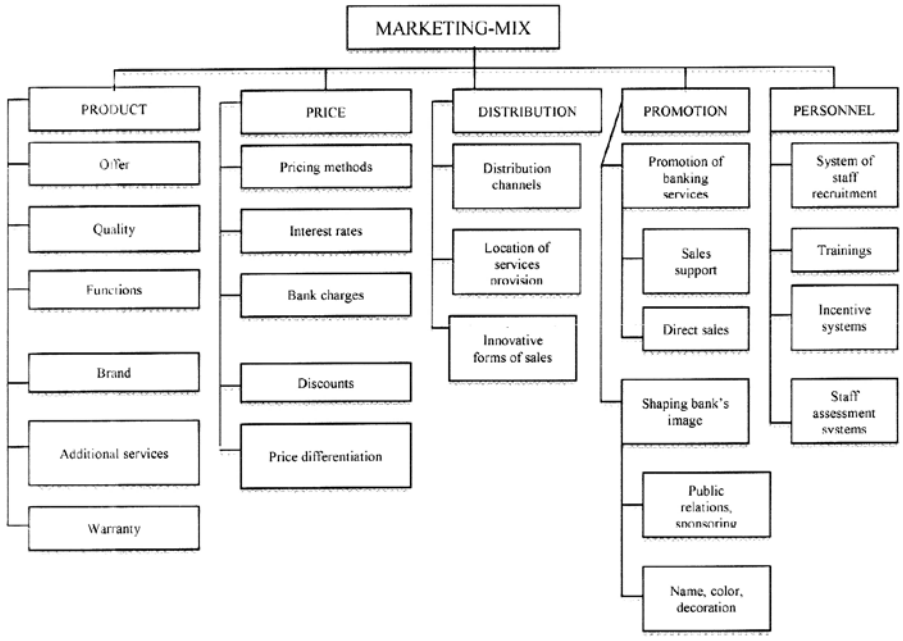

Fig. 3. The concept of the marketing – mix in a bank

Source: Marketing w usługach bankowych. [1]

CONCLUSIONS

Attracting customers and bringing them to conclude a transaction is an important part of the marketing strategy of banks, but currently what is much more important is the maintenance of existing customers and building profitable and long-term relationships with them . Relationships are formed primarily in the process of using banking services, however, the perception of banks plays an important role, since customers precisely select, organize and interpret data in order to create a reasonable and overall image of any institution. In the process of perception they build their trust and make decisions regarding the choice of particular products. Gaining a sustainable competitive advantage in the banking sector is be based upon constant improvement of service quality, which is inevitably related with investing in human capital resources and new technologies that enable the development of new products and new service access channels. In order to gain advantage upon their competitors, banks have to concentrate on customer loyalty and their retention. A crucial indicator of customer loyalty, which needs to be regularly monitored, is the transmission of positive information to others on the service provider or product features. The marketing activities of a bank must be concentrated on relational aspects between customers and bank personnel, creating a positive image of the institution and trust.

REFERENCES

1. Bednarska-Olejniczak D.: Marketing w usługach bankowych. In: Iwankiewicz-Rak B. (ed.), Marketing w usługach. Przykłady zastosowań. Wydawnictwo Wyższej Szkoły Bankowej w Poznaniu, Poznań 2011, p. 33.
2. Cichy J.: Jakość w usługach bankowych i jej rola w zwiększaniu efektywności i konkurencyjności banku. In: Harasim J. (ed.), Konkurencyjność i efektywność działania banku – podejście zasobowe. Wydawnictwo Akademii Ekonomicznej im. Karola Adamieckiego w Katowicach, Katowice 2009, s. 172, 178-181, 167-168.

3. Kudła J., Opolski K.: Jakość a wzrost efektywności oddziałów bankowych. CeDeWu, Warszawa 2006, p.11, p.30.
4. Pluta-Olearnik M.: Marketing usług bankowych, Polskie Wydawnictwo Ekonomiczne, Warszawa1999, p. 119.
5. Płonka M.: Marketing Instytucji Finansowych. Wydawnictwo Uniwersytetu Ekonomicznego w Krakowie, Kraków 2011, pp.11, 31-32.
6. Smoleń T.: Zarządzanie marketingiem w firmie usługowej. In: Burek J. (ed.): Marketing usług. Wolters Kluwer, Warszawa 2012, pp. 66-67, 183-186.

Alexander Linczényi, Renata Nováková[8]

THE QUALITY TRIAD AND INDICATORS OF PROFITABILITY OF QUALITY

Abstract: Quality management has to consider a lot of new aspects regarding the latest trends in the field. The authors of the proposed paper will point at the interconnection of three major aspects: technical, communication and economical aspect. The authors propose, based on these aspects, a Triad of Quality. The main aim of quality management is essentially to increase effectiveness indicators in the organisation, rather than satisfying customers by certain product properties or focusing on increasing the market share. The authors propose their indicators of profitability of quality- Return on Quality, ROQ. The Triad of Quality is proposed as a new way of perceiving the economical aspects of quality. The paper will present a proposal of a system of indicators based on the communication aspect and the economical aspect of quality.

Keywords: profitability of quality, Quality Triad, Returns on Quality, return on innovation activities

1. INTRODUCTION

It is interesting that neither the Slovak literature on quality, nor the professional community do mention that the majority of the projects aimed at building quality management systems and various quality programmes have failed. This obviously does not mean that the acquisition of a certificate or another form of support in the field of quality is considered a failure. The aim should be to achieve results better than those achieved before the application of the above mentioned projects, rather than the sole acquisition of a certificate. This means that the costs of the projects must be lower than the yields achieved thanks to the implementation of such a project. As documented in sources, numerous enterprises thus either abandoned those programmes or dramatically reduced them; there were even some cases of bankruptcy due to the application of such programmes. Neither do the Slovak sources mention how many enterprises, having won a quality certificate or award, went bankrupt. The bankruptcy under the conditions of economic crisis definitely cannot be ascribed to the application of quality projects. On the other hand, if quality projects are effective, the enterprise should be protected to a certain degree from the impact of the economic crisis.

There is a question whether quality does or does not have a direct influence on the economic results of an enterprise [2]. Authors of the presented paper are convinced that such direct influence does exist, yet certain principles (e.g. those accented by Juran, contact with customers in particular) have been neglected in the field of quality management. Just look at the contents of ISO standards. Customers are mentioned, yet the methods of contact, assessment of post-production stages and particularly their feedback on research and development are missing in the standards.

The first version of ISO standards defined the role of marketing in quality management (Juran's idea that marketing represents both the inlet and outlet of quality management), while this was omitted in the later versions. Similarly, the subject of economy quality was stated just marginally in ISO standards. The target should not be enhancing the technical properties of a product, or eliminating the active approach of employees towards quality by directive standards, but rather increasing the profitability of the organisation. Companies seem to forget that a product must meet customer demands, yet the main aim is increasing the profitability of the organisation; otherwise all the effort to increase quality proves fallacious. Increased attention should be therefore paid to communication with customers while emphasising the economic returns on quality.

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2. QUALITY TRIAD

Doubts regarding whether quality has or does not have a direct impact on the economic results of a company lead to the fact that management in many enterprises, instead of seriously dealing with quality, declares the increase of quality and the acquisition of a certificate only formally, thus considering the task accomplished.

Deming, one of the major gurus of quality, claimed (correspondingly to the concept of quality management in his time), that there is not a direct connection between financial results and quality, as financial returns on quality are invisible and unrecognisable. Such (mis)concept of management has been revealed by the U.S. General Accounting Office claiming that just a minority of enterprises-finalists of the Malcolm Baldridge Award proved some savings or better economic results achieved due to quality programmes [1]. Authors of this contribution take the liberty to claim that the situation in Europe is even worse in this context.

Quality is a very complex phenomenon influenced by numerous factors. When elaborating any quality programmes, three major aspects have to be taken into account:

- technical aspect; a product must be designed and manufactured with the properties assuring that the customer satisfaction will be met,
- communication aspect; customers must be convinced about the advantage of an offered product's purchase; thus the acquisition of new customers and retention of current ones are a matter of the communication aspect, yet it is the communication aspect which is not sufficiently regarded in quality programmes,
- economic aspect; the aim of the quality programmes should neither be increasing the technical level of individual properties of the manufactured products, nor increasing the level of satisfying the customer needs, but instead achieving an advanced technical level of the manufactured products and satisfying the customer needs, i.e. achieving better economic results and profitability of the enterprise.

The authors of this paper will attempt to express the relationships between these aspects through the Quality Triad (this triad is the contribution of the authors to a new understanding of quality economics). Since the technical aspect is primarily a matter of constructers, developers and managers of production processes, this paper focuses on the communication and economic aspects in particular. As for the communication aspect, it is worth to emphasise that the achieved economic results of quality depend on effective communication with customers, and the economic aspect must therefore express the main aim of quality programmes and quality increase. Neglecting those facts necessarily leads to the failure of programmes or projects of quality increase.

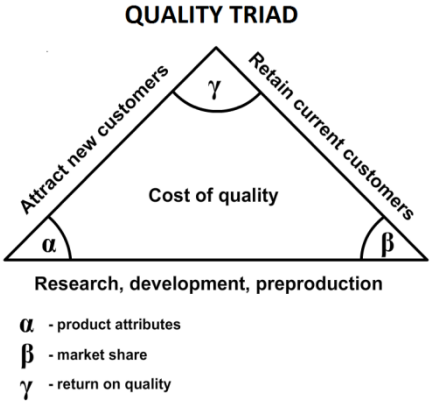

Figure 1. Triad of Quality

The sides of the triangle in the Triad of Quality express the activities that must be implemented in order to assure the success of quality programmes, while the basis expresses the technical aspect of quality (a product must be designed and manufactured with certain properties), and the arms express the communication aspect of quality (only an effective communication with customers and monitoring their demands and satisfaction with the supplied products can help retain current customers and attract new ones). Communication is generally carried out by the department of marketing, while it is the communication itself which is a pre-requisite of effective quality programmes.

The angles of the triangle express the results of activities. The results of activities in the field of design are products with certain properties, while the result in the field of communication with customers is the manufacturer's market share, and subsequently the increase of market share is the supposition of good economic results achieved via quality programmes. The top of the triangle expresses the economic result of the previous activities and can be thus indicated as Return on Quality (ROQ).

The sequence of the quality increase process can be expressed in four basic steps.

- Step 1: carrying out the research targeted to determining the customer requirements and assessing the organisation's ability to meet those requirements; elaborating the list of requirements and harmonising customer requirements with the organisation processes.
- Step 2: carrying out communication with customers in order to convince them about the organisation's ability to meet customer expectations,
- Step 3: assuring the impact of the manufactured product´s quality on customer satisfaction,
- Step 4: measuring the market share and the impact of quality on the achieved profit. Within this step, it is necessary to determine quality programme related costs, the net present value (NPV) due to the increased market share and to compare the profit improvement with the costs associated with the implementation of quality programmes.

The Triad of Quality provides a new insight into quality economics. Most companies currently apply the approaches based on the PAF model in quality economics. The model which appeared in 1946 does not regard the changes having taken place in quality management and the concept of quality itself. The PAF model is exclusively focused on the technical aspect, as its original objective was to seek an optimum level of low-quality production. This also defined the structure of so-called quality costs used in the model, which is focused on low-quality rather than quality, though losses due to low-quality production and product quality are in fact caused by wasting material, energy and workforce involved in a particular production process, thus having nothing in common with quality. In these conditions if the ratio of wasters decreases, quality is better and vice versa. This does not mean that the losses of wasters should not be decreased and monitored, yet by modern definition of quality these costs are not quality costs. Similarly, appraisal costs are in fact a component of production process costs, while prevention costs are a component of the costs for training staff [3].

Regarding the above mentioned Triad of Quality, we are presenting a brand new structure of quality costs focused on costs for quality assurance. The structure of quality costs comprises the following groups:

- costs for research, development and preparation of production,
- costs for retaining current customers (defensive strategy) [1],
- costs for acquiring new customers (offensive strategy) [1].

As for group 1, it actually expresses the slogan saying that 80 per cent of quality is created in pre-production phases. If this is true, then the costs in this field are quality costs. Costs to retain current customers actually represent the total of all benefits an organisation provides to loyal customers including the costs for post-production phases. Those costs may be considered the ones for the defensive strategy of a company. Costs for acquiring new customers represent the costs particularly for advertising, as well as the costs for market research, identifying the customer requirements etc. Those may be considered the costs for the offensive strategy of a company.

3. INDICATORS OF PROFITABILITY OF QUALITY

The effectiveness of such an approach requires building a system for monitoring and assessing quality costs, comprising the following steps [4]:

- defining the cost issues that will be included into particular groups of quality costs,
- determining responsibility for issuing the initial documents for individual cost issues,
- establishing a system for collection and summarisation of quality costs,
- assessing the impact of quality costs on company profit.

There are several options to assess quality. The ROQ indicator is one of them [5]. The authors of this paper propose that this indicator takes the following form:

$$ROQ = \frac{P}{QC}$$

Where QC = CRD + CD + CO

P is profit from the production of a particular product, costs for research and development (CRD), costs for defensive strategy (CD) and costs for offensive strategy (CO).

Denominator in the formula says that profit is not created barely by quality cost. The ratio does not directly express the effectiveness of a quality system. However, if we examine the ratio in a sequence of time, we can indirectly deduce the effectiveness of the quality management system from whether the variations of the ratio exhibit positive or negative development. When creating this indicator, the influence of the time factor should be taken into account. If a product is manufactured for more than 1 year, costs for research and development are single-shot; the ROQ formula should then involve only the ratio of the costs attributable to 1 year of product manufacturing.

The above mentioned indicator applies to total production. If a company manufactures several products and needs to express the ROQ indicator for one product, this indicator will include the profit and the quality costs of this product.

$$ROQ_i = \frac{P_i}{QC_i}$$

$$ROQ = \frac{P}{QC}$$

$$QC = CRD + CD + CO$$

$$ROIA = \frac{P}{CRD}$$

$$ROC = \frac{P}{CC}$$

$$CC = CD + CO$$

$$ROQ = \frac{PC\left(\frac{QC}{TC}\right)}{QC} > 1$$

$$ROIA = \frac{P\left(\frac{CRD}{TC}\right)}{CRD} > 1$$

$$ROC = \frac{P\left(\frac{CC}{TC}\right)}{CC} > 1$$

$$ROC = \frac{L\left(\frac{CC}{TC}\right)}{CC} < 1$$

The quality triad allows also to express the return on innovation activities with the indicator ROIA:

$$ROIA = \frac{P}{CRD}$$

If we follow the evolution of the profitability of quality this development could be expressed by means of the proportional indicator:

$$\frac{RQ_{x+1}}{RQ_x} = \frac{\frac{P_{x+1}}{QC_{x+1}}}{\frac{P_x}{QC_x}}$$

This indicator should be greater than 1. If it is not, the produced products cease to meet customers' requirements and the manufacturer should change the properties of products.

Using this approach we applied the method in a small company (47 employees) that produces furniture (sofas and kitchen units). The results for a period of 5 years are shown in the table.

Table 1. Using and results of indicators ROQ (2007-2011)

Indicators	2007	2008	2009	2010	2011
P	186	46	38	119	160
CQ	77	67	61	76	84
ROQ	2,41	0,69	0,62	1,57	1,9
ROQ_1/ROQ_0	-	0,29	0,01	2,53	1,21
CRD	48	62	43	55	61
ROIA	3,87	0,74	0,88	2,16	2,62

As can be seen, the ROQ is a dynamic indicator. This indicator reflects the state of the macro environment. More emphasis on quality attributes were reflected in the years 2010 and 2011. The organization began to vigorously invest in quality of products and the ROQ indicator grew.

4. DISCUSSION

The information in the article is based on previous analyses of foreign and domestic literature. Application of the ROQ indicator in practice has not yet been comprehensively evaluated and is currently the subject of solutions of grant tasks. All information contained in the article is the intellectual property of the authors and represents a new trend in the field of evaluation of profitability of quality. This approach is unknown and not used, neither in practice, nor in literature. The authors used expert methods treatment.

5. CONCLUSION

Besides the technical aspect, quality management should involve also communication and economic aspects in order to be successful. It is essential when regarding the effectiveness of quality management, the profit achieved and profitability of a company. The Triad of Quality discussed in the paper provides a new aspect of quality costs, focusing on quality itself rather than on low-quality as in the case of the PAF model. The quality costs used in the PAF model should be monitored because it reduces company profit, but has nothing common with the modern understanding of quality. In contrast, the approach used in this article and the designed structure of quality costs allows for tracking the relationship between quality and company profit and directly expresses the profitability of quality.

REFERENCES

1. Rust R., Zahorik A., KeininghamT.: Return on Quality. Irwin Professional Publishing, Chicago 1996.
2. Synek M. et al.: Managerial Economy. Grada Publishing, Prague 1996.
3. Linczényi A.: Indicators of Benefits from Quality, Proceedings Quality for Life, Ostrava 2006.
4. Nováková R.: Indicators of Profitability in Quality Management and their Influence on Competitiveness of the Company. Proceedings Quality for Life, Ostrava 2006.
5. Linczényi A., Nováková R.: Returns on Quality – ROQ model. 55. congress EOQ, Budapest, Hungary 2011.

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WORKS ON THE MACROECONOMIC INDEX OF ROUND WOOD PRICE CHANGE

Abstract: The up-to-date works on creating a macroeconomic index of round wood price change have been presented and summarized. The index is based on monthly published data concerning the economy of Poland and the European Union. It can facilitate commercial negotiations between forest industry entrepreneurs and The State Forests which take place once every half year.
Keywords: economic cycle, business cycle indicators**,** wood price.

INTRODUCTION

The conditions and trends in economic development, i.e. the periods of the economic cycle, are usually measured with business indexes. Generally speaking, their aim is to evaluate the condition of the economy, describe it thoroughly or partially and present trends and directions in terms of changes in the level of economic activity. The article presents current works on determining such an index, which could be useful when proposing initial prices for round wood purchased by recipients from the State Forests during the semi-annual negotiations, using Internet systems.

ECONOMIC CYCLE

The market economy, in which the Polish forest industry has been functioning since 1989, is cyclical in character. The basis of its development is the economic cycle (business cycle), in other words - the fluctuations in production, employment and prices – in accordance with the short-term development trend. In forest industry economic process a company's activity interchangeably grows (causing expansion) and declines (causing recession). The economic cycle, in other words, is the period between subsequent changes in a company's development trends (maxima and minima on the trend lines). It consists of the following periods [Lis 2012b]:

1) recession (decline) – production and prices decline, unemployment grows,
2) intermediate – stabilization of production and prices at a low level accompanied by high unemployment,
3) expansion (recovery) – growth of production and prices and decrease in unemployment level,
4) peak (boom) – stabilization of production and prices at a high level, accompanied by low unemployment rate.

An economic cycle may last from a few months to a few years, yet the scale of production, prices and unemployment rate vary. The economic cycle serves to compensate for developmental imbalance in various sectors of the economy. According to Austrian economist Schumpeter (Schumpeter 2009) – „recession is a period of recovery following the excesses of prosperity". Crises eliminate from the market the biggest risk-takers and optimists that are its weakest elements. The economy emerges from a recession phase stronger - as the weakest entities are eliminated, solid and stable companies increase their market share and new companies enter the market encouraged by occurring opportunities, such as increase in demand and price, and relative availability of labour force.

In the forestry sector the economic cycle is represented by periodic shortages of round wood and its really high prices (prosperity periods: 1998, 2008, 2011), as well as fast slumps in prices accompanied by an excessive supply of wood (depression periods: 2003, 2009).

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An important cause of economic cycles is the fluctuation in companies' investment in forest industry, further strengthened by the fact that, to a large extent, they are financed by the company's own resources.

BUSINESS CYCLE INDICATORS

Business cycle indicators (measures, indexes) are a set of signs used for measuring the terms of the economic life cycle, describing the condition of economy either as a whole or its specific fragment (for example the commodity market), allowing to determine the trend in relation to changes in economic activity. Depending on the means and possibilities of predicting changes in the economy, one may classify the indexes as: leading – preceding changes coincidentally – those that change in accordance with the general condition of the economy, and lagging – those that show the trend only some time after the upturn in economic development.

Leading indexes represent the biggest practical significance. One may calculate a complex index by taking into consideration the data concerning various aspects of the economic life. The observation of changes of an index determined in that way, in all likelihood, allows predicting economic changes [Lis 2012c].

Examples of business cycle indicators are: Composite Leading Indicator (CLI) of the Organization for Economic Cooperation and Development (OECD); Sentiment Indicator (SI) of the Central Statistical Office; IRG Barometer of the Research Institute for Economic Development of the Warsaw School of Economics; Business Indicator of the Polish Confederation of Private Employers 'Lewiatan' (PKPP 'Lewiatan'); Consumer Confidence Index; Purchasing Managers Index - PMI; IFO – Business Climate Index; „Rzeczpospolita" Barometer; Legatum Prosperity Index. Those indexes have been further described in the article [Lis 2012a].

An important business cycle indicator is also the unemployment rate that in 2012 did not decrease even in the summer, which happens frequently. It was the lowest in July 2012 and from August till September it stayed at June's level and then increased again. There is evidence that it may grow even faster. Those are undoubtedly significant signs of a serious economic recession.

An indicator proposed in this article is leading in character. It is calculated on the basis of five or six component ratios published monthly by the Central Statistical Office (around 25 each month). Initial indicators are calculated differently for EU countries (UE-27) and for Poland and then in adequate proportions, which range between 30 and 70 per cent; they are taken into account in an aggregated indicator. The final indicator also takes into account the euro exchange rate for the last three months.

Five variables indicators

For the UE-27 there are three components added within the range of 30 to 70 per cent:

1) GDP (Gross Domestic Product) expressed in %;
2) foreign trade balance in billions of euro – because this indicator is not published for the EU only the figures for the biggest country as well as the biggest Polish foreign trade partner have been taken into account – namely Germany, moreover due to the disproportionate balance between Poland and Germany the published figure has been divided by 10,
3) industrial output in % as well as two components are subtracted:
   a) harmonized unemployment rate in %,
   b) harmonized indicator of consumption prices in %.

Next, the sum of those five components is multiplied by the share of the EU-27 – this way an adjusted EU-27 indicator is obtained.

It works similarly in case of component ratios for Poland. They are added with a share (100 minus the EU-27 part), hence the range between 70 per cent and 30 per cent: GDP in %; foreign trade balance in billions of euro; industrial output in %, harmonized unemployment rate in % and harmonized indicator of consumption prices in % are subtracted. Their sum is also multiplied by the Polish share this and way an adjusted indicator for Poland is obtained.

Six variables indicators

The 5-component index for the EU-27 and for Poland is further adjusted with data on the construction industry output expressed in % (Table 2).

The macroeconomic index of round wood price change is the result of summing up adjusted indicators for the EU-27 and Poland, as well as the average 3-month euro exchange rate (which for the last 3 months amounted to 4,11 zł/€).

Calculations of those indicators are shown in Tables 1 and 2:

- in Table 1 – macroeconomic index of wood price change excluding construction output was determined,
- in Table 2 - macroeconomic index of wood price change including construction output was determined.

Both tables (1 and 2) were created based on the following assumption for component ratios: 50 per cent for the EU-27 and 50 per cent for Poland. The results were noted on the left side of both tables.

Moreover, on the right side of Tables 1 and 2 those figures were calculated for five different shares of component ratios:

- EU - 27 = 30%, Poland = 70%,
- EU - 27 = 40%, Poland = 60%,
- EU - 27 = 50%, Poland = 50%,
- EU - 27 = 60%, Poland = 40%,
- EU - 27 = 70%, Poland = 30%.

Calculations were done on the basis of two prices of wood:

- from the 1st half of the year 2012 and
- from the 2nd half of the year 2012.

In each of the tables (1 and 2), 20 variants of the ratios and the round wood prices based on them were analyzed. Those variants were juxtaposed and compared in Table 3.

Table 1. Determining the macroeconomic index of changes in wood prices excluding the construction industry output

Determining macroeconomic index of changes in wood prices	EU- 27					Poland					Macroeconomic index of round wood price change						
	1	2	3	4	5	1	2	3	4	5	Assumption for components		1	2	3	4	5
	Q4-11	Q1-12	Q2-12	Q3-12	Q4-12	Q4-11	Q1-12	Q2-12	Q3-12	Q4-12			Q4-11	Q1-12	Q2-12	Q3-12	Q4-12
	10.2011	01.2012	04.2012	07.2012	10.2012	10.2011	01.2012	04.2012	07.2012	10.2012	EU - 27	Poland	10.2011	01.2012	04.2012	07.2012	10.2012
Gross Domestic Product (GDP) in %	1,70	1,40	0,80	0,10	-0,30	4,5	4,2	4,4	3,8	2,5	30	70	56,24	55,32	*54,69*	50,62	50,64
Foreign trade balance in billions of euro	8,89	12,92	1,31	5,93	10,91	-6,6	-10,3	-1	-4,8	-7,8	40	60	51,40	50,56	47,93	44,97	45,66
Harmonized unemployment rate in % (-)	-9,50	-9,80	-10,20	-10,30	-10,50	-9,4	-10	-10,2	-9,9	-10	50	50	50,56	49,79	45,17	43,33	44,67
HICP - harmonized indicator of consumption prices in % (-)	-3,30	-3,00	-2,90	-2,60	-2,70	-3,5	-4,5	-3,9	-4,2	-3,8	60	40	53,72	53,02	46,41	45,68	47,68
Industrial output in %	4,30	0,00	-1,80	-2,30	-1,80	5,5	9,8	5,5	2,4	4,6	70	30	*60,88*	*60,25*	51,65	*52,03*	*54,69*
Construction output in %	0,00	0,00	0,00	0,00	0,00	0	0	0	0	0	Round wood price expressed in zł/ m^3 in November 2012 based on prices from the first half of the year						
Crude rate = sum of elements	2,09	1,52	-12,79	-9,17	-4,39	-9,50	-10,80	-5,20	-12,70	-14,50							
Assumption for components	50					50					Assumption for components		SO				SW
Adjusted rate	26,045	25,76	18,605	20,415	22,805	20,25	19,60	22,40	18,65	17,75			S2B		W_STANDARD		
Average three-month euro exchange rate - zł/€						4,27	4,43	4,17	4,26	4,11	EU - 27	Poland	pld	sed	pld	sed	pld	sed
Macroeconomic index of changes in round wood prices						50,56	49,79	45,17	43,33	44,67	30	70	*161,87*	*236,86*	*182,35*	*306,69*	*181,69*	*314,91*
Changes in macroeconomic index						1	0,985	0,893	0,857	0,883	40	60	159,66	233,64	179,87	302,51	179,22	310,62
								1	0,959	0,989	50	50	158,80	232,38	178,90	300,88	178,25	308,95
Type of wood	Assortment	Application Wood Web Portal				Round wood price in zł/ m^3					60	40	159,54	233,46	179,73	302,28	179,08	310,38
						I	Q1-12	Q2-12	Q3-12	wrz-12	70	30	161,48	236,30	181,92	305,96	181,26	314,16
SO pine	S2B average-size wood	forest and wood web portal				179,77	177,07	160,53	154,06	158,80	Round wood price expressed in zł/ m^3 in November 2012 based on prices from the second half of the year							
		e- systemic wood web portal				*263,05*	259,10	234,90	225,43	232,38								
	W_STANDARD large- size wood	forest and wood web portal				202,52	199,48	180,85	173,56	178,90	Assumption for components		SO				SW	
		e- systemic wood web portal				*340,60*	335,49	304,16	291,89	300,88			S2B		W_STANDARD			
SW spruce	W_STANDARD large- size wood	forest and wood web portal				201,78	198,75	180,19	172,93	178,25	EU - 27	Poland	pld	sed	pld	sed	pld	sed
		e- systemic wood web portal				*349,73*	344,48	312,31	299,72	308,95	30	70	152,98	196,32	192,06	239,94	222,90	297,64
Type of wood	Assortment	Application - wood web portal				Round wood price in zł/ m^3					40	60	157,36	201,94	197,56	246,81	229,28	306,15
						II	Q3-12	Q4-12			50	50	163,36	209,64	205,09	256,21	238,02	317,82
SO pine	S2B average-size wood	pld - forest and wood web portal				165,2	*158,43*	*163,36*			60	40	169,71	217,78	213,06	266,17	247,27	330,17
		sed - e- systemic wood web portal				212	203,31	209,64			70	30	*174,91*	*224,46*	*219,59*	*274,33*	*254,85*	*340,29*
	W_STANDARD large- size wood	pld - forest and wood web portal				207,4	*198,90*	*205,09*			Proposed price		186		230		277	
		sed - e- systemic wood web portal				259,1	248,48	256,21										
SW spruce	W_STANDARD large- size wood	pld - forest and wood web portal				240,7	*230,83*	*238,02*										
		sed - e- systemic wood web portal				321,4	308,22	317,82										

Source: own elaboration based on the data on the economic condition of the country

Table 2. Determining the macroeconomic index of changes in wood prices including the construction industry output

Determining the macroeconomic index of changes in wood prices	EU- 27					Poland					Macroeconomic index of round wood price change						
	1	2	3	4	5	1	2	3	4	5	Assumption for components		1	2	3	4	5
	Q4-11	Q1-12	Q2-12	Q3-12	Q4-12	Q4-11	Q1-12	Q2-12	Q3-12	Q4-12			Q4-11	Q1-12	Q2-12	Q3-12	Q4-12
	10.2011	01.2012	04.2012	07.2012	10.2012	10.2011	01.2012	04.2012	07.2012	10.2012	EU - 27	Poland	10.2011	01.2012	04.2012	07.2012	10.2012
Gross Domestic Product (GDP) in %	1,70	1,40	0,80	0,10	-0,30	4,5	4,2	4,4	3,8	2,5	30	70	62,51	*64,77*	*60,69*	*53,73*	43,07
Foreign trade balance in billions of euro	8,89	12,92	1,31	5,93	10,91	-8,5	-12	-1	-3,9	-6,4	40	60	56,86	58,76	51,73	46,65	38,20
Harmonized unemployment rate in % (-)	-9,50	-9,80	-10,20	-10,30	-10,50	-9,4	-10	-10,2	-9,9	-10,1	50	50	55,21	56,74	46,77	43,58	37,32
HICP in % (-)	-3,30	-3,00	-2,90	-2,60	-2,70	-3,5	-4,5	-3,9	-4,2	-3,8	60	40	57,56	58,72	45,81	44,50	40,44
Industrial output in %	4,30	0,00	-1,80	-2,30	-1,80	5,5	9,8	5,5	2,4	1,7	70	30	*63,91*	64,70	48,85	49,42	*47,56*
Construction output in %	0,60	0,70	-9,40	-6,90	-6,80	10,6	14,9	12,6	6,5	-6,3	Round wood price expressed in zł/ m^3 in November 2012 based on prices from the first half of the year						
Crude rate = sum of elements	2,69	2,22	-22,19	-16,07	-11,19	-0,80	2,40	7,40	-5,30	-22,40							
Assumption for components	50					50					Assumption for components		SO				SW
Adjusted rate	26,345	26,11	13,905	16,965	19,405	24,60	26,20	28,70	22,35	13,80			S2B		W_STANDARD		
Average three-month euro exchange rate - zł/€						4,27	4,43	4,17	4,26	4,11	EU - 27	Poland	pld	sed	pld	Sed	pld	sed
Macroeconomic index of changes in round wood prices						55,21	56,74	46,77	43,58	37,32	30	70	123,86	181,25	139,54	234,68	139,03	240,98
Changes in macroeconomic index						1	1,028	0,847	0,789	0,676	40	60	120,75	176,69	136,03	228,78	135,54	234,92
								1	0,932	0,798	50	50	121,50	177,79	136,87	230,20	136,38	236,37
Type of wood	Assortment	Application wood web portal				Round wood price in zł/ m^3					60	40	126,29	184,80	142,27	239,27	141,75	245,69
						I	Q1-12	Q2-12	Q3-12	Q4-12	70	30	*133,77*	*195,75*	*150,70*	*253,45*	*150,15*	*260,25*
SO pine	S2B average-size wood	forest and wood web portal				179,77	184,80	152,26	141,83	121,50	Round wood price expressed in zł/ m^3 in November 2012 based on prices from the second half of the year							
		e- systemic wood web portal				*263,05*	270,42	222,80	207,55	177,79								
	W_STANDARD large- size wood	forest and wood web portal				202,52	208,19	171,53	159,78	136,87	Assumption for components		SO				SW	
		e- systemic wood web portal				*340,60*	350,14	288,49	268,73	230,20			S2B		W_STANDARD			
SW spruce	W_STANDARD large- size wood	forest and wood web portal				201,78	207,43	170,91	159,20	136,38	EU - 27	Poland	pld	sed	pld	Sed	pld	sed
		e- systemic wood web portal				*349,73*	359,52	296,22	275,94	236,37	30	70	117,25	150,47	147,21	183,90	170,84	212,61
Type of wood	Assortment	Application - wood web portal				Round wood price in zł/ m^3					40	60	121,98	156,54	153,14	191,31	177,73	221,18
						II	Q3-12	Q4-12			50	50	131,81	169,15	165,48	206,73	192,05	239,00
SO pine	S2B average-size wood	pld - forest and wood web portal				165,2	*153,97*	*131,81*			60	40	145,82	187,13	183,07	228,71	212,47	264,41
		sed - e- systemic wood web portal				212	197,58	169,15			70	30	*160,82*	*206,39*	*201,91*	*252,24*	*234,33*	*291,61*
	W_STANDARD large- size wood	pld - forest and wood web portal				207,4	*193,30*	*165,48*			Proposed price		150		186		215	
		sed - e- systemic wood web portal				259,1	241,48	206,73										
SW spruce	W_STANDARD large- size wood	pld - forest and wood web portal				240,7	*224,33*	*192,05*										
		sed - e- systemic wood web portal				321,4	299,54	256,43										

Source: own elaboration based on the data on economic condition of the country

Average 3-month euro exchange rate - own elaboration based on data as of end of October, January, April, July
Foreign trade balance in billions of euro: to EU-27 = value from CSO to Germany/10; to Poland = value from CSO
HICP - harmonized indicator of consumption prices in % (-)

Table 3. Comparison of macroeconomic indexes of changes in wood prices and prices including (100%) and excluding (in table 3) output in the construction industry

Relation of macroeconomic indexes of changes in round wood prices							
Assumption for components		1	2	3	4	5	
		Q4-11	Q1-12	Q2-12	Q3-12	Q4-12	
EU- 27	Poland	10.2011	01.2012	04.2012	07.2012	10.2012	
30	70	*111,15*	*117,08*	*110,97*	*106,14*	85,05	
40	60	110,62	116,22	107,93	103,74	83,66	
50	50	109,20	113,96	103,54	100,58	83,54	
60	40	107,15	110,75	98,71	97,42	84,81	
70	30	104,98	107,39	94,58	94,98	*86,96*	
Relation of round wood prices in % based on prices from the first half of 2012							
Assumption for components		SO				SW	
		S2B		W_STANDARD			
EU- 27	Poland	pld	sed	pld	sed	pld	Sed
30	70	76,52	76,52	76,52	76,52	76,52	76,52
40	60	75,63	75,63	75,63	75,63	75,63	75,63
50	50	76,51	76,51	76,51	76,51	76,51	76,51
60	40	79,16	79,16	79,16	79,16	79,16	79,16
70	30	*82,84*	*82,84*	*82,84*	*82,84*	*82,84*	*82,84*
Relation of round wood prices in % based on prices from the second half of 2012							
Assumption for components		SO				SW	
		S2B		W_STANDARD			
EU- 27	Poland	pld	sed	pld	sed	pld	sed
30	70	76,64	76,64	76,64	76,64	76,64	71,43
40	60	77,51	77,51	77,51	77,51	77,51	72,24
50	50	80,69	80,69	80,69	80,69	80,69	75,20
60	40	85,93	85,93	85,93	85,93	85,93	80,08
70	30	*91,95*	*91,95*	*91,95*	*91,95*	*91,95*	*85,69*
		81		81		78	

Source: own elaboration

- pld stands for Portal Leśno – Drzewny, that is: the Forest and Wood Web Portal,
- sed stands for e-drewno systemowe, that is: systemic auction at the e-drewno wood web portal,
- SO stands for pine,
- ŚW stands for spruce,
- W stands for large- size wood,
- S stands for average-size wood,
- STANDARD means unsorted.
- macroeconomic index of wood price change including construction output = 100%
- macroeconomic index of wood price change excluding construction output - in table

Higher expected round wood prices were obtained for ratios excluding the construction output (Table 1). In the fourth quarter of 2012 the component ratios for construction output are very low, which has an impact on the significant decrease of the macroeconomic index and round wood prices determined on the basis thereof.

If the prices from the first half of 2012 are to form the basis for determining round wood prices in the future – then the lowest prices are obtained for the following share of component ratios: EU-27 = 40 per cent, Poland = 60 per cent, and the highest for the proportion: 70 per cent for the EU-27, 30 per cent for Poland (Table 2).

Whereas if the basis for future prices are to be the prices from the second half of 2012 – the lowest prices are obtained for the following share of component ratios: EU-27 = 30 per cent, Poland = 70 per cent, the highest, similarly to when prices from the first half of the year formed the basis, were obtained for the proportion: 70 per cent for the EU-27 and 30 per cent for Poland (Table 2).

In order to forecast the prices for the fourth quarter of 2012 it is suggested to select the variant including the construction output (Table 2), based on round wood prices from the second half of 2012 and for the following share of component ratios: EU-27 = 50 per cent, Poland = 50 per cent. All figures are recorded in Table 2.

Those are as follows:

SO S2B pld = 132 zł/m^3,
SO S2B sed = 169 zł/m^3,
SO W_STANDARD pld = 165 zł/m^3,
SO W_STANDARD sed = 207 zł/m^3,
ŚW W_STANDARD pld = 192 zł/m^3,
ŚW W_STANDARD sed = 239 zł/m^3,

where:
pld stands for: Portal Leśno–Drzewny, that is the Forest and Wood Web Portal,
sed stands for: e-drewno systemowe, that is the e-drewno systemic wood web portal,
SO stands for pine,
ŚW stands for spruce,
W stands for large- size wood,
S stands for average-size wood,
and STANDARD means unsorted.

Those prices are approximately 20 per cent lower when the construction output (sixth component) is excluded as an element of component ratios.

On such basis, for the initial price of purchase for the first half of 2013 we suggest to use the prices from the second half of 2012 – as average prices from both the Forest and Wood Web Portal (Portal Leśno – Drzewny) (pld), and from the e-drewno systemic wood web portal (e-drewno systemowe) (sed), which is as follows (Table 2):

SO S2B = 150 zł/m^3,
SO W_STANDARD = 186 zł/m^3,
ŚW W_STANDARD = 215 zł/m^3.

The proportion of EU-27 = 50 per cent and Poland = 50 per cent will allow to keep the best stability of conditions for cooperation between the forest sector and the wood industry. It also meets the currently forecasted conditions for operations in the forest and wood sector for the upcoming six months.

CONCLUSION

The Polish economy has been ever more intensively going into a recession phase. It is estimated that the year 2013 will be very unfavourable for Polish economic development. Undoubtedly, Poland will not be "a green Island" on the map of Europe anymore, and will cease to demonstrate GDP growth. Significantly higher GDP will be noted by countries like Slovakia, Bulgaria and the Baltic states.

During the previous recession in 2008 and 2009 our relatively good economic development was the result of investments – financed by EU funds. They have also stimulated our internal market

which became the second important source of activating the economy and intensifying the business cycle.

Funds for investment from the EU budget for the period of 2007 – 2013 will soon be spent. This has already been significantly experienced in the construction sector. A gradual yet deepening decrease in internal demand caused by poor and ever worsening consumers' confidence demonstrate negative labour market prospects, especially the systematically growing unemployment rate.

The trend in the whole economy is reflected by the industry, especially the wood industry. Since mid 2012 the situation has been worsening. Efficiency declines and the levels of purchase orders are also decreasing.

This process is first reflected in the accessibility of wood and then in wood prices. The symptoms in the forest industry signify that the sector's representatives are more concerned with round wood prices than its supply.

There are significant signs of decrease in wood prices. Information published by the Central Statistical Office and the Monitor Polski on the 24th of October shows that sales prices of 1m3 of round wood have decreased for the first time since 2009. The change is small, only by 0,14 per cent, but it only proves the observed trend true.

Also the macroeconomic indexes, used for determining trends on the round wood market, have shown a gradual decline. It is therefore a good moment for introducing new solutions concerning negotiating wood prices.

Round wood prices are still determined by the energy sector, its demand and subsidized biomass burning. In this respect the changes in Polish regulations which have been already introduced may significantly reduce the irrational burning of biomass, not only that produced from wood. Moreover, interventions at the EU level seem vital here.

REFERENCES

1. Czopek P. (2012): Usytuowanie i regulacje prawne dotyczące biomasy leśnej. Ministerstwo Gospodarki, Departament Energii Odnawialnej (24.10.2012).
2. Lis W. (2011a): Biomass as an energy source. Intercathedra No 27/4. ISSN 1640-3622. Poznań, pp. 19-22, Tab. 3, Ref. 8.
3. Lis W. (2011b): Czy drewno powinno być źródłem energii odnawialnej? Przemysł Drzewny 12/2011, vol. 62, pp.7-23, Tab. 17, Fig. 3, Ref. 73.
4. Lis W. (2011c): Wood and biomass used for energy purposes. Intercathedra No 27/3. ISSN 1640-3622. Poznań, pp. 39-43, Tab. 1, Ref. 9.
5. Lis W. (2012a): Akceptowalna przez przemysł drzewny zmiana struktury podaży oraz cen drewna – wpływ wzrostu udziału biomasy drzewnej na cele energetyczne. In: Możliwości oraz uwarunkowania podaży drewna do celów energetycznych. Instytut Badawczy Leśnictwa. Sękocin Stary 20-21.11.2012, p. 16, Tab. 5, Ref. 20.
6. Lis W. (2012b): Kryzys gospodarczy oraz sytuacja ekonomiczna polskiego sektora leśno - drzewnego w 2012 roku. Przyrodnicze i gospodarcze aspekty produkcji oraz wykorzystania drewna – stan obecny i prognozy. Zimowa Szkoła Leśna przy Instytucie Badawczym Leśnictwa – IV sesja. Sękocin Stary 20-22.03.2012, pp. 273 - 297, Fig. 1, Tab. 8, Ref. 78.
7. Lis W. (2012c): Recipients of roundwood from the State Forests in Poland. „Intercathedra" No 28/1. ISSN 1640-3622. Poznań, pp. 36-41, Tab. 3, Ref. 31.
8. Lis W. (2012d): Zaopatrzenie przemysłu w drewno na tle sytuacji gospodarczej w Polsce I Europie. Rynek Drzewny, Ed. On-line: 07.02.2012. Biuletyn Polskiej Izby Gospodarczej Przemysłu Drzewnego. Poznań, pp. 1- 10, Tab. 2, |Ref. 15.
9. Łangalis M. (2012): Ranking najbardziej dynamicznie rozwijających się gospodarek na świecie. Wyd. Instytut Globalizacji.
10. Materiały (2012) Konferencji: Forum biomasy – produkcja, kontraktowanie, logistyka. Ministerstwo Gospodarki. Bełchatów, 27-28.10.2011; Ostrołęka 22-23.03.2012.

11. Projekt (2012) rozporządzenia Ministra Gospodarki w sprawie szczegółowego zakresu obowiązków uzyskania i przedstawienia do umorzenia świadectw pochodzenia, uiszczenia opłaty zastępczej, zakupu energii elektrycznej i ciepła wytworzonych w odnawialnych źródłach energii oraz obowiązku potwierdzania danych dotyczących ilości energii elektrycznej wytworzonej w odnawialnym źródle energii. Ministerstwo Gospodarki, Departament Energetyki 2012.
12. Schumpeter J. (2009): Kapitalizm, socjalizm, demokracja. PWN Warszawa.

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SOLID AND ENGINEERED WOOD AND ITS SIGNIFICANCE FOR INNOVATIVE SOLUTIONS IN TIMBER BUILDING PROJECTS

Abstract: The results of deteriorating economic situation in Europe are visible in numerous fields of economy also in Poland. Wooden sector is also among those undergoing a difficult phase. It is the result of its specific production process as well as its Total dependence from the main supplier that is National Forests. Hence seeking solutions which will enable the producers to function properly in this period of an economic slump becomes a necessity.

The aim of the article is to highlight the broad potential of engineered wood, which in the situation of increase of wood prices and the shortage of this material on the market becomes an interesting, often cheaper alternative for wooden construction. Additionally, its aim is to present the parameters of solid and engineered wood in a context of wooden construction, as well as point at the innovative solutions which facilitate meeting European Union contemporary standards in home building.

Keywords: timber construction, wood materials, innovations

INTRODUCTION

Modern solutions in respect to materials and construction techniques used in wooden construction become popular with both home producers as well as the investors. New ideas focus not only on technical aspects but also economic and ecological ones, which currently determine the trends in home building.

Currently functioning systems of timber frame construction prove that the origin of their creation and modernization lies mainly in the usage of the qualities of solid wood and based on it composite wood. As a consequence home producers following the new market trends ever more eagerly seek innovative solutions, mainly in respect to wooden materials using their technical, practical and aesthetic qualities (Mydlarz 2011).

SOLID WOOD AS CONSTRUCTION MATERIAL AND ITS PROPERTIES

Mechanical and physical solid wood properties are basic parameters which confirm its usability especially in construction sector (Dzbeński 1984, Kokociński 2004). The quality of wood assigned for engineering to a large extend depends on the type of habitat its productivity class and the age of the stand. An important element is mainly the technical maturity of the material. Surveys carried out in respect to that for pinewood, which constitutes the basic material in wooden construction indicate that parameters such as diameter and the length of knot-free area determine the usability of the material also for construction. It is assumed that there is a close relation between those ratios and physical parameters such as density, compressive strength and static bending of obtained wood.

Physical parameters of wood have a large impact on mechanical features of lumbar for construction sector. Basic parameters are density and moisture. Wood mechanical strength grows along with the increase in density and the decrease in absolute wood moisture. Wood density as well as its mechanical strength are proportionally linked to the share of late wood and its growth enhances wood compressive strength. Hence the width of annual ring has an impact on wood mechanical properties (Dzbeński et al. 2005, 2007).

Engineered wood aims at eliminating its defects in order to maximize quantitative yield of standard value material. Therefore, apart from solid elements composite elements are also manufactured. Thanks to a simple manipulation of eliminating defects present in solid wood and

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then gluing processed elements one obtains material of high mechanical parameters and dimensional stability, limited warping, large cross-section and theoretically an unlimited length – practically only restricted by transport requirements (Krzosek 2009, Wieruszewski et al. 2009, 2010, 2011).

When designing construction elements mainly mechanical properties of base material are considered thanks to which determining a safe cross-section of a construction element is possible (Mielczarek 1994, Kotwica 2004, Neuhaus 2004).

ENGINEERED WOOD PROPERTIES

Composite wood is largely used both in wooden as well as traditional construction. It is mainly manufactured from particles or fibers and other wood waste. Their popularity to a large extend is the result of very good technical parameters general accessibility and good price. Apart from that in many cases there are simply no substitutes available. Composite wood covering might serve as an example, as it constitutes one of the basic materials for constructing walls in wooden frames. Among them there are OSB panels and chipboard V-100. It's main characteristics is high rigidity which influences building construction durability. Wood wool becomes ever more common insulating material and solid wood - the basic material from which wooden constructions are manufactured is substituted by engineered wood.

Common usage of engineered wood especially in timber frame constructions is also justified by its high efficiency. For wood it comes to approximately 90%, while the efficiency of sawmill material assigned for construction assortment does not exceed 60-70% (Wieruszewski, Mydlarz 2007).

Intensive popularization of engineered wood is also an effect of ever growing deficit of high-quality large-size wood. Hence what is significant for their production is the fact that mainly less valuable material is used which mass growth is few times larger than that of standard value sawmill material. (System Kronopol 2007).

SOLID AND ENGINEERED WOOD IN HOME BUILDING

The significance of technical parameters of both solid and engineered wood stems from the fact that the share of those materials in the overall cost of the construction regardless of the implemented technology is of crucial importance. In picture 1 the share in the total price of both solid and composite wood has been presented on the example of one-family house build using three different technologies: traditional – based on clay filler blocks, timber frame and timber log technology. As it can be observed from the presented data, the highest share of wood in relation to the price of all materials used for the construction is characteristic for timber log technology and amounts to approximately 52%. While the lowest share relates to traditional technology and amounts to 7,3%. In timber frame technology the ratio of wood to the remaining construction materials amounts to 25%. The highest share of engineered wood among those analyzed construction technologies is noted in timber frame technology and amounts to almost 5% (Fig. 1).

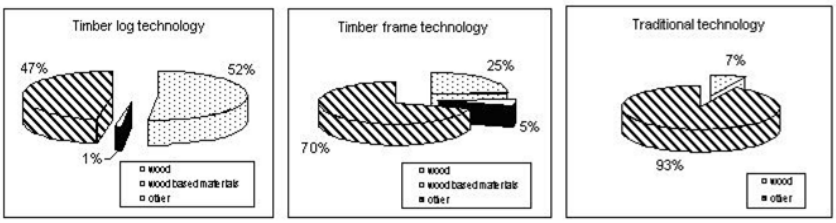

Fig. 1. Share of solid and engineered wood in the overall price of one-family house built in various technologies

Substantial share of solid and composite wood in the total price of a complete house causes problems with timely completion of the projects due to an unstable wood market Apart form that even the smallest increase in prices of raw material with a large share of wooden materials in the overall costs is visibly reflected in the price of a final product. Therefore, a decrease in the demand for such houses can be observed. It is a problem for the producers not only due to a shrinking domestic market, which is generally small, but most importantly decreasing demand among foreign investors for who, in such situation, Polish producers lose their competitive value.

INNOVATIVE SOLUTIONS IN WOODEN CONSTRUCTION

Economic target of each company including the producers of timber frame houses is achieving economic efficiency. To make it possible potential for development is vital, it characteristics are among others an adequate condition and structure of capital, the quality of human resources, predisposition for investing and the innovative abilities which is a tool for becoming competitive on the market. Due to that companies gain advantage over their competitors. Competition is most often the factor which stimulates introducing changes and seeking new solutions.

Home building for years has been looking for solutions which would speed up the building process as well as have an impact on the reduction of operating costs. Special attention is paid to the improvement of house energy parameters, which as it has been stated in EU directive aims at reducing global energy usage, and from ecological point of view – at lowering the emissions of greenhouse gases (Dyrektywa 2002/91/UE (EPBD). Therefore, building companies and houses producers improve contemporary technologies looking for new solutions. An example in wooden construction might be the systems which are most frequently implemented in western European countries. One of them is German palisade system, the other Swiss Do-It-Yourself Steco system. Both solutions were implemented in order to fill in market niche. House installation in case of using Steco system aims at maximum reduction of installation costs giving each investor a possibility of self-completing the construction. In case of palisade system a small-size wood and 72 mm diameter logs are used which makes the material cheaper and more accessible (Mydlarz 2011).

Another alternative for large-size wood is Polish system of building houses using prefabricated wooden logs (the system is protected by Polish and international patent law). Due to filling the log with multiple insulating material substantial amounts of wood are saved while achieving dimensional stability, resistance to bending and cracking, low weight of elements as well as high heat transfer coefficient – from 0,18 up to 0,24 W/m2K. It facilitates constructing buildings where low energy usage for heating purposes guarantees low operating costs (magnusholding.maxtrader 2010).

Fig. 2. Combination of stromal (www.domysyberyjskie.pl)

Innovations apart from modernizing technologies also aim at reducing company costs, better allocation and logistics of their resources. Hence entrepreneurs create new project so as to keep or improve the efficiency of their operations.

SUMMARY

Implementing modern solutions in house construction one has to account for the risk being the result of changeable level of demand, which is the consequence of a difficult economic situation in Europe. Potential clients have to be convinced that the change in costs is justified in order to accept innovative solutions. Thanks to that in the long-term one may expect the improvement in company profitability. Otherwise, the recipients may be critical of the idea. Hence it is vital that market research and initial market analysis are carried out carefully and systematically in order to properly reflect economic reality. As the result limiting potential risk will become possible while the company image will improve due to ever more modern technological changes and enhancing economic factors in the process of manufacturing and maintaining buildings.

The process of introducing technical and technological innovations is an important aspect of company operations. Taking account of the changes in building law and ever growing quality requirements concerning both the material and performance they will determine if the company develops or does not meet market demand.

REFERENCES:

1. Dyrektywa 2002/91/UE (EPBD)
2. Dzbeński W.: Nieniszczące badania mechanicznych właściwości iglastej tarcicy konstrukcyjnej wybranymi metodami statycznymi i dynamicznymi. SGGW-AR, Warszawa 1984.
3. Dzbeński W., Kozakiewicz P., Krzosek S.: Wytrzymałościowe sortowanie tarcicy budowlano-konstrukcyjnej. SGGW, Warszawa 2005.
4. Dzbeński W., Kozakiewicz P., Wiktorski T.: Sortowanie tarcicy ogólnego przeznaczenia. SGGW, Warszawa 2007.
5. Kokociński W.: Drewno Pomiary właściwości fizycznych i mechanicznych. Poznań 2004.
6. Kotwica J.: Konstrukcje Drewniane W Budownictwie Tradycyjnym. Arkady, Warszawa 2004-2005.
7. Krzosek S., (2009): Wytrzymałościowe sortowanie polskiej sosnowej tarcicy Krzosek S., 2009: Wytrzymałościowe sortowanie polskiej sosnowej tarcicy konstrukcyjnej różnymi metodami, SGGW, Warszawa.
8. magnusholding.maxtrader (2010)
9. Mielczarek Z. (1994): Budownictwo drewniane, Arkady
10. Mydlarz K. (2011): Contemporary timber-frame construction systems in Europe. Annals of Warsaw University of Life Sciences – SGGW Forestry and Wood Technology No 75, 2011: s. 122-126
11. Neuhaus H. (2004 – 2008): Budownictwo drewniane. Polskie wydawnictwo techniczne, Rzeszów.
12. System Kronopol (2007) – www.kronopol.pl
13. Wieruszewski M., Gołuński G., Hruzik G. J., Gotych V. (2010): „Glued elements for construction" , Annals of Warsaw University of Life Sciences – SGGW Forestry and Wood Technology No 72, s 453 – 458, Warszawa 2010
14. Wieruszewski M., Gotych V., Hruzik G., Gołuński G. (2009): Jakość sosnowych elementów klejonych dla budownictwa szkieletowego. VIII Konferencja Naukowa: Drewno i materiały drewnopochodne w konstrukcjach budowlanych, ZUT, Szczecin 2009.
15. Wieruszewski M., Gotych V. (2011): Prefabrication for production purposes of skeleton furniture, Annals of Warsaw University of Life Sciences – SGGW Forestry and Wood Technology No 76, s 184 – 189, Warszawa 2011
16. Wieruszewski M., Mydlarz K. (2007): Definition of productivity and effectiveness of construction wood in relationship with its turnover on domestic market. Intercathedra No 23; s. 152
17. www.domysyberyjskie.pl 2012

Waldemar Perdoch, Bartłomiej Mazela[11]

INNOVATIVE APPLICATION OF GLYCERIDES IN BIOCIDE-FREE WOOD PROTECTION AGENTS

Abstract: The presented paper discusses utilisation of glyceride compounds as well as glyceride compounds in mixtures with silico-organic compounds as a potential active constituent of biocide-free systems enhancing biological wood durability. Experiments were carried out on Scots pine (Pinus sylvestris L.) wood with respect to wood decaying fungi. In addition, biological tests were conducted taking into consideration aging processes. The applied system turned out to have potential possibilities of competing with biocidal systems that are being withdrawn for ecotoxicological reasons.

Keywords: glycerides, organosilicon compounds, biocide-free wood protection BPD, economical aspect.

INTRODUCTION

The practical and cognitive objectives of the performed experiments involved the development of biocide-free wood protection systems based on glycerides as well as mixtures of glycerides and silico-organic compounds. This will contribute to improved wood durability exposed to biotic factors. However, the overriding aim of investigations was the elimination of biocides from wood protective systems for environmental and economic reasons. During the period of unrestricted increase in numbers and diversity of active as well as biologically active substances, very restrictive rules were implemented attempting to regulate the principles of utilisation of these products. In the member states of the European Union these regulations are to be found in the Directive 98/8 of the European Parliament and Council, whose aim is to protect human health and the environment as well as to harmonise the continental market. On the basis of the above-mentioned Directive, many biocidal agents were withdrawn from use or, alternatively, their utilisation was considerably restricted. Furthermore, the introduction of new biocides has become more difficult for economic reasons since the applicant bears significant financial expenses for carrying out verification investigations which last from 3 to 4 years. These regulations also enforced the implementation of changes in biocidal agents applied in wood protection. That is why it seems rational to seek and utilise biocide-free systems which are safer for the environment and humans and can be cheaper.

Biocide-free agents containing esters of higher fatty acids or/and silane additives can contribute to the improvement of physico-chemical properties and decrease the risk of action of biotic factors, especially fungi [3]. There are wood impregnation agents [2] which are based on resins which are the reaction products of fatty acid anhydrides. Moreover, alcohol esters of fatty acids constitute components of agents which can increase resistance to decaying and aging processes and which are employed in the patent application PL 193500 [5]. One of the principal extractive constituents of pine wood, apart from fatty and resin acids, waxes, fatty alcohols, sterols and steryl esters are glycerides. Wood deprived of these constituents is characterised by a significantly reduced resistance to biological attack [1]. An addition of silico-organic compounds which, thanks to their chemical structure, form new silane-wood bonds [6,7], leads to reduced hygroscopicity, surface hydrophobisation and to the increase of dimensional stability [8]. Novel biocide solutions are impatiently expected by both manufacturers and consumers of wood protection-decorative agents who are interested in cheaper and increasingly ecological products.

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MATERIAL AND METHODS

The scope of investigations comprised practical organic chemistry of biocidal formulations containing economically rational concentrations of silico-organic compounds (5%) and glycerides as well as mycological experiments with respect to fungi decaying wood which was protected by the prepared systems.

Mono- di- and triglycerides of butyric acid (20%) as well as the following silico-organic compounds: aminethyl-aminpropyl trimethoxysilane (AEAPTMOS) [Xiameter OFS-6020 Silane] and methyltrimethoxysilane (MTMOS) [Wacker M1-trimethoxy silane] (5%) were used to prepare the experimental protective systems for wood, while ethyl alcohol and water were employed as solvents. The prepared systems were used to treat pine wood samples measuring 0.7 x 2.5 x 5 cm (the last measurement was taken along fibres) with the soaking method for a period of 45 min. The impregnant absorption was controlled and amounted to 80 – 110 L/m^3. The chemical composition of the prepared systems is presented in Table 1.

Table 1. Chemical composition of the examined protective systems

Code symbol	Glyceride concentration %	MTMOS concentration %	AEAPTMOS concentration %
1	20	0	0
2	20	2.5	2.5
3	20	5	0
4	20	0	5
5	0	5	0
6	0	0	5
7	0	0	0

Mycological examination – all samples were exposed to the action of the wood decaying fungus *Coniophora putaena* in accordance with the screening test-method based on the EN 113 standard. Mass losses following the exposure were measured after eight weeks. All the examined systems were subjected to aging tests in accordance with the EN 84 standard and then mycological tests were performed according to the above-mentioned procedure.

RESULTS

The results of mycological investigations of Scots pine wood treated with the systems containing glyceride as well as glyceride and silico-organic compounds are presented in Table 2. The collected data comprises mean values from five samples subjected and five samples not subjected to aging processes (L).

In the case of wood which was not subjected to aging processes, the exclusive treatment with 20% glyceride solution turned out to be most effective. Mass loss after 8-week long exposure amounted only to 1.4 per cent, while the mass loss of the non-treated wood reached about 16 per cent. Unfortunately, this substance is not resistant to aging processes because after leaching, glyceride effectiveness decreased significantly and the wood mass loss following the applied biological test amounted to 14.2 per cent, i.e. it was very similar to crude wood. In the next step, silico-organic compounds were added in order to increase the effectiveness of glyceride action after aging tests. The best results were determined following the application of a 5 per cent addition of MTMOS. For leached samples, high effectiveness was maintained as the recorded mass loss amounted to 2.4 per cent and it increased only slightly to 4 per cent for aged samples. Moreover, it should be emphasised that the AEAPTMOS silane alone exhibited fungistatic properties (non-leached – 2.3 per cent mass loss; leached – 5.1 per cent). This, however, failed to translate into the system with glyceride in which (in comparison with pure silane) both values of the mass loss, before (3.2 per cent) as well as after (7.2 per cent) leaching, were found to deteriorate. Figure 1 presents photographs of a non-aged wood sample impregnated with glyceride (Photo 1a), an aged

wood sample (Photo 1b) and a crude wood sample (Photo 1c). Macroscopically, a clear difference is apparent between effectively protected wood (Photo 1a) and the control and aged samples. Well-protected wood maintained its colour and undamaged surface structure.

Table 2. Mass loss of wood impregnated using glyceride systems and exposed to the action of Coniophora putaena

Code symbol	Retention [L/cm^3]	Wood moisture content after test %	Mass loss %
1	98	27.9	1.4
1L	96	42.2	14.2
2	97	77.3	1.6
2L	99	41.1	7.9
3	94	66.1	2.4
3L	89	35.3	4.0
4	107	63.4	3.2
4L	109	39.9	7.2
5	78	28.5	4.4
5L	81	43.9	9.4
6	87	32.5	2.3
6L	83	35.9	5.1
7	0	32.6	15.7

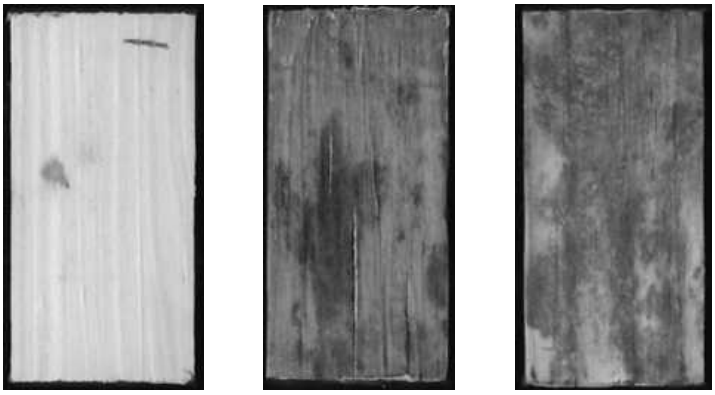

Photo a. Photo b. Photo c.

Fig. 1. Wood exposed to the action of the *Coniophora putaena* test fungus: wood sample impregnated with preparation 1 without the aging cycle – Photo a; wood sample impregnated with preparation 1 following the aging cycle – Photo b; control sample – Photo c.

CONCLUSIONS

The performed investigations demonstrated potential application possibilities of glyceride compounds in biocide-free wood protection systems. The recorded negligible loss of pine wood impregnated with the glyceride confirmed the fungistatic effectiveness of the examined substance against the test fungus. Furthermore, the addition of silico-organic compounds increased the biological resistance of wood subjected to artificial aging. Investigations conducted on novel biocide-free agents make it possible to considerably reduce implementation expenses which, for new biocidal substances, can run into hundreds of thousands of euros. The innovative application in the experimental systems of the two main constituents, i.e. triglycerides hitherto not used for wood protection as well as silico-organic compounds gaining increasing acceptance presented in this study, was presented more thoroughly in the submitted patent application No. P-398677 [4].

REFERENCES

1. Dorado J., van Beek T.A., Claassen F.W., Sierra-Alvarez R.: Degradation of liphophilic wood extractive constituents in Pinus sylvestris by the white-rot fungi Bjenkandera sp and Trametes versicolor. Wood science and technology, 2001, 35, 117-125.
2. EP 1174231 Wood preserver.
3. Hill C., Mastery Farahani M., Hale M.: The use of organo alkoxysilane coupling agents for wood preservation. Holzforschung, 2004, 58:316–325.
4. P-398677 Środek ochrony drewna i materiałów drewnopochodnych oraz sposób zabezpieczania drewna i materiałów drewnopochodnych.
5. PL 193500 Środek ekologiczny uodparniający drewno na procesy gnilne i wpływy atmosferyczne.
6. Ratajczak I., Mazela B.: Chemical reaction of cellulose with alkoxysilane molecules. Part I. FTIR analysis. Annals of Warsaw University of Life Sciences, Forestry and Wood Technology, 2009, 69, 219-222.
7. Ratajczak I., Mazela B.: Chemical reaction of cellulose with alkoxysilane molecules. Part II. AAS analysis. Annals of Warsaw University of Life Sciences, Forestry and Wood Technology, 2009, 69, 223-226.
8. Sèbe G., Tingaut P., Safou-Tchiama R., Pétraud M., Grelier S., De Jéso B.: Chemical reaction of maritime pine sapwood (Pinus pinaster Soland) with alkoxysilane molecules. 6thWorkshopon, Optimisation and Remediation of Preservatives 2004.

Marcin Senderski[12]

SELF-REGULATION AS A REMEDY FOR MARKET TURMOIL: AN OVER-THE-COUNTER OR A PRESCRIPTION DRUG?

Abstract: The paper tackles the problem of the overwhelming regulatory burden that marks its presence in a post-crisis environment. With evidence of regulatory overload in some cases, paths for more effective design of regulatory frameworks should be sought. Although self-regulation does not enjoy favorable publicity and happens to fail to prove its value in times of distress, it still may serve as a remedy. A number of studies shows that, under specific circumstances, the self-regulatory framework may operate seamlessly for the benefit of all stakeholders. The goal of this paper is to identify these circumstances and validate them on the basis of three concise case studies from the health care, advertising and financial services industry. It is instructive for policy makers in deciding on whether to abandon or reduce public oversight in certain areas, by allowing businesses more freedom in terms of setting and enforcing the rules.

Keywords: self-regulation, self-regulatory organization, regulatory agencies, financial crisis, financial services industry, health care industry, advertising industry

INTRODUCTION

Whatever the new paradigm of market regulation will turn out to be, it will emerge from the ashes of the current financial crisis. The legacy of austerity, public discontent, and citizens' greater vigilance to corporate misconduct, is likely to leave its stamp on it. The rising regulatory pressure emerged as a powerful trend, with the role of regulators growing in significance. This pertains first and foremost to the financial services industry, where the amount of regulations has been growing unceasingly since the outbreak of the downturn. Heavy regulations of ecological nature are also imposed on sectors dealing with energy production, raw materials or building materials.

The overload of regulations may take two forms: the extended coverage of regulatory activities that embraces industries that do not need them; and the elevated scrutiny in regulation, which hinders economic freedom to an unjustified degree. Customer-centrism, the most desired virtue of regulation, decays. The fraction of laws that directly protect customer interest is on remarkable decline. The regulators boost their statistics on the number of bills passed, but are often thought to overlook the utility that should be delivered to ultimate beneficiaries. The Volcker rule or the pressure on regulating the "buyer beware" vehicles, such as private equity or hedge funds 821, could be put forth as examples. In several sectors, the far-flung influence of regulators hampers innovation and curbs entrepreneurship. To introduce a new regulation means to draw the firm away from its core business and make it produce compliance reports and hire consultants.

The once defined basic institutions of capitalism not only remain basic, but enjoy a leading role in the economy and garner political blessing. Over-regulating is typically associated with developed countries (budget of the U.S. regulatory universe amounts to 60 bn USD, i.e. roughly two thirds of Poland's total budget revenue), but the drift towards excessive zeal infests, e.g. to China 20. The costs of public intervention often outweigh the benefits it intends to convey.

Hence, the aim of this paper is to bring about a more conscious application of self-regulatory efforts, being the surrogate for public regulation. They should be given more trust and room for development in industries that are best positioned in this respect. The paper features three case studies from different sectors, in an attempt to detect the characteristics of these industries, which enabled successful private oversight. The term "self-regulation" (alternatively, "private oversight") embodies a situation in which an independent self-regulatory organization (later referred to as SRO) exercises regulatory authority over a certain industry or profession, exclusively or to a certain

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extent. It has to be suitably empowered to perform its duties, either through an explicit government imprimatur (probably in the form of "enforced" self-regulation), a carte blanche for the SRO, or through a pre-emptive move of the SRO, tacitly consented by the public authorities.

RESEARCH QUESTIONS

The criticism around self-regulation rests on the conviction that the quality of oversight would suffer. First, although competitive markets are second to none in terms of efficient production of private goods and accurate allocation of scarce resources, they do not reward market actors for taking care of public welfare. Second, the argument of disastrous market imperfections, unavoidable in self-regulation, is raised. Responding to the first caveat: is public surveillance of a truly superior quality? An average UK small firm has a chance to be controlled for workforce safety once every 80 years [1]. Simultaneously, the level of stress and costs to be borne are high. In this respect, public watchdogs do not hold a candle to their private counterparts. With regard to the second claim, Spinello [22] reminds us of a widespread bias that "market failures" are given more publicity than "government failures", while the latter are far more evident. Therefore, unless the existence of a regulator freed from imperfections is ensured, the complaint lacks validation.

Some critics say that self-regulation is a new weapon of despaired Wall Street sinners, willing to trade orthodox scrutiny for the meaningless trinket of self-regulation. Certainly, ceding regulatory clout to industry is not a life-saving pill. But it might be a risk diversification tool that will wipe out the overkill of regulators and voice the needs of businesses, making them weigh more in decision making processes. However, self-regulation is not a one-size-fits-all approach. Frameworks should be carefully crafted and take into account the peculiarity of different economic sectors and different jurisdictions, as well as the feature that public and private regulations may complement each other [17], which is actually desirable. The empirical harvest is quite edifying, e.g. López-Gamero et al. [18] proved that voluntary norms have an edge over the command-and-control model. Haufler [12] provides some evidence of improved industry practices, but also delivers counterarguments by stating that self-regulation faces considerable organizational and enforcement difficulties and is sometimes unlikely to respond effectively to the underlying challenges. Indeed, the issue of observance of SRO endorsements is problematic in some frameworks, but it is crucial to note that SROs are designed rather to disentangle disputes than to punish for non-compliance.

Between the extremes of pure play self-regulation and pure play state regulation, there is the so-called enforced self-regulation. In this framework, the state strives to co-opt the regulatory potential of corporations. Such mixed approaches have been extensively researched, yielding both: red flags [13] as well as more neutral conclusions [17], and quite enthusiastic inferences [19]. It is difficult to define the superior incarnation of justice and effectiveness, but it surely would feature some amalgamation of self-regulation and government shackles. Unfortunately, self-regulation is apparently not taken seriously by many influential scholars. Stiglitz [23] labels self-regulation as an oxymoron. In their recent publication, Brunnermeier et al. [5] seem to ostensibly neglect self-regulation, thus presumably expressing their vote of no confidence. Cukierman [7] distrusts the whole genre of SROs, driven by the recent moral abuses by top management.

Has the golden age for self-regulation already passed? Despite the critical stances, it is hardly plausible. Provided that conventional oversight is experiencing its dark ages, the opportunity for refurbishing self-regulation arises. How do we harness SROs effectively for collective social benefit?

SCIENTIFIC HYPOTHESES

Based on the qualitative analysis of available case studies, several hypotheses may be drafted in order to identify the industries in which SROs may add value and become or remain a credible source of regulation. These preconditions are enumerated below.

1. Historical evidence that public opinion is satisfied with the performance of SRO. This is somewhat the easiest prerequisite, as it rests on a broad status quo consensus.

2. Market players are embedded with the capability to effectively control each other and exhibit a true commitment to do so. The motivation for ethical conduct and genuine mutual control must be in place until the misbehaviour of one firm proves detrimental to its peers, prompting the deterioration of the whole sector's image.
3. A market involving very complicated, interdisciplinary knowledge, with numerous interdependencies. This would make the headhunting for skilled public regulators futile or the authorities would incur huge costs when staffing the regulatory body.
4. An environment in which quick decisions are needed, and the public regulators, inherently slow-moving, are not well-positioned to satisfy this precondition. The perfect example of such an environment is the Internet, where self-regulation has recently attracted much attention, although this trend has its contenders, too.
5. A market which is out of or remote from the epicentre of public interest. The institutions are not subject to instigate systemic problems or the parties affected by their potential malfunctioning are limited in number or well-qualified to detect the malfunctioning using their own skills (e.g. accredited investors, involved in hedge funds or venture capital industries). This condition seems to be the most difficult to satisfy.

One must notice that the aforementioned list indicates that if the enumerated prerequisites are met, the existence of SROs is facilitated. However, it cannot evaluate a priori the effectiveness of their operations and, consequently, the quality of the regulations introduced by them.

The break-even point, at which the public authority should step in to ensure soundness of regulation, is when the conflict of interest within an industry is deemed too severe and hampers impartiality. The need for external supervision in such cases has been suggested in literature [6].

RESEARCH ISSUE

This paper is anticipated to lay foundations for the "targeted" self-regulation idea, i.e. the selective application of the private oversight model, basing on thorough analysis of market characteristics. A series of brief case studies will facilitate the accomplishment of this objective.

In the case of the medical industry the situation is unsophisticated. There are three broadly defined self-regulated dimensions in medical professions: standards by which people may enter the profession and practice medicine; teaching the medical community how to properly apply those standards; enforcing those standards and disciplining for non-compliance [4]. The medical society was granted the privilege of self-regulation in the middle of the 19th century [16]. This signifies the magnitude of the status quo (requirement no. 1), since the subsequent four preconditions are either partially satisfied or not satisfied at all. The prerequisite no. 2 is ambiguous. On one hand, unethical or incompetent doctors may spoil the reputation of the entire profession [14]. On the other hand, doctors belong to a hardly substitutable profession and may be immune from public dissatisfaction. However, this is the arousing conflict of interest that marked the slow downfall of self-regulation in this industry, as public opinion has become sceptical of the physicians' ability to balance altruism and self-interests. As for the complexity of knowledge, the discrepancy between practitioners and the general public is still considerable, although many decades ago it seemed much more immense [6]. SROs, such as the American Medical Association in the United States or the General Medical Council in the United Kingdom, still remain a vital element of the social contract. Their Polish counterpart is the Chamber of Physicians and Dentists (Naczelna Izba Lekarska) that is also deeply rooted in history, being founded in 1921.

The Commission of Ethics in Advertising (Komisja Etyki Reklamy, later referred to as KER) illustrates the simplicity of the regulatory regime. KER is a Polish-based SRO, founded by marketing agencies, the media and enterprises. It is an arbitration body of the Advertising Council, which is part of the Europe-wide EASA (European Advertising Standards Alliance, grouping 35 SROs). Consumers who are disgusted or misled by any piece of ad submit a written complaint to KER, which is later judged by independent referees. All signatories of the code of ethics have a

formal duty to obey the verdicts and withdraw their advertisements in case they have been found to be in breach of the code's provisions, but membership also entitles them to use the label "I advertise ethically" for marketing purposes. The advertising industry has been traditionally operating under self-regulatory models in most European countries, as well as overseas (e.g. the Advertising Self-Regulatory Council in the United States), although some public oversight is also present in several jurisdictions. Other preconditions are fulfilled: first, the damage caused by unethical advertisement may heavily spoil the whole industry, therefore mutual control is genuine; second, the environment consists of several stakeholders (advertisers, agencies, media), which makes it difficult to capture for public authorities; third, unethical commercials call for immediate reaction in order to restrain the negative consequences they had prompted (68 per cent of complaints against EASA-associated SROs were resolved within one month [11]); fourth, although the implications of a fraudulent ad are certainly not so devastating as the aftermath of Wall Street misconducts, there is still some component of greater risk (e.g. with pharmaceutical or alcohol ads).

Finally, to feature the case from the most beleaguered financial industry, the 30-year old National Futures Association (NFA) is presented. Contrary to the Advertising Council, membership in the NFA is mandatory for everyone conducting business with the public on the U.S. futures exchanges. There is a dualism in the origin of regulations, since the NFA was created eight years after the state-established Commodity Futures Trading Commission (CFTC) in 1974. Throughout NFA's history, the CFTC has authorized the NFA to conduct additional regulatory functions. NFA is responsible for market education, setting registration requirements and compliance rules, as well as for enforcement and resolving arbitration or mediation claims. Futures contracts are a relatively complex sub-segment of the financial sector and are dedicated primarily to corporate entities (or high net worth individuals). Nevertheless, the systemic risk component is still present here, as the concentration of failed investments may lead to market-wide turmoil, as the case of Amaranth Advisors hedge fund instructs [2]. Moreover, the self-regulatory Chicago Mercantile Exchange has recently suffered from a wave of criticism for the flaws in futures brokerage firm examination, which contributed to the traumatic bankruptcy of MF Global [10].

Table 1. The matrix of self-regulation preconditions and their fulfilment in selected industries

Economic sector	Historical consensus	Commitment for control	Complex environment	Dynamic setting	Limited, non-systemic risks
Health care industry	Met	Ambiguous	No longer met	Not met	Not met
Advertising industry	Ambiguous	Met	Met	Met	Ambiguous
Futures contracts (finance)	Met	Met	Met	Met	Ambiguous

Source: own analysis.

The financial sector's self-governance is not limited to the NFA. In the United Kingdom the Financial Services Authority, independent of government and funded entirely by the institutions it regulates, has a by far broader scope of competences. However, this entity is being gradually taken over by the British government [25], as it has already happened in April 2010 to its judicial body, the Financial Services and Markets Tribunal [24]. Hence, the tripartite British regulatory framework (i.e. FSA, the central bank, and the Treasury) will soon cease to exist. Seemingly, the self-regulation over the full breadth of the financial services industry was unfeasible. The challenge for the future is whether we may obtain this wisdom *a priori* rather than only *a posteriori*.

The examples were purposely taken from different segments and cannot be directly compared.

CONCLUSIONS AND FURTHER RESEARCH

Self-regulation is certainly not an over-the-counter drug, as the conflict of interest in some industries may turn out to be unmanageable from the inside, which calls for an external rule-setter. However, identifying the attributes of a given sector, decisive for whether self-regulation may be

applicable or not, may greatly improve the regulatory standards by increasing the quality of regulation and reducing its cost from the taxpayer perspective. Such an approach sees self-regulation as a prescription drug. The question remains on how to convince policy makers to overweight private regulation at the cost of the public one. For the emerging industries, such as the Internet, the solution is easy: a pre-emptive move of a self-regulatory actor will most probably discourage public authorities from action or will considerably impede this action. However, the situation is much more challenging in already established economic sectors. A qualitative shift from police-like regulation to coordination-oriented regulation is a moderately plausible concept, since vested interests have already petrified the *status quo*. Regulatory authorities have grown in size and influence, and they are now self-protective, immune to changes, unwilling to delegate their bread-and-butter business to SROs and eager to assure markets of their prominence [15]. This is the point where regulators need to be deregulated in order for self-regulation to restore its reliability and regain its momentum. It is not to say that the publicly founded and funded organizations have no commitment for developing operative regulatory principles. Instead, it is to highlight the uncontrolled growth in top-down prescriptive regulations that fail to account for financial sector heterogeneity, dynamism and asymmetries of information and thus overshoot their targets [3]. The right balance between "state" and "self" should be pursued, as the industries can reasonably be expected to be better off with diversified sources of regulation rather than with single-origin rules that lead to the accumulation of all imperfections the lack of diversification implies.

As far as the original contribution to the field of science is concerned, the study – undoubtedly a preliminary one – provides an insight into the problem of identifying the targets for self-regulation. It gives a hint on what market characteristics may be interpreted as a "green light" for the application of the private oversight model. Consequently, conventional regulation might be forsaken or limited in these industries, and SROs may be equipped with more prerogatives.

Researching the issue of regulation is problematic for several reasons. First, the actual impact and quality of regulatory measures cannot be determined a priori. Second, the motivation of the regulator is often opaque, even if it is formally expressed. Some light may be shed on it through experimental economics, which is best in detecting and validating behavioural aspects of regulatory frameworks. The paper also encourages further research in the field of enforced self-regulation, since this model is most feasible in terms of implementation and has showcased some success stories.

REFERENCES

1. Anderson A.R. and Russell, E.O. (2011): Self-regulation: a strategic alternative for small firms?. Journal of Business Strategy, Vol. 32, No. 4, pp. 42-47.
2. Anson M.J.P. (2009): Hedge Fund Collapses, in CAIA Level I: An Introduction to Core Topics in Alternative Investments. Hoboken, NJ: John Wiley & Sons, Inc., pp. 287-296.
3. Awrey D., Blair W., Kershaw D. (2012): Between Law and Markets: Is There a Role for Culture and Ethics in Financial Regulation? 5 October, http://ssrn.com/abstract=2157588 [20.10.2012].
4. Bertkau A., Halpern J., Yadla S. (2005): The Privileges and Demands of Professional Self-Regulation. Virtual Mentor, Vol. 7, No. 4 (April), http://virtualmentor.ama-assn.org/2005/04/fred1-0504.html [20.10.2012].
5. Brunnermeier M., Crocket A., Goodhar, Ch., Persaud A.D., Shin H. (2009): The Fundamental Principles of Financial Regulation. Geneva: International Center for Monetary and Banking Studies; London: Centre for Economic Policy Research.
6. Cruess S.R., Cruess R.L. (2005): The Medical Profession and Self-Regulation: A Current Challenge. Virtual Mentor, Vol. 7, No. 4, http://virtualmentor.ama-assn.org/2005/04/oped1-0504.html [17.10.2012].
7. Cukierman A. (2011): Reflections on the crisis and on its lessons for regulatory reform and for central bank policies. Journal of Financial Stability, Vol. 7, pp. 26-37.

8. Curran, R. (2011): Hedge fund regulation? What hedge fund regulation?, "Fortune", 14 June, http://finance.fortune.cnn.com/2011/06/14/hedge-fund-regulation-what-hedge-fund-regulation [19.01.2012].
9. Currie C. (2006): A new theory of financial regulation: Predicting, measuring and preventing financial crises, The Journal of Socio-Economics, Vol. 35, pp. 48-71.
10. Doering, Ch. (2012): MF Global triggers regulatory rethink at CFTC, Reuters, www.reuters.com/article/2012/02/01/us-mfglobal-cftc-policy-idUSTRE8102IV20120201 [21.10.2012].
11. European Advertising Standards Alliance (2011) European trends in advertising complaints, copy advice and pre-clearance, Author.
12. Haufler V. (2001) A Public Role for the Private Sector: Industry Self-Regulation in a Global Economy, Washington, D.C.: Carnegie Endowment for International Peace.
13. Hutter B.M. (2001) Is Enforced Self-regulation a Form of Risk Taking? The Case of Railway Health and Safety, International Journal of the Sociology of Law, Vol. 29, pp. 379-400.
14. Irvine D. (2003) The Doctor's Tale: Professionalism and Public Trust, Abington, UK: Radcliffe Medical Press.
15. Joskow P.L. (2010) Market Imperfections versus Regulatory Imperfections, Journal for Institutional Comparisons, Vol. 8, No. 3 (Autumn), pp. 3-7.
16. Krause E. (1996) Death of the Guilds: Professions, States and the Advance of Capitalism, 1930 to the Present, New Haven, Conn: Yale University Press.
17. Lazzarini S.G., and de Mello, P.C. (2001) Governmental versus self-regulation of derivative markets: examining the U.S. and Brazilian experience, Journal of Economics and Business, Vol. 53, pp. 185-207.
18. López-Gamero M.D., Molina-Azorín J.F., Claver-Cortés E. (2010): The potential of environmental regulation to change managerial perception, environmental management, competitiveness and financial performance. Journal of Cleaner Production, Vol. 18, Issues 10-11, pp. 963-974.
19. Ojo, M. (2011): Co-operative and competitive enforced self regulation: The role of governments, private actors and banks in corporate responsibility. Journal of Financial Regulation and Compliance, Vol. 19, No. 2, pp. 139-155.
20. Rabinovitch S. (2011): Asia's banks: The fish always stinks from the head. Financial Times, 12 December, www.ft.com/intl/cms/s/0/127a364a-2031-11e1-9878-00144feabdc0.html [13.12.2011].
21. Shadab H.B. (2007): The Challenge of Hedge Fund Regulation. Regulation, Vol. 30, No. 1, www.cato.org/pubs/regulation/regv30n1/v30n1-1.pdf [19.01.2012].
22. Spinello R.A. (2002): Decentralizing Regulation, in Regulating Cyberspace: The Policies and Technologies of Control. Westport, CT: Quorum Books, pp. 47-64.
23. Stiglitz J.E. (2008): Reversal of Fortune. Vanity Fair, November, www.vanityfair.com/politics/features/2008/11/stiglitz200811 [15.10.2012].
24. The Transfer of Tribunal Functions Order 2010 (2010): No. 22, 6 January, www.legislation.gov.uk/uksi/2010/22/made [20.10.2012].
25. Vina G. (2010): U.K. Scraps FSA in Biggest Bank Overhaul Since 1997. Bloomberg, www.bloomberg.com/news/2010-06-16/u-k-scraps-fsa-in-biggest-bank-regulation-overhaul-since-1997.html [20.10.2012]

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THE EFFECT OF REFRIGERATOR STORAGE ON PHYSICOCHEMICAL PROPERTIES OF SELECTED COLD-PRESSED OILS

Abstract: Cold-pressed oils as a rich source of polyunsaturated fatty acids and various valuable health promoting compounds, e.g. tocopherols, sterols, squalene, are recommended to be included into diet. An essential limitation to the broad commercialization of these products is their susceptibility to oxidation, which negatively affects safe consumption. In the conducted study 6 commercially available samples of sunflower, rapeseed, pumpkin seed, flaxseed, false flax, blessed milk thistle cold-pressed, non-refined oils were stored at +4 °C for 12 weeks, regularly opened and poured out to simulate real consumers' storage conditions. The peroxide value, p-anisidine value, iodine value, acid value and colour were determined. The results suggest that refrigerator storage might preserve physicochemical properties of analyzed cold-pressed oils for at least 12 weeks.
Keywords: Cold-pressed oil, storage, oxidative stability, quality of oils

INTRODUCTION

According to recent studies [14, 15],an increase in consumer awareness of the impact of selected food ingredients on health is observed . Especially it is seen in the scope of fatty acids, which play a crucial role in many vital processes in the body. Among essential fatty acids (EFA) that cannot be synthesised by the organism are polyunsaturated fatty acids, e.g. linoleic acid (LA) and alpha-linolenic acid (ALA) that are recommended by the European Food Safety Authority to consume at a certain level – 4 per cent and 0,5 per cent of daily energy intake, respectively [3].

Rich sources of EFA are edible oils. Due to consumers' desire for natural food products with high nutritive properties the segment of cold-pressed plant oils is now emerging. Cold-pressed oils are edible vegetable oils obtained by mechanical procedures, e.g. expelling or pressing, without the application of heat or chemical treatments. They may be purified by washing with water, settling, filtering and centrifuging only [2]. With this method many edible oils are obtained, e.g. rapeseed, corn, flaxseed, sunflower, sesame, but also oils with special properties appearing as diet supplements, e.g. evening-primrose, borage, sea-buckthorn and oils for cosmetic purposes, e.g. from plum stone or tomato seed. The production of oil by using only cold-pressing without further refining allows retaining various valuable ingredients in the final product, e.g. tocopherols, sterols, squalene, carotenoids and phospholipids [13]. Cold-pressed oils are advised to be consumed cold, without thermal processing, and they can be added to salads, potatoes, groats, cottage cheese or meat.

An essential limitation to the broad commercialization of these products is their susceptibility to oxidation. These unfavourable processes may lead to a decrease in nutrition value, loss of sensory acceptability and development of substances toxic to health. In the literature little can be found about the stability of cold-pressed oil in real storage conditions recommended by producers (storage in a cool and dark place). Many investigations were conducted with use of accelerated oxidative tests [1, 10, 12], however, the approximation of results to real storage conditions seems to be inadequate [8].

Moreover, there is a lack of specific regulations for cold-pressed oils from different seed materials which causes difficulties in setting clear limits for different physicochemical characteristics, considered as indicative of oxidative deterioration.

Therefore, the objective of the present study was to evaluate the changes of quality parameters of selected cold-pressed oils during storage in typical consumer conditions.

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MATERIALS

Six commercially available samples of sunflower (*Helianthus annuus*), rapeseed (*Brassica napus*), pumpkin seed (genus *Cucurbita)*, flaxseed (*Linum usitatissimum)*, false flax (*Camelina sativa*), and blessed milk thistle (*Sylibum marianum*) cold-pressed, non-refined oils were directly purchased from their producers in their original packaging (glass bottles, 250 ml volume). All oils were placed at +4 °C just after opening and stored for 12 weeks. Typical consumers' storage conditions were achieved by warming the samples every third day to room temperature for 15 minutes and pouring out 5 ml of oil content. The evaluation of physicochemical properties of the samples was performed just after opening the oils and after 4, 8 and 12 weeks of storage. All oils were within the „best before" date during the whole storing period.

METHODS

The following parameters were determined: peroxide value, p-anisidine value, iodine value, acid value and spectrophotometric colour. The peroxide value (PV) is one of the most commonly used tests for evaluation of oxidative rancidity in oils and fats. It measures the concentration of peroxides and hydroperoxides formed in the initial stages of lipid oxidation. The PV of all samples was measured by the iodometric method according to PN-ISO 3960: 1996. The assessment of the p-anisidine value (p-AV) enables to estimate the amount of secondary lipid oxidation products – mostly aldehydes, ketones, alcohols and organic acids arising from the break out of peroxides and hydroperoxides. This process is based on the reactiveness of the aldehyde carbonyl bond with the p-anisidine amine group. The spectrophotometric measurement of the p-anisidine value was done according to PN-ISO 6885:2008. The iodine value (IV) is a measure of the total number of unsaturated bonds present in fats and oils. It is expressed in grams of iodine that will react with the double bonds in 100g of fats or oils. The evaluation was conducted according to PN-ISO 3961:1996. The acid value (AV) is a common parameter in the specification of fats and oils which measures the amount of free fatty acids (FFA) present in the product. It is defined as the weight of KOH in mg needed to neutralize the organic acids present in 1g of fat. An increment of the FFA amount in a sample of oil or fat indicates hydrolysis of triglycerides. The acid value was assessed by the titration method according to PN-EN ISO 660:2005. Determination of the general spectrophotometric colour of oils was done in accordance with the Polish standard - PN-A-86934:1995.

STATISTICAL ANALYSIS

The presented results are the means of at least three determinations. Statistical analysis was performed using the Statistica 9.0 software package. Statistical differences between the oil samples were estimated by applying two-way ANOVA and using the Tukey test at a significance level of 5 per cent ($p<0.05$).

RESULTS AND DISCUSSION

Table 1 presents selected physicochemical properties of analysed cold-pressed oils freshly opened. The samples exhibited good quality. The values were characteristic for seed origin and significantly differ between the oils. The lowest peroxide value was measured in flaxseed oil (1.02 ± 0.00 meq O_2/kg), while the highest in blessed milk thistle oil (12.06 ± 0.09 meq O_2/kg). The peroxide values of all cold-pressed oils were well within the limit of 15 meq O_2/kg of oil for virgin oils and cold-pressed fats and oils stated in the Codex Alimentarius Commission standard 19-1981 [2]. The p-anisidine value, which expresses the amount of secondary lipid oxidation products, was low varying from 0.33 in flaxseed oil to 1.06 in blessed milk thistle oil. Iodine value amounted to 138, 118, 111, 178, 155, 122 g iodine/100g oil in sunflower, rapeseed, pumpkin, flax, false flax, blessed milk thistle, respectively. Acid value varied from 1.62 mg KOH/g in sunflower oil to 6.47 mg KOH/g in blessed milk thistle oil. According to the Codex Alimentarius Commission standard 19-1981 (amended in 2009) the acid value of cold-pressed fats and oils should not exceed 4.0 mg

KOH/g fat or oil. The AV of pumpkin seed and blessed milk thistle oils were above the limits but that could be due to the specificity of the seeds. The sunflower oil showed the lowest colour value, while the pumpkin seed oil was significantly the highest.

Table 1. The physicochemical properties of cold-pressed oils at the beginning of the storage period

	Cold-pressed oil	Peroxide value [meq O_2/kg]	P-anisidine value	Iodine value [g iodine/ 100g oil]	Acid value [mg KOH/g]	Colour
1	sunflower	$10{,}58^{e} \pm 0{,}12$	$0{,}48^{ab} \pm 0{,}10$	$138^{bc} \pm 2$	$1{,}62^{a} \pm 0{,}00$	$28^{a} \pm 1$
2	rapeseed	$2{,}94^{b} \pm 0{,}04$	$0{,}68^{b} \pm 0{,}11$	$118^{ab} \pm 2$	$2{,}34^{b} \pm 0{,}02$	$477^{d} \pm 9$
3	pumpkin	$7{,}35^{d} \pm 0{,}27$	$0{,}44^{ab} \pm 0{,}14$	$111^{a} \pm 4$	$4{,}69^{c} \pm 0{,}14$	$1045^{e} \pm 9$
4	flaxseed	$1{,}02^{a} \pm 0{,}00$	$0{,}33^{a} \pm 0{,}00$	$178^{d} \pm 2$	$1{,}99^{a} \pm 0{,}01$	$422^{c} \pm 13$
5	false flax	$4{,}67^{b} \pm 0{,}02$	$0{,}59^{ab} \pm 0{,}09$	$155^{c} \pm 6$	$2{,}33^{b} \pm 0{,}05$	$143^{b} \pm 8$
6	blessed milk thistle	$12{,}06^{f} \pm 0{,}09$	$1{,}06^{c} \pm 0{,}03$	$122^{ab} \pm 2$	$6{,}47^{d} \pm 0{,}01$	$473^{d} \pm 1$

** Means with different letters within columns indicate significant differences ($p<0.05$) among the oil samples*

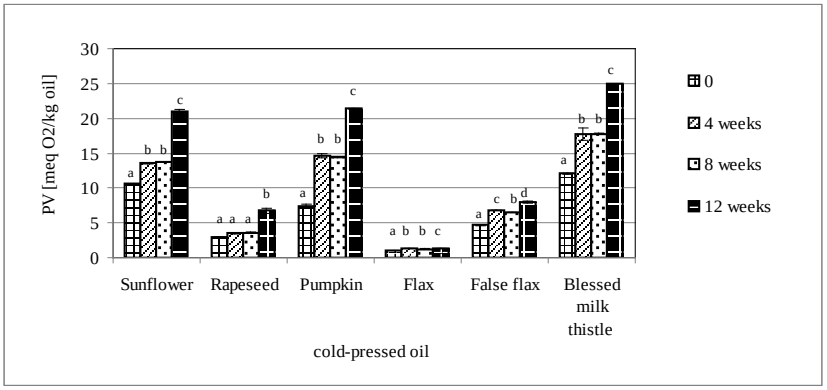
Source: own studies

During a complex oxidation process of fats and oils two main phases could be distinguished. In the first one, fatty acids react with oxygen determining odourless compounds as peroxides. During the second phase the peroxides degrade into many substances e.g. as volatile aldehydes, responsible for the rancid odour and flavour, and in a non-volatile portion. The primary oxidation products are normally measured with the peroxide value test (PV) and the secondary products with the p-anisidine test.

The undertaken study showed that the peroxide value of all samples increased significantly during storage (Figure 1). In most cases a significant change of PV was seen between 0 and 4 weeks of storage, then a phase of stability was observed and after 8 weeks an accelerated increase of PV was determined. The increment of the PV value at the end of the storage period when compared to the beginning was the highest in pumpkin oil and then followed the order of rapeseed oil>blessed milk thistle oil>sunflower oil>false flax oil>flaxseed oil.

After 12 weeks of storage the highest level of PV was observed in case of the blessed milk thistle, pumpkin and sunflower oils and amounted 24.95±0.01, 21.39±0.04 and 20.93±0.41 meq O_2/kg of oil respectively. The sunflower and pumpkin oils' PV exceeded the upper limit (15 meq O_2/kg of oil) [2] after 8 weeks of storage, while blessed milk thistle oil did this after only 3 weeks. The other oils' peroxide value remained below the maximum acceptable level.

At the end of the storing period the lowest level of the peroxide value was observed in flaxseed oil (1.40±0.0 meq O_2/kg of oil). What is more, the pace of formation of oxidation products was the lowest in case of flaxseed oil. It might be due to the specific properties of flaxseed oil based on its natural ability to dry. When flaxseed oil is exposed to air the double bonds of ALA react with oxygen and create a relatively soft, durable film [6] that prevents development of oxidation products. Storage of flaxseed oil in room or fridge temperature shows little increase in oxidation products [11]. The increase of PV of flaxseed oil is seen while storing in higher temperature [10, 12].



* Means with different letters within same oil indicate significant differences ($p<0.05$)

Fig. 1. Change in the peroxide value of cold-pressed oils during storage at +4 °C for 12 weeks

Source: own studies

Generally, the analysed oils revealed low levels of the p-anisidine value (Figure 2). In case of flaxseed, false flax and rapeseed oils no significant changes in p-AV were estimated throughout the whole storing period. In other oils the p-AV slightly increased. After 12 weeks of storage the highest p-anisidine value was detected in blessed milk thistle oil (1.42±0.07), while the lowest was in rapeseed oil (0.34±0.00). The biggest increase of p-AV was determined in sunflower oil and after storing for 12 weeks it doubled.

Cold-pressed oils, as opposed to refined ones, are characterized by definitely lower levels of the p-anisidine value due to avoiding high temperatures while processing. The refining process, especially its deodorization stage, seems to determine high amounts of secondary oxidation products in refined edible oils [16]. The p-anisidine limit value for refined oils and fats is 8 units - according to the PN-A-86908:2000 standard. Makareviciene and Janulis [7] suggest that the maximum value of the p-anisidine number for extra virgin oils should not exceed 3 units. Unfortunately, there are no standardised limits of p-AV specifics for cold-pressed oils. Taking into consideration the above mentioned restrictions, the high quality of the studied oils was outlined in the scope of analysed parameters.

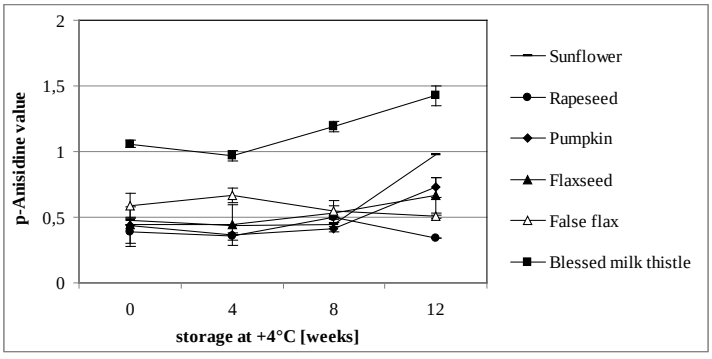
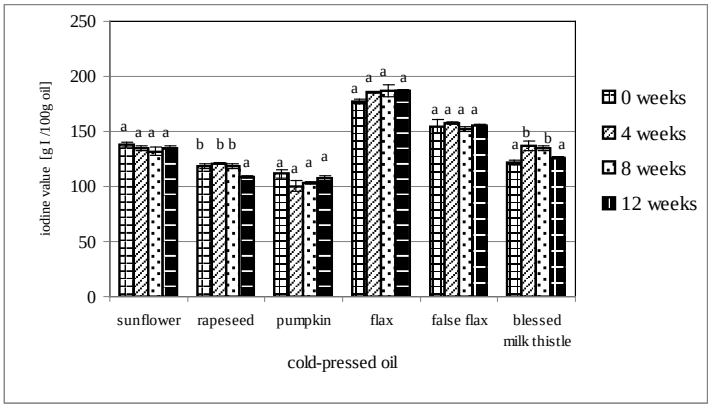


Fig. 2. Change in the p-anisidine value of cold-pressed oils during storage at +4 °C for 12 weeks

Source: own studies

Figure 3 presents the results of iodine value measurement in analysed oils during storage. Keeping at fridge temperature for 12 weeks had no significant impact on changes in iodine value in sunflower, pumpkin, flax and false flax oils, which means that there was no change in the overall

sum of unsaturated bonds. In case of rapeseed oil after 8 weeks of storage the amount of iodine value slightly decreased. Polyunsaturated fatty acids including linoleic and linolenic acids are considered to be easier oxidised than mono-unsaturated fatty acids. Therefore, the relative contents of linoleic and linolenic acids during storage are to decrease [5]. This decline was detected in rapeseed oil, which can be connected with strong increase in peroxide value (Figure 1) and formation of oxidation products of fatty acids.



* Means with different letters within same oil indicate significant differences ($p<0.05$)

Fig. 3. Change in iodine value of cold-pressed oils during storage at +4 °C for 12 weeks

Source: own studies

The presence of free fatty acids might be an important indicator of rancidity of food products [4]. In the conducted study small but statistically significant changes in acid values during storing were observed (Figure 4). Definitely the highest acid value was exhibited by blessed milk thistle oil, while the lowest values during the whole storage periodwere assigned to flaxseed and sunflower oil. The biggest increase in acid value was determined in false flax seed oil and amounted to 32 per cent after 12 weeks of storage in comparison to measurements taken after first opening the bottle. Substantial increase in AV was visible also in sunflower (27 per cent) and pumpkin oil (23 per cent). The increment could be explained by the formation of acids that originate from the decomposition of hydroperoxides and oxidation of aldehydes [1].

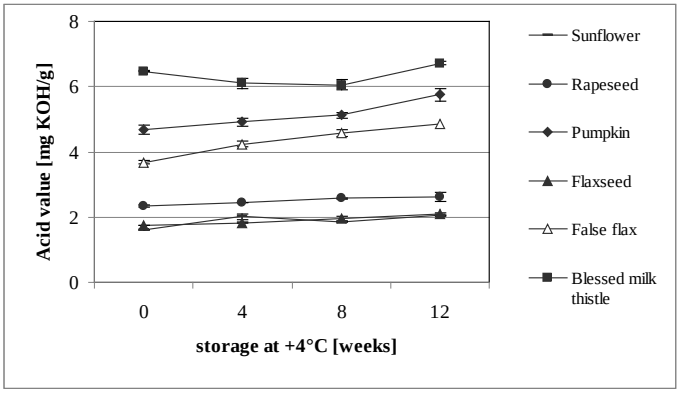


Fig. 4. Change in acid value of stored cold-pressed oils at +4 °C for 12 weeks

Source: own studies

According to the Codex Alimentarius Commission standard 19-1981 (amended in 2009) the acid value of cold-pressed fats and oils should not exceed 4.0 mg KOH/g fat or oil. Three of out of six studied oils proved correct low levels. The blessed milk thistle, pumpkin seed and *Camelina* oil revealed values above the maximum levels, which may be due to the peculiarity of raw material or specific preparation scheme of the seeds for oil production.

Table 2 shows the changes in colour of the samples subjected to refrigerated storage. The colour values of the samples increased with the passing of time and in most cases data show significant ($p<0.05$) differences in discolouration of oil during storage. The biggest increment in spectrophotometric colour value was determined in sunflower, false flax and pumpkin oil and amounted to 84 per cent, 65 per cent and 39 per cent after 12 weeks of storage in comparison to the value obtained during the first opening, respectively. The literature confirms that long term storage may lead to the discolouration of samples due to oxidative deterioration [9].

Table 2. Change in colour of analysed cold-pressed oils during storage at +4 °C for 12 weeks

	Cold-pressed oil					
storage period [weeks]	sunflower	Rapeseed	pumpkin	flaxseed	false flax	blessed milk thistle
0	28^{a} ±1	477^{a}±9	1045^{a}±9	422^{a}±13	143^{a}±8	473^{a}±1
4	68^{bc}±9	476^{a}±4	1241^{b}±4	431^{ab}±1	199^{b}±1	495^{a}±6
8	74^{c}±2	475^{a}±9	1479^{c}±6	461^{bc}±0	215^{bc}±4	497^{a}±6
12	52^{b}±2	486^{a}±1	1451^{c}±7	487^{c}±2	236^{c}±5	550^{b}±19

* Means with different letters within columns indicate significant differences ($p<0.05$)

Source: own studies

CONCLUSIONS

The results of the presented analysis suggest that refrigerator storage of selected cold-pressed oils in typical consumer conditions might preserve their physicochemical properties for at least 12 weeks. Changes in investigated parameters were observed but the extent was small enough not to influence the overall good quality. The biggest increase of value was detected in case of peroxide value, which is an indicator of the primary oxidation products of the oils. Generally, the oil that showed the significantly highest levels of peroxide value, p-anisidine value and acid value throughout the whole storage period was blessed milk thistle oil. This oil is valued for its medicinal properties, including protection and rejuvenation of the liver, and is often implemented as a variable-diet supplement. It is rather not directly consumed because of its strong taste and smell.

Difficulties in appropriate quality assessment of stored samples were encountered, which is caused by the lack of uniformed standards for various cold-pressed oils. It is essential to set standardised limits for different physicochemical parameters in order to monitor the oxidative stability of cold-pressed oils with respect to the specificity of the raw material.

REFERENCES

1. Abramovic H., Butinar B., Nikolic V.: Changes occurring in phenolic content, tocopherol composition and oxidative stability of Camelina sativa oil during storage. Food Chemistry, 2007, 104, pp. 903-909.
2. Codex Alimentarius Standard 19-1981 for edible fats and oils not covered by individual standards, 2009, www.codexalimentarius.org/standards/list-of-standards/en/?no _cache=1 (10.10.2012).
3. EFSA Panel on Dietetic Products, Nutrition, and Allergies (NDA); Scientific Opinion on Dietary Reference Values for fats, including saturated fatty acids, polyunsaturated fatty acids,

monounsaturated fatty acids, trans fatty acids, and cholesterol. EFSA Journal 2010, 8(3):1461 http://www.efsa.europa.eu/en/efsajournal/pub/1461.htm (10.10.2012).
4. Frega N., Mozzon M., Lercker G.: Effects of free fatty acids on oxidative stability of vegetable oil. JAOCS, 1999, 76 (3), pp. 325-329.
5. Jeong M., Lee J., Cho W-I., Lee J.: Correlation of Volatiles and Fatty Acids in Thermally Oxidized Fatty Acid Model Systems Using Statistical Approaches. Food Sci. Biotechnol, 2010, 19 (5), pp. 1233-1239.
6. Jhala A.J., Hall L.M.: Flax (Linum usitatissimum L.): Current Uses and Future Applications. Australian Journal of basic and Applied Sciences, 2010, 4(9), pp. 4304-4312.
7. Makareviciene V., Janulis P.: Analiza jakości olejów jadalnych oraz obowiązkowe wymagania. Tłuszcze Jadalne 1999, 34(1-2), pp. 15-32.
8. Martín-Polvillo M., Márquez-Ruiz G., Dobarganes M.C.: Oxidative Stability of Sunflower Oils Differing in Unsaturation Degree During Long-Term Storage at Room Temperature. JAOCS 2004, 81 (6), pp. 577-583.
9. McGinely L.: Analysis and quality control for processing and processed fats. In: J.B. Rossell, L.R. Pritchard (eds.). Analysis of Oilseeds, Fat and Fatty Food, Elsevier Applied Science, New York 1991, pp. 440-470.
10. Michotte D., Rogez H., Chirinos R., Mignolet E., Campos D., Larondelle Y.: Linseed oil stabilisation with pure natural phenolic compounds, Food Chemistry, 2011, 129, pp. 1228-1231.
11. Mińkowski K.: Studia nad stabilnością oksydatywną olejów roślinnych bogatych w polienowe kwasy tłuszczowe o budowie trienowej, rozprawa habilitacyjna. Roczniki Instytutu Przemysłu mięsnego i tłuszczowego, Warszawa 2008.
12. Omar K.A., Shan L., Wang Y.L., Wang X.: Stabilizing flaxseed oil with individual antioxidants and their mixtures. Eur. J. Lipid Sci. Technol., 2010, 112, pp. 1003-1011.
13. Sionek B.: Oleje tłoczone na zimno. Roczniki PZH 1997, 48 (3), pp. 283-294.
14. Sojkin B., Małecka M., Olejniczak T., Bakalarska M.: Konsument wobec innowacji produktowych na rynku żywności. Wydawnictwo Uniwersytetu Ekonomicznego w Poznaniu, Poznań 2009, pp. 151-153.
15. Sojkin B., Małecka M., Sielicka M., Olejniczak T.: Wyznaczniki procesu akceptacji innowacji na rynku produktów żywnościowych In: B. Sojkin (ed.): Komercjalizacja produktów żywnościowych. PWE Warszawa 2012, pp. 133-154.
16. Wroniak M., Kwiatkowska M., Krygier K.: Charakterystyka wybranych olejów tłoczonych na zimno. Żywność. Nauka. Technologia. Jakość, 2006, 47 (2), pp. 46-58.

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Robert Szulc, Barbara Łaska[14]

RESULTS OF THE COMPARATIVE EXPLOITATION STUDY ON THE VERTICAL HEAT EXCHANGER IN WINTER AND SUMMER

Abstract: Investigations of the heat acquisition from vertical ground heat exchangers were performed. From April to September 9.242 GJ of heat from ground boreholes have been obtained and the heat pump processing achieved 23.107 GJ of total heat used in the heating system. Coefficient of performance (COP) was 2.504 in spring and 1.981 in summer and compared to the heating period (winter) was 26.4 per cent lower with a COP of 3.05. The reason for reduction of the COP was probably high air temperatures in spring and summer (as confirmed by the correlation coefficient r = -0.178 in spring and r = -0.559 in summer).
Keywords: heat exchanger, energy, livestock building, heat.

INTRODUCTION

Renewable energy sources are an alternative to the limited resources of fossil fuels. Increasing energy prices and environmental pollution contributes to the development of systems using renewable energy sources. Significant share of energy required to power the central heating and hot water in the overall energy consumption causes growing interest in renewable heat. In agriculture there is a high demand for energy and heat, especially in livestock production. Myczko et al. [2003] indicate that the strong concentration of production is the cause of high energy consumption in livestock buildings. Renewable heat can provide farms with the heat necessary for heating animal housing and social buildings, heating utility water, greenhouses in horticultural plants and for heating the air in the dryer. Such solutions improve the energy balance in livestock buildings, can help to reduce costs of production and stimulate growth of profitability [Kreis-Tomaczak 2008]. A heat pump is a device that transfers renewable heat from the environment to a heat sink. Heat pumps for heating purposes are commonly used in Sweden, Austria, Switzerland, Germany and Denmark [3].

The ground (soil) is one of the most stable and more reliable sources of energy. It has a relatively constant temperature all year round (7-13 °C). For extraction of thermal energy from the ground a vertical or horizontal heat exchanger is used in which the resistance to freezing working fluid transports the heat. Adamovski and Kara [1] observe that the use of ground source heat pumps can reduce energy consumption and that it is an opportunity to become independent from fossil fuels.

When using ground heat exchangers is important to consider the type of soil and its heat capacity and the demand for heating energy. Kurpaska et al. [7] has studied the efficiency of the ground source heat pump for heating foil greenhouses. The efficiency of the heat pump depended on the exchanger (horizontal or vertical) and on the demand for heat. Benli, [2] comparing the performance of vertical and horizontal exchangers, also stated that the efficiency of the heat pump depends on the type of exchanger. In addition, Latała et al. [8] notes that with increasing thermal efficiency of ground heat exchangers, the heat pump coefficient of performance (COP) also increases. Knaga [5] states that a reduction in the difference between the lower and upper heat source contributes to an increase in efficiency of the heat pump. Hepbasli et al. [4], determining the efficiency of the ground source heat pump, pointed out that it is important to adapt the system to the heat demand, as an inadequate device selection decreases the system's efficiency. Rutkowski et al. [10] notes that the ground which is placed in the heat exchanger should demonstrate good thermal

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performance, also the geological conditions and temperature variations during the year affected by the climate in the region are important.

THE RESEARCH PROBLEM

Based on analysis of the literature available and previous results, the following research problems were formulated:

1) how do summer conditions affect the amount of heat inthe ground?
2) does exploitating the vertical heat exchanger in winter reduce the potential of thermal deposits?

THE AIM OF THE STUDY

The aim of the study was to analyse the efficiency of the ground source heat pump to power the heating system in office building and renewable energy laboratory in summer. Moreover, the study was to verify whether the exploitation of two vertical heat exchangers operating in winter and using the heat obtained for heating buildings has an impact on the reduced energy potential of the soil and reduces the efficiency of the system by acquiring less heat in the summer.

In addition, a research hypothesis was formulated: exploitation of vertical ground heat exchangers - even in the summer - without additional ground discharge through heat from solar collectors will not affect the amount of heat and the efficiency of the installation during the next winter season.

This hypothesis shall be verified after the next phase of research conducted in December 2012 - March 2013.

THE SUBJECT OF THE STUDY

The subject of the research was the ground source heat pump and two vertical ground heat exchangers for heating two buildings.

METHODOLOGY OF THE STUDY

The The study was conducted based on the methodology indicated by Łaska, Szulc [12]. The studies were conducted in the renewable energy laboratory "Ecobuilding" located in the Institute of Technology and Life Sciences in Poznań. The "Ecobuilding" has walls made of sheets filled with a 10 cm layer of polystyrene. It is equipped with a Vitocall 200 heat pump (Figure 1) which has a power of 8 kW, a storage tank with a capacity of 200 dm^3 and two vertical ground heat exchangers with a depth of 70m each. Heat meters are installed at the entrance and exit of the heat exchanger and heating installation. The “Ecobuilding” is also equipped with liquid solar panels on the roof with the possibility of directing heat excess to the ground heat exchangers in the summer. The “Ecobuilding” itself and the basement of the office building were heated. The study was conducted from April 2012 to the end of July 2012. The analysis of the results was developed using appropriate formulas and presented as output in Excel 2010.

Fig. 1. The heat pump in the „Ecobuilding"

Source: own study.

The determination of the heat pump coefficient of performance (COP) expressing the energy efficiency of the system was obtained as the heat extracted divided by the energy inputs. Simultaneously, the outside air temperature and indoor temperature were measured.

RESULTS

The results of the study carried out for the installation of the heat pump and vertical heat exchanger used forcentral heating are presented in Table 1.

The study shows that the vertical ground heat exchanger worked without failure from December to July. However, it was noted that the efficiency of heat recovery (COP) had been decreased with increasing outside air temperature. The results of the winter measurements show the COP average value of 3.050 [11]. In spring, the ratio of the heat obtained to the input energy decreased. In April 2012 the COP was at 2.504 and in summer (June-July) the COP decreased to 1.981. Further, less heat extraction from the ground was noticed.

In winter (December 2011-February 2012) the amount of heat obtained from the vertical ground heat exchangers was at 0.266 GJ every day, only in the spring and summer of 2012 the value remained constant and amounted to 0.265 and 0.266 GJ·day^{-1}.

The heat pump was produced in spring 0.403 GJ day^{-1}, in the summer 0.401 GJ day^{-1} and in winter 0.538 GJ day^{-1}.

The electricity consumption of the heat pump in the winter was at an average of 47.7 kWh·day^{1}, which was also confirmed in spring when it was at 47.738 kWh·day^{-1}. In the summer of 2012 electricity consumption increased to an average of 55.445 kWh·day^{-1}. During the period of June-July 2012 electricity consumption of the heat pump increased by 26.4 per cent. The results show that the installation of the ground source heat pump works properly, acquiring and processing the same amount of heat.

Table 1. Fragment of the summer results of the study from 2 April 2012 to 28 July 2012

	Ecobuilding							Basement		Heat pump						
Date	Air temp. (°C)	Air temp. inside (°C)	Daily heat gain (GJ)	T1 (°C)	T2 (°C)	Δ T (K)	Moment. Power (kW)	Air temp.	Moment. Power (kW)	T_1 (°C)	T_2 (°C)	Δ T (K)	Heat meter (GJ)	*Daily amount of heat (GJ)*	*Daily electricity consump. (kWh)*	COP
2.IV.2012	4	20	*0,291*	33,7	30,6	3,0	1,34	17,0	6,334	38,7	33,6	5,1	241,44	*0,512*	*56,700*	**2,508**
3.IV.2012	4	23	*0,264*	39,3	31,6	7,6	2,96	16,0	6,302	40,6	34,6	6,0	242,01	*0,571*	*63,000*	**2,518**
4.IV.2012	2	21	*0,265*	39,0	31,3	7,7	2,95	17	6,261	40,3	34,2	6,1	242,54	*0,534*	*61,000*	**2,432**
5.IV.2012	1	20	*0,251*	37,6	30,1	7,5	2,92	15	6,254	39,0	32,9	6,1	243,08	*0,535*	*57,800*	**2,571**
6.IV.2012	5	22	*0,254*	38,3	30,9	7,4	2,91	18	6,277	39,7	33,7	6,0	243,62	*0,538*	*59,100*	**2,529**
7 IV 2012	b.d.	b.d.	*0,249*	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	244,13	*0,519*	*57,475*	**2,508**
8 IV 2012	b.d.	b.d.	*0,249*	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	244,65	*0,519*	*57,475*	**2,508**
9 IV 2012	b.d.	b.d.	*0,498*	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	245,17	*0,519*	*57,475*	**2,508**
10.IV.2012	7	22	*0,498*	38,0	30,2	7,8	2,86	15,5	6,374	39,4	33,2	6,2	245,69	*0,522*	*57,475*	**2,523**
11.IV.2012	11	26	*0,270*	41,7	33,5	8,2	3,15	18	6,195	42,8	36,8	6,0	246,21	*0,520*	*61,000*	**2,368**
12.IV.2012	8	22	*0,307*	45,8	36,8	9,0	3,64	18	4,820	41,3	41,6	-0,3	246,73	*0,518*	*64,900*	**2,217**
13.IV.2012	5	19	*0,370*	46,9	36,8	10,1	4,58	18	5,924	48,1	43,3	4,8	247,22	*0,491*	*69,400*	**1,965**
17.IV.2012	5	11	*0,310*	9,3	9,4	-0,2	0,00	8	0,087	9,7	9,6	0,1	247,37	*0,060*	*4,900*	**3,401**
25 VI 2012	16	21	*0,225*	20,2	20,0	0,2	0,00	13	0,095	20,4	20,3	0,1	253,04	*1,733*	*255,300*	**1,886**
26 VI 2012	12	26	*0,297*	44,4	39,1	5,3	3,56	20	6,412	47,9	41,7	6,2	253,56	*0,516*	*63,600*	**2,254**
27 VI 2012	b.d.	b.d.	*0,475*	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	254,07	*0,514*	*67,700*	**2,109**
28 VI 2012	b.d.	b.d.	*0,238*	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	254,59	*0,514*	*67,700*	**2,109**
29 VI 2012	22	32	*0,476*	54,5	48,6	5,9	5,02	22	5,863	55,1	49,4	5,7	255,10	*0,516*	*67,700*	**2,117**
4 VII 2012	b.d.	b.d.	*0,328*	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	256,91	*0,513*	*70,500*	**2,021**
5 VII 2012	19	29	*0,329*	48,1	40,2	7,9	3,32	22	6,452	48,5	42,3	6,2	257,42	*0,513*	*70,500*	**2,021**
6 VII 2012	25	32	*0,336*	54,6	45,5	9,1	3,86	25	6,161	55,7	49,6	6,05	257,87	*0,449*	*67,400*	**1,850**
7 VII 2012	b.d.	b.d.	*0,320*	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	258,27	*0,400*	*59,300*	**1,874**
8 VII 2012	b.d.	b.d.	*0,320*	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	258,67	*0,400*	*59,300*	**1,874**
9 VII 2012	19	32	*0,320*	53,8	45,2	8,6	3,74	23	6,117	55,0	48,8	6,2	259,07	*0,402*	*59,300*	**1,883**
10 VII 2012	20	31	*0,319*	51,1	44,1	7,0	2,98	23	6,264	52,9	46,8	6,1	259,52	*0,447*	*62,500*	**1,987**
11 VII 2012	21	30	*0,329*	50,9	42,7	8,2	3,54	23	6,364	51,8	45,6	6,2	259,98	*0,458*	*66,300*	**1,919**
12 VII 2012	17	23	*0,199*	22,4	22,3	0,1	0,00	20	0,171	22,6	22,4	0,2	260,19	*0,216*	*37,000*	**1,622**
13 VII 2012	16	30	*0,244*	45,0	37,9	7,0	2,95	24	6,551	45,6	39,2	6,4	260,69	*0,498*	*59,100*	**2,341**
14 VII 2012	b.d.	b.d.	*0,210*	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	261,05	*0,356*	*48,730*	**2,029**
15 VII 2012	b.d.	b.d.	*0,210*	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	261,40	*0,356*	*48,730*	**2,029**
16 VII 2012	15	19	*0,211*	22,7	19,9	2,7	0,28	21	8,087	28,0	20,0	8,0	261,76	*0,356*	*48,740*	**2,029**
17 VII 2012	13	26	*0,253*	44,9	37,8	7,2	2,91	22	6,507	45,4	39,2	6,2	262,31	*0,550*	*63,900*	**2,391**
18 VII 2012	16	28	*0,283*	45,6	38,3	7,3	3,04	22	6,370	45,9	39,7	6,2	262,84	*0,532*	*67,800*	**2,180**
19 VII 2012	18	29	*0,290*	49,5	40,6	8,9	3,81	22	6,202	50,2	44,3	5,9	263,38	*0,536*	*70,000*	**2,127**
20 VII 2012	16	20	*0,090*	19,4	19,4	0,0	0,00	19,5	0,159	19,6	19,5	0,1	263,49	*0,113*	*20,400*	**1,539**
21 VII 2012	b.d.	b.d.	*0,126*	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	263,71	*0,219*	*30,130*	**2,019**
22 VII 2012	b.d.	b.d.	*0,126*	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	b.d.	263,93	*0,219*	*30,130*	**2,019**
23 VII 2012	20	22	*0,128*	19,8	19,1	0,7	0,00	20	8,306	27,5	19,2	8,3	264,15	*0,219*	*30,140*	**2,018**
24 VII 2012	22	30	*0,298*	50,7	41,1	9,6	4,13	22	6,203	50,6	45,3	5,3	264,64	*0,495*	*61,600*	**2,232**
25 VII 2012	25	31	*0,317*	50,6	42,5	8,1	3,53	23	0,155	46,7	46,4	0,3	265,07	*0,429*	*60,300*	**1,976**
26 VII 2012	29	31	*0,329*	52,8	44,5	8,3	3,65	23,5	0,109	48,6	48,6	0	265,47	*0,400*	*58,700*	**1,893**
27 VII 2012	26,5	28	*0,344*	54,6	44,0	10,7	4,63	24	0,261	49,8	49,7	0,1	265,83	*0,360*	*55,700*	**1,795**
28 VII 2012	33	32	*0,31*	31,8	30,3	1,5	0,00	23	0,042	31,4	31,2	0,2	265,84	*0,007*	*1,500*	**1,296**
SUM	-	-	**16,79**	-	-	-	-	-	-	-	-	-	-	**23,107**	**2546,900**	-
MEAN	14,4	24,3	**0,270**	39,5	33,2	**5,8**	2,703	19,04	4,587	40,1	35,8	3,9	254,69	**0,398**	**45,454**	**2,151**
Standard deviation	8,0	6,2	**0,1**	14,8	11,4	**4,0**	1,7	4,8	2,9	14,3	12,8	3,0	7,9	**0,4**	**38,9**	**0,4**
min	1	11	**0,02**	9,25	9,43	**-0,2**	0	8	0,042	9,7	9,6	-0,3	241,4	0,00	0,00	1,296
max	33	32	**0,5**	55,7	48,6	**12,1**	5,24	25	8,306	56	50	8,3	265,8	2,003	255,3	3,401
T/COP r=(1)	-0,2														**COP (1)**	**2,504**
T/COP r=(2)	-0,6														**COP (2)**	**1,981**

Source: own study.

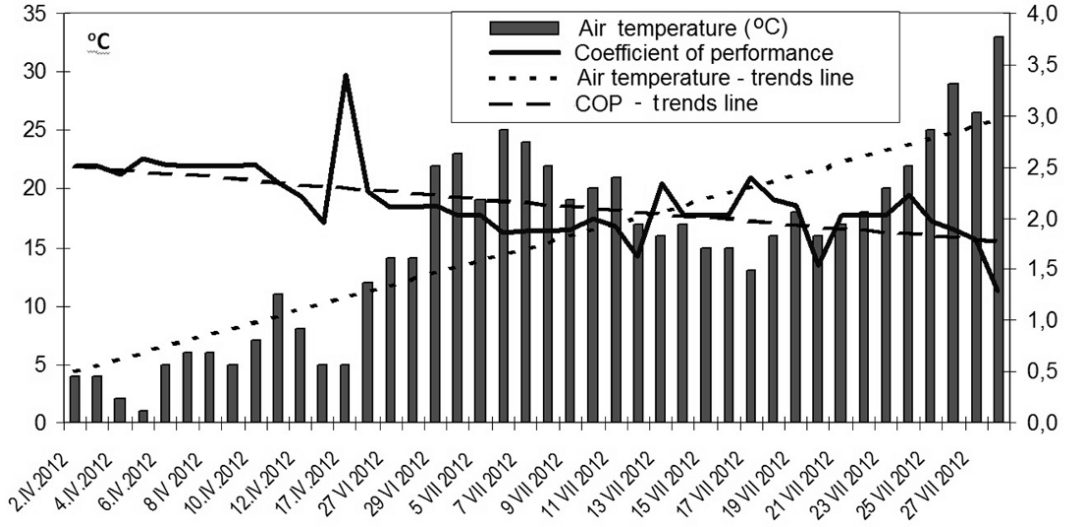

Fig. 2. The relationship between the air temperature and COP and their trend lines.

Source: own study.

In the summer electricity consumption was increased because of high air temperature. The heat pump was more loaded (like the refrigerator or freezer - winter and summer), and power consumption was higher (Fig. 2). The correlation factor takes an average of the air temperature and COP was r = -0.178 in spring and r = -0.559 in summer. Increased air temperature has a significant effect on the decrease of COP due to electricity consumption.

The heat obtained was the same and electricity consumption was increased, so COP decreased by about 18 per cent from 3.05 in winter to the value of 2.504 in spring, and was 35 per cent lower in summer falling to 1.981. Cost-effectiveness ratio decreased by approximately 29.5 per cent and the amount of electricity consumption increased by 26.4 per cent.

A preliminary economic analysis of the installation was conducted. According to the methodology of Romaniuk [12] the analysis included the costs of maintenance (1) and costs of use (2) as a component of the device's operating costs. The cost of use consist of the repairs costs (Cr), labour (Cl), supplies (Cs), and electricity (Ce); the costs of maintenance – depreciation costs (Cd), insurance (Ci) and construction costs (Cc):

$$\mathbf{C_m = C_d + C_i + C_c} \quad \text{[PLN]} \quad (1)$$

$$\mathbf{Cu = Cr+Ce+Cs+Cl} \quad \text{[PLN]} \quad (2)$$

Throughout the studies the major expenditure was formed by electricity consumption and labuor costs. The investment costs were formed primarily by the vertical ground heat exchangers - estimated at around 80 PLN/m; and heat pump systems with a value of about 32 800 PLN. The yearly cost of use amounted to about 3500 PLN, which is about 30-40 per cent of costs in the case of traditional heating with natural gas. Only the investment costs seem questionable, which, in this case, offer a return after about 7-8 years. It is quite a long period of depreciation, but when one takes into account that the financing terms of investments in unconventional sources of energy are more frequent and more favourable, their value and the amortisation period are reduced.

CONCLUSIONS

Based on the studies from installations to heat with using vertical ground heat exchangers in the spring and summer of 2012 the conclusions and observations were formulated.

1. In the period from April to July acquired 9.242 GJ of heat by ground heat exchanger, when processed by the heat pump to use was 23.107 GJ of heat, which was use for heating buildings,

16.786 GJ was sent to the office building heating system, and the remainder was used to heat "Ecobuilding".
2. COP of the system was 2.504 in the spring and 1.981 in the summer, which in relation to the relevant period of heating (winter) COP = 3.05 was a value of about 26.4% lower.
3. The reason for reduction of the COP was high air temperatures in spring and summer (as confirmed by the correlation coefficient r = -0.178 in the spring and r = -0.559 in summer).
4. Amount of heat was constant and independent of the time of year. It was at around 0.2 GJ per day, and after processed by the heat pump was from 0.538 $GJ \cdot day^{-1}$ in winter to 0.402 $GJ \cdot day^{-1}$ and 0.538 $GJ \cdot day^{-1}$ in spring and summer.
5. The installation of a ground source heat pump worked properly with stable level of performance and efficiency.
6. Further measurements in winter 2012-2013 will determine the amount of received heat from the ground in the next heating season, and verify a "heat recovery" from ground which was not recharged by the solar collectors in the summer.

REFERENCES

1. Adamovski R., Kara J. (2001): Energy and Economic Aspects of Energy Integrated System of Farm for Pigs Breeding. Scientific Conference: Techniczne, ekologiczne i ekonomiczne aspekty energetyki odnawialnej. Warszawa. SGGW, pp. 49-55.
2. Benli H. (2013): A performance comparison between a horizontal source and a vertical source heat pump systems for a greenhouse heating in the mild climate. Elaziğ, Turkey. Applied Thermal Engineering Volume 50, Issue 1. pp.197–206.
3. Czekalski D. (2011): Nowoczesne pompy ciepła jako konkurencja dla tradycyjnych technik grzewczych. In: Ekoinnowacje na Mazowszu. Poradnik Transferu Technologii w Dziedzinie Ochrony Środowiska. Podręcznik internetowy. Warszawa. Centrum Transferu Technologii i Rozwoju Przedsiębiorczości Politechniki Warszawskiej. ISBN 978-83-7207-999-2 p. 24.
4. Hepbasli A., Akdemir O., Hancioglu E. (2003): Experimental study of a closed loop vertical ground heat pump system. Energy Conversion and Management, 42 (4), p. 527-584.
5. Knaga J. 2007. Zależność efektywności energetycznej sprężarkowej pompy ciepła od czynników eksploatacyjnych. Problemy Inżynierii Rolniczej 2, p. 113-118.
6. Kreis-Tomaczak K. (2008): System pozyskiwania energii cieplnej z sond geotermalnych. Problemy Inżynierii Rolniczej. No 2(60) p. 167-173.
7. Kurpaska S., Latała H., Michałek R., Sporysz M.. (2008): Analiza efektywności elementów systemu wykorzystującego pompę ciepła do ogrzewania tunelu foliowego. Inżynieria Rolnicza 2 (100), p. 163-170.
8. Latała H., Kurpaska S., Sporysz M. (2011): Wybrane aspekty współpracy pompy ciepła z gruntowymi wymiennikami ciepła. Inżynieria Rolnicza 6 (131), p. 117-124.
9. Myczko A., Karłowski J., Nawrocki L., Kreis-Tomaczak K. (2003): Proekologiczny budynek inwentarski - produkcja i wykorzystanie energii. Journal of Research and Applications in Agricultural Engineering. Vol 48(2) s. 67-70.
10. Rutkowski K., Kurpaska S., Latała H. 2006. Metodyczne aspekty doboru dolnego źródła pompy ciepła do ogrzewania tunelu foliowego. Inżynieria Rolnicza. Nr 11(86). p. 409-416.
11. Romaniuk W. (1996): Wpływ funkcjonalno - technologicznych rozwiązań obór na energochłonność i koszty produkcji mleka w gospodarstwach rodzinnych. Rozprawa habilitacyjna. Prace Naukowo-Badawcze IBMER, Warszawa.
12. Szulc R. Łaska B. (2012): Badania instalacji do odzysku ciepła z odwiertów geotermalnych. Journal of Research and Applications in Agricultural Engineering, Vol. 57(2), p. 175-178.

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VERSATILE AND EFFICIENT MANUAL PRODUCTION SYSTEMS (MPS) AS A CONTINUOUS IMPROVEMENT PROCESS

Abstract: This paper presents the universal manual production systems (MPS), which are developed in accordance with various aspects of lean manufacturing. They allow quick and easy design and implementation of lean manufacturing facilities. Requirements for modern, lean manufacturing are more and more focusing on individual modules of manufacturing systems. In fact, the focus is on an integrated system with the concept of joint implementation.
Keywords: Manual production systems, CAD systems.

INTRODUCTION

One major problem of modern production is avoiding waste. Manual Production Systems (MPS) brought greater efficiency and gain in the production process in the form of variously equipped workstations and material flow. Innovative shelving systems can always ensure an optimum amount of material. All MPS modules are compatible with each other and can be combined in any way.

Thanks to its comprehensive range MPS components create a base for a truly effective production resource. With these systems inefficient production processes can be minimized or even completely eliminated. The emergence of overproduction can be avoided through effective and organized processes; thereby the supply of material will be reduced. This entire process is transparent, i.e. unnecessary downtimes are eliminated and material flow is improved. Manual production systems are introduced gradually, as needed, into the production facilities. They present the basis for a continuous process and investment improvement [6].

Fig. 1. An example of the production system for manual installation or removal

Source: own elaboration

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MANUAL PRODUCTION SYSTEMS (MPS)

Manual Production Systems are based on three pillars:

- freely configurable workstations and accessories,
- facilities for material preparation and distribution,
- devices for interconnection of workstations.

Single sites and equipment are highly flexible, which means that they can be adapted to given requirements, or can be easily re-adjusted or extended during production change. The system of connecting individual components, compatible with each manual modular manufacturing system, is simple and allows for quick building and rebuilding.

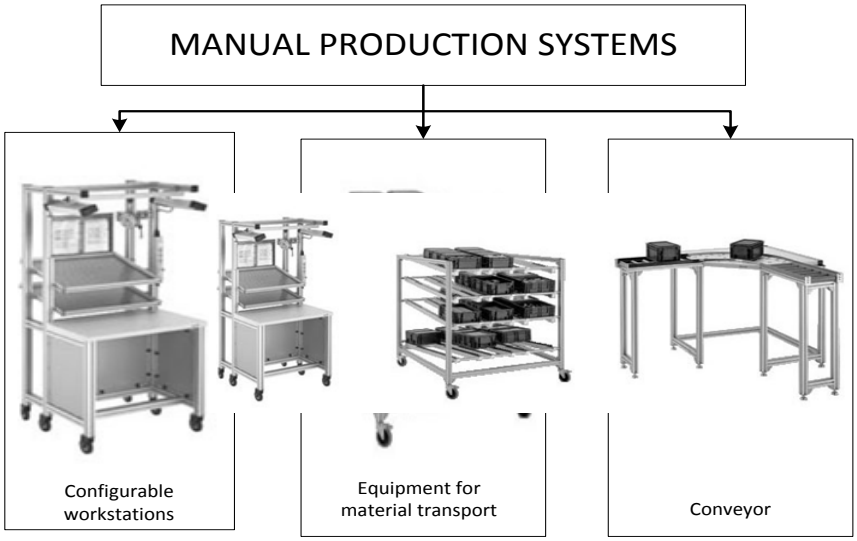

Fig. 2. Manual Production Systems three pillars

The flexible modular system as opposed to a fixed single solution can ensure material storage in different ways. Regardless of what industry it is, benefits of system enter the process everywhere [6]:

- economical for every need: variety of conveyors with different roll segments,
- universal use: bespoke function and size according to customer,
- adaptable for future use: fast and simple conversion and extension,
- effective processes by implementing FIFO.

In general, the basic unit of the modular workstation is the desk. Its high application possibilities ensure construction extension, which can be formed by a professional module (profimodul - special tools, jigs, measuring devices) and a power components module and connections (electrical outlet air connections).

Various parts can be assigned to higher production clusters with structures based on their destination, level of equipment and modification level of compatibility. This allows for the application of resources and enhanced quality and productivity, as well as optimal use of material and energy flows, production facilities etc.

CAD SYSTEM FOR DESIGNING PRODUCTION SYSTEMS (MPS)

The whole system of manual production systems is easily designable with CAD programs. Modular manufacturing systems can be created based on an individual customer's needs.

Currently, the market of CAD systems offers a wide range of products to support virtual design of modular manual production systems, not only for the engineering industry. CAD systems allow us to see the exact picture of the production system before its physical construction. Using such software for various problems, such as planned workplace errors, e.g. incorrect workstation layout - collisions elimination, perfect material flow etc. can be identified[3].

Some CAD systems use hardware features, such as cameras, projectors, scanners and other sensors in connection with software applications and thus allow for a more accurate view of the future manufacturing system. Systems designed for modeling modular production systems are closely related to systems that allow the simulation of manufacturing systems, and make it possible to see static objects that were created by designing software, assign dynamic properties or actual workers' movement, material flow, production machinery movements and other [3].

Figure 3 represents a brief overview of selected CAD systems suitable for reconfigurable manufacturing systems designs.

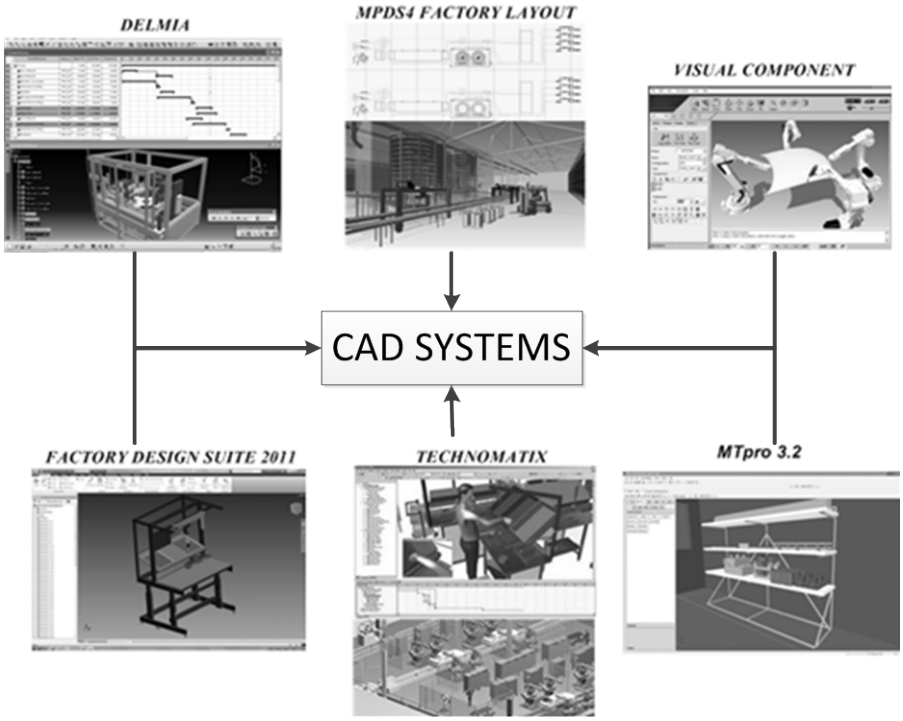

Fig. 3. Overview of selected CAD systems suitable for manual production systems design

CONCLUSION

Implementation of these modular manual production systems in practice significantly affects the actual design and perception of the development of new production systems. System development of methods, procedures and techniques of design is determined by knowledge of other disciplines, professional creativity, collective decision-making and other factors resulting from turbulent market conditions. Advantages from the application thereof in the construction of production structures are undisputable. Apart from direct economic and marketing benefits (flexibility, high modifiability, wide range of layout and function combinations, etc.) they have many other advantages, for example modern design influencing the change of production company culture, ability of ergonomic re-configurability and many more.

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REFERRENCES

1. Kováč J., Rudy V.: Prevádzka výrobných systémov. In: TU-SjF, Košice 2006, p. 136, ISBN 80-8073-233-7.
2. Kováč J., Liška O.: Development of Modularity of Assembly Systems. In: 119-th Pannonial applied mathematical meeting. Herľany 1997.
3. Šesták J., Rudy V.: Využitie CAD systémov v projektovaní stavebnicových výrobných - elektronický optický disk (CD-ROM). In: Strojárstvo - strojárstvo extra. No 5/2011, p. 41/1-41/5. ISSN 1335-2938.
4. Kočiš R.: Riešenie ručnej montáže a jej aplikovanie v štíhlej výrobe In: Trendy a inovatívne prístupy v podnikových procesoch. Košice 2009. ISBN 978-80-553-0330-7.
5. Prospektové materiály, katalógy a CD ROM firiem Bosch, MK Maschinenbau Kitz, Innotech, RK Rose + Krieger, Palettisystems.
6. www.mts.sk/profily/profily-06.php [2012].
7. www.boschrexroth.com [2012].

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TARGET COSTING IN MANAGEMENT OF ENTERPRISES

Abstract: The paper presents principles and procedures for the application of target costing. The potential was indicated for the implementation of target costing as a standard management method in enterprises operating in the face of considerable competition and continuous need to change the range of products. Key advantages and drawbacks of target costing have been discussed.
Keywords: management of enterprises, target costing, target price, target cost, target profit

INTRODUCTION

Japanese car manufacturers, who started to expand export of their products on the American market in the 1960's, faced a barrier in the form of market conditions, changed in comparison to the era of predominance of mass-scale production. In response to such a situation a new costing and pricing method was developed, referred to as target costing or target cost management (Japanese genka kikaku) [Masztalerz 2006]. Target costing was implemented for the first time in 1965 in the Toyota Motor Corporation. The aim of this method is to adapt the level of manufacturing costs of products to the expectations of potential customers and to determine the most advantageous possible prices for offered products. Horvath et al. defined target costing as "a package of management methods and tools facilitating the formulation and realisation of objectives concerning costs at the concept and development phase of a new product, in order to identify the foundations for cost control at the execution phase and to ensure the realisation of profit objectives over the entire life cycle of a product" [Mirowski 2007].

In the 1970's the new costing method started to be applied in such car manufacturing companies as Nissan Motor Co. Ltd. and Daihatsu Motor Co., Ltd. Target costing was also adopted by consumer electronics manufacturers, Panasonic Corporation (previously Matsushita Industrial Co., Ltd.) and Sharp Corporation, as well machine building and precise equipment sectors [Jaruga et al. 2001]. In literature on the subject the target costing method was presented as late as the late 1980's [Masztalerz 2006]. In the 1990's it was already a well-known method in management circles of key companies operating on the market of end consumer products. This resulted in a considerable number of publications, in which authors developed target costing procedures and indicated its different applications [Sakurai 1989, Monden and Hamada 1991, Kato 1993, Cooper and Slagmulder 1997, Robinson 2000, Kee and Matherly 2006, Ansari and Bell 2009, Rains 2010].

The aim of the paper is to present basic principles of target costing. The target costing method is a convenient management tool in enterprises. Particular advantages of its application may be observed in enterprises which operate in a strongly competitive environment. Another incentive for the implementation of this method is connected with the need to frequently launch new or modified products on the market. In such a situation without target costing it is difficult for companies to be successful on the market.

1. PRINCIPLES OF TARGET COSTING

Classical costing methods are based on costs generated in the course of manufacturing of products already available in the market offer of an enterprise. They are both *ex post* (historical) and *ex ante* (future) costs. In contrast, target costing may be applied to establish prices and to establish costs of new products. Those are products to be launched on the market and which have not been elements of the market offer. Target costing may also be used in relation to products modified in terms of their utility or aesthetic value. In all cases target costs are established at the design stage and at the introduction of products to production, i.e. in the first stage of their life cycle.

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Approximately 80 - 90 per cent of manufacturing costs of a product are defined at the stage of their design and implementation (Figure 1). In the production stage the possibilities to reduce costs are considerably limited [Jaruga et al. 1997].

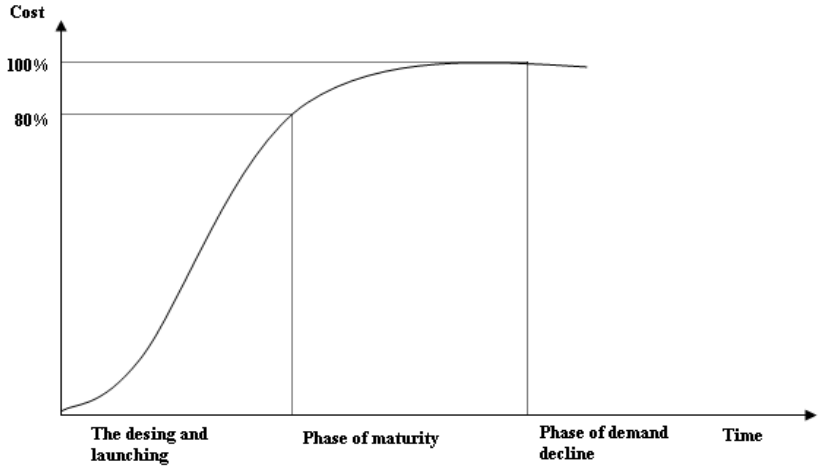

Fig. 1. Modification of manufacturing costs depending on the product life cycle phase

Source: own study.

Target costing is also applicable in the other stages of product life. This results from the principles of this type of costing, stipulating that the determined target cost is maintained until the product is withdrawn from the market offer. This requires continuous control of manufacturing costs and appropriate response to their increase. This is achieved using product cost controlling. In such an approach target costing becomes a tool in reaching the assumed profit throughout the entire period of production and sale of a given product.

Several variants (versions) of target costing are mentioned in literature on the subject, distinguished due to the more or less developed procedure of their determination [Wierzbiński 2001]:

- Market into company – attainable (target) sale price of a product is determined on the basis of marketing analyses, performed in the course of its designing. The method which proves useful in such studies is the conjoint analysis. As its result we obtain a set of product functions together with a scale of importance of these functions and the accepted product price. The planned (target) unit profit (profit margin) is deducted from the established price. The resulting difference constitutes allowable cost of the product, which is assumed as equivalent to target cost,
- Out of company – in this approach target costs for the designed product are identified on the basis of an analysis of technological and technical production conditions, available know-how, professional experience of employees and production capacity of the enterprise. Target cost is established as the product cost, which is generated under technological and organisational conditions found in the enterprise,
- Into and out of company – costing is performed based on the combination of the two previous procedures. First, the allowable cost is determined according to the method defined by the market into company approach. Next, planned (initial or current) manufacturing costs are established according to the out of company procedure to reduce them to the level which does not exceed the previously established allowable cost. It is assumed that target cost is equal to allowable cost. Reduction of planned manufacturing costs may be executed using the function method and value analysis,

- Out of competitor – target cost of the designed product is established at a level not exceeding costs attained by the main competitors offering similar products or it is assumed at the level of the lowest costs attained by companies operating in the same sector for competitive products. In such analyses we may apply the method of comparative analysis of competitors – benchmarking,
- Out of standard cost – the target cost is established on the basis of standard costs (drifting costs, direct standard costing). Standard (normative, postulated) costs for designed products are established on the basis of materials consumption standards for production factors, assuming optimal manufacturing conditions [Nowak et al. 2004].

2. PROCEDURE OF TARGET COSTING

The starting point in target costing is connected with marketing studies. Their aim is to determine the target price of the product, acceptable for the market. First, needs and requirements of buyers of the future product are identified. For this purpose analyses are conducted concerning potential customers, most typically using the in-depth interview. Characteristics and prices of competitive products offered on the market are analysed with the benchmarking method. On the basis of results of these analyses parameters and functionality (a set of functions) are analysed for the product. Next, the degree of willingness of future customers to pay for developed products is determined. In this case the survey method is applied. Using this method different proposed sets of functions and related prices of product models are compared. The version of the product is selected, which is well-accepted by prospective customers and has the most advantageous price. It is the target price of the product.

In case of modified products the target price is modified by adding or deducting the value of the functions from the prices of the product already existing on the market. The procedure is similar when the target price is established on the basis of technical parameters of the product, such as weight, rotational velocity, etc. Then the price of the product offered so far is changed by the value of increased or reduced physical properties.

After establishing the target price, the next stage of target costing is to determine target profit (profit margin). The procedure is analogous for both new and modified products. Calculations are based on the return on sales (ROS) assumed in the enterprise for the manufactured range of products or recorded mean value of profit for the sector in which a given company operates. Target profit, established on the basis of the return on sales index, is determined from the formula:

$$TP = ROS*PS, \quad (1)$$

where:

TP – target profit in the assumed period,

ROS - return on sales,

PS – planned income from sales in the assumed period.

If the target profit is determined for a modified product, in formula (1) the return on sales is applied as attained for the product offered so far. Target profit calculated according to formula (1) pertains to the period for which income from sales is planned. Target unit profit (TUP) is determined by dividing target profit for the assumed period by the planned number of products which are to be sold in the assumed period.

On the basis of target price and target profit the allowable unit cost is determined according to the formula:

$$AUC = TPR – TUP, \quad (2)$$

where:

AUC – allowable unit cost,

TPR – target price,

TUP – target unit profit.

In Japanese enterprises target cost is established in two ways. At Nissan Motor Co. Ltd. allowable cost is equated with target cost. The aim of successive actions is to reduce current

(planned) costs so that they reach the level determined by the target cost equal to allowable cost. In turn, at Toyota Motor Co. Ltd. target cost is considered to be the difference between current and allowable cost. Further actions aim at an elimination of the calculated difference in costs.

In the next stage of target costing the target cost is divided between basic components of the designed product. This is done based on the functions served by the product. Types of functions and evaluation of their importance for potential buyers are determined using the survey method. Respondents assign an appropriate score to analysed functions, in proportion to their importance. Scores collected from all questionnaires are converted into percentage proportions, thus producing weight evaluations for the importance of functions. Target costs are allocated to analysed functions adequately to the volume of weights. As a result a vector of target costs of a function is created.

Next it is determined to what degree individual components of the product are carriers of functions. A correlation of components and functions is obtained by indicating, for each pair of a component and a function, the degree of their mutual relationship. As a result a value matrix is produced, which determines the power of the relationship between individual functions and components. The matrix thus obtained is multiplied by the previously determined vector of function costs. The result of the calculations provides target costs, determined for every analysed component. It is assumed that the determined costs are maximum manufacturing costs of product components. These costs may not be exceeded in the course of production throughout the entire life cycle of the product. The primary advantage of these costs stems from the fact that their level is accepted by customers.

If an enterprise does not manufacture certain product components, the established target cost is at the same time the maximum price at which the company is willing to purchase the final component from a supplier or order it from a contractor. In this way target costing may produce low prices throughout the entire chain of cooperating enterprises. By imposing the sale price a reduction of costs is enforced for all successive manufacturers.

The last stage in target costing consists in the reduction of planned (current) costs of the product and its components to the level not exceeding target costs established in the previous stages of the calculation procedure. Value analysis is a method frequently used in designing of products and reduction of costs.

Basic principles of value analysis were developed in 1947 by L.D. Miles, an employee of General Electric. The essence of the method is to systematise the search for the potential cost reductions based on the analyses of functions and utility characteristics of the designed product [Martyniak 1997]. With the use of value analysis the objective is to implement technological and organisational innovations in the manufacturing processes, as well as simplify the design of the product structure and apply cheaper substitution materials in order to decrease manufacturing costs.

Value analysis is performed in the following steps [Biliński et al. 1972]:

1) determination of the scope of analysis, i.e. selection of components and functions of the product and manufacturing processes which will be thoroughly investigated,
2) collection of information on the product, i.e. data on the used materials, admissible substitutes and their prices, designed structure of the product and the course of the manufacturing processes and their costs,
3) performance of a critical analysis of collected information on the product and development of several solutions which will facilitate obtaining of the same functions using different methods,
4) selection of the most advantageous solutions from the point of view of cost reduction in comparison to the initial solution. The total manufacturing cost of the product after value analysis and cost reduction should not exceed the level of target costs,
5) preparation of a product design on the basis of the most advantageous solution in terms of costs and realisation of the project for production implementation and launching of the product on the market.

Target costing and supporting methods are tools which may find permanent applications in management processes in enterprises. A one-time use of these methods provides only short-time effects. They may disappear due to the rapidly changing external and internal environment of the company. Incorporation of target costing to the package of management methods markedly enhances the chance to attain long-term economic success by the enterprise.

CONCLUSIONS

Application of target costing requires collection of detailed and reliable data concerning components of the manufacturing cost. A considerable role is played by accurate, in-depth market analyses in terms of the product acceptance by potential customers. Quality of market studies to a high degree determine the accuracy of results obtained by target costing. In an impropriate application the method may lead to a deterioration of product quality as a result of preference for poor quality materials.

REFERENCES

1. Ansari S.L. J., Bell E. (2009): Target Costing. Mountain Valley Publishing, LLC.
2. Cooper R. Slagmulder R. (1997): Target Costing and Value Engineering. Productivity Press Inc.
3. Biliński W., Ceraficki J., Nowakowski A. (1972): Analiza wartości. Państwowe Wydawnictwo Ekonomiczne, Warszawa.
4. Horvath P., Niemand S., Wolbold M. (1993): Target Costing – State of Art. W: P. Horvath Target Costing. Stuttgart.
5. Jaruga A.A., Nowak W.A., Szychta A. (2001): Rachunkowość zarządcza. Koncepcje i zastosowania. SWSPiZ, Łódź.
6. Kato Y. (1993): Target costing support systems: Lessons from leading Japanese companies. Management Accounting Research (March): pp. 33-47.
7. Kee R. Matherly M. (2006): Decision control of products developed using target costing. Advances in Management Accounting (15): pp. 267-292.
8. Martyniak Z. (1997): Organizacja i zarządzanie. 15 efektywnych metod. Antykwa, Kraków – Kluczbork.
9. Mastalerz M. (2006): W poszukiwaniu definicji rachunku kosztów docelowych. Prace Katedry Rachunkowości z okazji jubileusz 75-lecia. W. Gabrusewicz (red), Zeszyty Naukowe Akademii Ekonomicznej w Poznaniu, No 82: pp. 129-133.
10. Mirowski T. (2007): Koncepcja rachunku kosztów docelowych produkcji biomasy na cele energetyczne. Polityka energetyczna, tom 10, zeszyt specjalny No 2: pp. 343-353.
11. Monden Y., Hamada K. (1991): Target costing and kaizen costing in Japanese automobile companies. Journal of Management Accounting Research (3): pp. 16-34.
12. Nowak E., Piechota R., Wierzbiński M. (2004): Rachunek kosztów w zarządzaniu przedsiębiorstwem. Polskie Wydawnictwo Ekonomiczne, Warszawa.
13. Rains J. (2010): Target Cost Management: The Ladder to Global Survival and Success. CRC Press.
14. Robinson F. (2000): A Practical Guide To Target Costing. Stylus Publications.
15. Sakurai M. (1989): Target costing and how to use it. Journal of Cost Management (Summer): pp. 39-50.
16. Wierzbiński M. (2001): Rachunek kosztów docelowych, w: Rachunek kosztów w praktyce. Wydawnictwo Dashofer, Warszawa.

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IMPACT OF RAW MATERIAL QUALITY VERSUS PRODUCTION OF CONSTRUCTION ELEMENTS

Abstract: For the production of wooden construction determining the quality of pinewood to be used is of vital importance. Material on which the research was carried out came from two quality classes: WBO and WCO. Large-size as well as laboratory samples were obtained from the material to undergo tests of their physical and mechanical parameters. As the result of quality classification process of construction materials the impact of raw material quality on the parameters of semi-finished products used for the production of wooden construction was determined.
Keywords: raw wood, quality, wood components

INTRODUCTION

Wood is a building material, used mainly for construction and finishing elements. High endurance, small dead load, as well as the simplicity of processing are its main features. Materials of the above mentioned qualities are bearers and parts of timber roof trusses but also those elements which are used in unfavorable weather conditions. (Neuhaus 2004). Companies specializing in timber construction develop through the implementation of new technologies, through continuous research and evolutionary activities. Due to that this sector of economy stands a chance of continuous developing and overcoming limitations related to wood usage. In order to obtain the characteristics of technical parameters of wood accounting for its heterogeneous and anisotropic structure complex endurance tests in accordance with the requirements of traditional science of wooden materials are vital (Dzbeński 1984, Dzbeński at al. 2005, Krzosek 2009, Wieruszewski et al. 2009, 2010, 2011).

PURPOSE AND SCOPE OF WORK

The aim of paper is to establish the quality efficiency ratio when processing pinewood of WB and WC class (that is large size wood of good and average quality). Research was carried out in order to obtain construction lumber and determine its physical and mechanical features. The aim of the research was also to determine a detailed characteristics of roundwood.

The research was directed at obtaining the data concerning the creation of endurance and quality parameters of a given material. Also, the analysis of usefulness of sawn materials possessed for production purposes and used as construction elements in the building industry and other economy sectors was carried out.

METHODOLOGY

Material assigned for research came from the forest sub-district of Sokolniki (Przedborów District) close to Wieruszów (Łódź voivodeship), section 8510.

The material was delivered to the sawmill where it was then sawn. Research determining the features of pinewood was carried out on the material belonging to both quality categories, namely WB and WC. The material, from which large size samples were cut out for the purpose of the research, was prepared individually at the sawmill Witar Tyble. 24 unedged boards were obtained, out of which 16 were radial-sawn and a further 16 were flat-sawn (measuring 40x150x2400 mm). The sawn timber was dried in order to achieve a moisture content of 12 per cent.

In Table 1 below sample marks from the beginning of the sawing process - the number of log up till the final plank marking - were presented. For the purpose of the research, two groups of

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marks were adopted. The group of radial-sawn samples was marked R, while flat-sawn samples were marked T. Individual groups were described as presented below.

Research on elasticity, as the indicator in the process of nondestructive control, was carried out in accordance with the recommendations of the standard: PN-EN 384: "Construction wood. Marking characteristic mechanical features and density".

Determining the elasticity ratio at static bending was done on a testing machine type DM 2214, using instrumentation adequate for endurance testing.

Table 1. Designation of samples

Designation of samples	wood class	dimensions		Designation of samples	wood class		dimensions
1RP 1RL	B		40x150x2800	5RP 5RL	C		40x150x2800
1TP				5TP			
1TL				5TL			
2RP 2RL	B		40x150x2800	6RP 6RL	C		40x150x2800
2TP				6TP			
2TL				6TL			
3RP 3RL	C		40x150x2800	7RP 7RL	B		40x150x2800
3TP				7TP			
3TL				7TL			
4RP 4RL	C		40x150x2800	8RP 8RL	B		40x150x2800
4TP				8TP			
4TL				8TL			

The data obtained served to calculate the coefficient of elasticity during bending for samples of real moisture content „W" [%], according to norm: PN-EN 1912;2010 and PN-63/D-04117

RESULTS

Wood density is one of its most important physical features and it is also a factor determining wood mechanical endurance. (Witkowska 1999). In Table 2 the results of tests on pinewood density for laboratory samples, accounting for geographical direction on the cross-section of the tested material were juxtaposed (Karkoszka 2012).

Table 2. Average wood density for individual samples

Designation of samples	Average density of wood [g/cm^3]			Average
	South	North	East - West	
1	0,557	0,599	-	0,578
2	0,520	0,578	0,570	0,556
3	0,486	0,535	0,495	0,505
4	0,545	0,534	0,565	0,548
5	0,520	0,615	0,549	0,561
6	0,464	0,457	0,521	0,481
7	0,515	0,479	0,505	0,500
8	0,483	0,458	0,528	0,490
Average	0,511	0,532	0,533	0,526

Interpreting all obtained data on pinewood density, we may state that solid material density reached approximately 530 kg/m3. Hence, the obtained density may be compared with the average density presented in literature (Krzysik 1978, Kokociński 2004).

Coefficient of elasticity was carried out on 32 large-sized samples, out of which 16 were flat-sawn and the remaining 16 radial-sawn. From each log 4 large-sized samples have been made (2 flat-sawn and 2 radial-sawn). In Table 3 the arithmetic mean coefficient of elasticity at absolute moisture content of 12 per cent was presented for both types of logs, that is flat- and radial-sawn. (Karkoszka 2012).

Interpreting Table 3, one may observe that flat-sawn pinewood has a better coefficient of elasticity than radial-sawn pinewood. An average value of the coefficient of elasticity at moisture content „W" obtained from large-sized samples of solid core wood amounts to 7849 N/ mm^2. The lowest value was obtained for sample 4 (6709 N/mm^2) and the highest value was for the experimental material number 2 (9402 N/mm^2). It is worth noticing that the high coefficient of elasticity for experimental materials 1, 2, 7, 8 is the result of the quality class of the raw material: WBO, while the remaining material was of quality class WCO.

Table 3. The value of the coefficient of elasticity at moisture content of 12 % for flat-sawn and radial-sawn samples

Designation of samples	T [N/mm^2]		R [N/mm^2]		Average [N/mm^2]
	Eg_w	Eg	Eg_w	Eg	
1	8343,96	7913,30	8955,10	8406,92	8160,11
2	10408,05	9782,26	9562,26	9022,79	9402,11
3	7616,38	7318,57	6706,97	6235,19	6776,88
4	7411,19	7128,71	6582,23	6289,60	6709,16
5	10051,62	9541,21	5710,37	5401,94	7471,58
6	7607,61	7064,10	6869,24	6356,97	6710,53
7	7980,99	7486,59	10505,67	9728,12	8607,35
8	12374,97	11636,83	6761,35	6282,77	8959,80
Average	-	8483,95	-	7215,54	7849,69

Obtained results for the experimental construction elements are lower than data available in the literature (Krzysik 1978, Kokociński 2004).

In accordance with norm PN-EN 338 „Construction wood. Endurance classes", the endurance class has been determined comparing samples obtained from „WITAR" Tyble sawmill with model samples. The standard adopted was the result of the average coefficient of elasticity and its 5 per cent quantile. Sorting results were presented in Table 4 (Karkoszka 2012).

Table 4. Endurance classification based on the results of the coefficient of elasticity

Strength class	Designation of samples							
	1	2	3	4	5	6	7	8
C14	Meets	Meets	Meets	5%	Meets	5%	Meets	Meets
C16	Meets	Meets	5%	5%	5%	5%	Meets	Meets
C18	5%	Meets	5%	5%	5%	5%	5%	Meets
C20	5%	Meets	5%	5%	5%	5%	5%	5%
C22	5%	5%	5%	-	5%	-	5%	5%
C24	5%	5%	-	-	5%	-	5%	5%
C27	5%	5%	-	-	-	-	5%	5%
C30	5%	5%	-	-	-	-	5%	5%
C35	-	5%	-	-	-	-	-	5%
C40	-	5%	-	-	-	-	-	-
C45	-	-	-	-	-	-	-	-
C50	-	-	-	-	-	-	-	-

Meets requirements – given batch meets standard criteria

5% - 5% quantile of the coefficient of elasticity meets norm requirements

Pinewood construction elements should meet the requirements for the individual endurance classes in accordance with norm PN-EN 338. Therefore, large-sized pinewood solid samples may be qualified into the endurance class C14/C16. Solid large-sized pinewood samples show low mechanical features which are required for individual quality classes. This is largely due to wood defects such as knots. Hence more and more frequently glulam is being used due to the fact that it lacks defects and as the result the coefficient of elasticity significantly increases.

CONCLUSIONS

Based on research carried out on pinewood lumber the following observations and conclusions have been made:

1. Average wood density amounted to approximately 530 kg/m^3. The value of determined density ranged from 450 up to 600 kg/m^3 at moisture content of 8 per cent and was sufficient for obtaining high-class endurance in accordance with adequate norms.
2. Comparing two classes of wood quality, namely WBO and WCO one may clearly state that better features are characteristic for material of WBO class. The difference in coefficients of elasticity of those classes is significant and amounts to approximately 2 000 [N/mm^2].
3. According to the standard, large-sized solid samples, in reference to their endurance, may be classified as C14/C16. Low mechanical features characteristic for pinewood are the result of defects which may be found in this type of wood, such as knots. Therefore more and more often glulam is being used as it is free of defects, thus its endurance grows significantly.
4. The knowledge of physical and mechanical features determined in this paper allows for an adequate system of control, which to a large extent helps to define quality and endurance of semi-finished products.

REFERENCES

1. Dzbeński W., (1984): Nieniszczące badania mechanicznych właściwości iglastej tarcicy konstrukcyjnej wybranymi metodami statycznymi i dynamicznymi. SGGW-AR, Warszawa.
2. Dzbeński W., Kozakiewicz P., Krzosek S. (2005): Wytrzymałościowe sortowanie tarcicy budowlano-konstrukcyjnej. SGGW, Warszawa.

3. Karkoszka I. (2012): Wydajność jakościowa sosnowej tarcicy konstrukcyjnej z surowca wielkowymiarowego klasy W(C) w tartaku WITAR Tyble, Praca magisterska.
4. Kokociński W. (2004): Drewno Pomiary właściwości fizycznych i mechanicznych. Poznań.
5. Krzosek S. (2009): Wytrzymałościowe sortowanie polskiej sosnowej tarcicy konstrukcyjnej różnymi metodami. SGGW, Warszawa.
6. Krzysik F. (1978): Nauka o drewnie. PWN. Warszawa.
7. Neuhaus H. (2004–2008): Budownictwo drewniane. PWT, Rzeszów.
8. Witkowska J. (1999): Gęstość drewna sosny zwyczajnej (*Pinus sylvestris L.)* w zależności od wieku drzew, XIII Konferencja Naukowa Wydziału Technologii Drewna SGGW, Warszawa**.**
9. Wieruszewski M., Gotych V., Hruzik G., Gołuński G.: Jakość sosnowych elementów klejonych dla budownictwa szkieletowego VIII Konferencja Naukowa „Drewno i materiały drewnopochodne w konstrukcjach budowlanych" ZUT, Szczecin 2009.
10. Wieruszewski M., Gołuński G., Hruzik G. J., Gotych V.: Glued elements for construction, Annals of Warsaw University of Life Sciences – SGGW Forestry and Wood Technology No 72, 2010: pp. 453 – 458, Warszawa 2010.
11. Wieruszewski M., Gotych V.: Prefabrication for production purposes of skeleton furniture, Annals of Warsaw University of Life Sciences – SGGW Forestry and Wood Technology No 76, 2011: pp. 184 – 189, Warszawa 2011.
12. PN-63/D-04117: Fizyczne i mechaniczne własności drewna. Oznaczanie współczynnika sprężystości przy zginaniu statycznym.
13. PN-68/D-4103: Fizyczne i mechaniczne własności drewna. Oznaczanie wytrzymałości na zginanie statyczne.
14. PN-EN 384: Drewno konstrukcyjne. Oznaczanie wartości charakterystycznych właściwości mechanicznych i gęstości.
15. PN-EN 338: Drewno konstrukcyjne. Klasy wytrzymałości
16. PN-EN 1912: Drewno konstrukcyjne. Klasy wytrzymałości. Wizualny podział na klasy i gatunki.

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