Managing Innovativeness in International Enterprises

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MANAGING INNOVATIVENESS IN INTERNATIONAL ENTERPRISES

Summary

The paper aims at explaining the importance of innovations in modern enterprises. Activities leading to creation of innovative solutions, types of innovations and their meaning for enterprise's strategic planning have been presented. The meaning of product quality in relation to manufacturing costs has been introduced. The explanation of this relation has been performed with help of Taguchi Loss Function. The author tries also to answer the question how to assess the aptitude of individual innovations for maintaining an optimal cost / income balance, hence the economic rationality of innovative undertakings. The proposed tool for multi – criteria decision making is the Analytic Hierarchy Process method (AHP) by Thomas L. Saaty. Main assumptions of the model, as well as methods of its application have been presented.

***Key Words**: innovations, multi – criteria decision making, Analytic Hierarchy Process*

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1. Introduction

The omnipresent pressure for high quality of a product is a fact. This pressure comes from various sources – clients, competitors, engineers, research & development centers, new manufacturing technologies, etc. Enterprises tend to respond to these market needs by inventing and implementing innovations. Meanwhile the modern economy knows enough examples of missed investments in the innovations area. They can become extremely painful for modern enterprises, due to high initial and implementation costs. Thence an important question arises – which innovations should be accepted for funding and which rejected? What criteria to apply in order to maintain the economic everlasting balance between costs and income? And finally, what implementation methods to choose to make the product manufacturing process the most rational one? The present paper is author's attempt to answer these questions.

2. Characteristics of Innovations

The word "innovation" (*novus* in Latin) has a wide meaning, varying from new products, new quality features, new production processes, new services, new markets, new materials as well as new methods of management.

An innovation is an idea that creates a measurable economic value. Any innovative activity has to be preceded by an "invention", which is not directly meant to bring profit in terms of money. However, an innovation should at least imply a hope for creating net income. According to this definition, an innovation that is not creating any economic value does not fall under this term. Implementing innovations has a taste of the unknown, because any already known solutions are not innovations.

Innovations are the effect of three following activities:

- Acquiring knowledge (curiosity, attentiveness, creativity);
- Transferring knowledge into praxis (ambition, bravery);
- Transforming knowledge into actions (courage, persistence, finance).

Linking innovation to scientific research implies the understanding of science as transformation of money into knowledge. Following this logic, innovation means exactly the opposite[1].

Seen from economic perspective innovations can be divided into three categories[2]:

- Transformative Innovations – being an inspiration for new projects or production processes, they have the strongest impact on the economy. They can open new markets and bring strong competitive advantage, also in terms of stimulating future generations' creativity. They can also result in putting traditional methods of management into question.
- Real Innovations – they offer a smaller range of changes that Transformative Innovations, but still do reverse the existing order. They are important and clearly visible both for client and producer. They consist of innovative solutions, items or services providing the organization a number of applicable functions, information and skills to be included in its products. They require involvement of company's authorities. Real Innovations have generative nature, which means that they give incentives for creating further innovations.
- Incremental Innovations – they help making the existing solutions better. For many companies this group of innovations is the driving force of most organizational changes and upgrades. Due to the fact that incremental innovations in most cases use existing production facilities and distribution channels, they can

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[1] Koch J., *Innowacje siłą napędową rozwoju*. Materiały konferencyjne INTELTRANS'2004, Kraków 2004, p.123 – 131.
Warnecke H.-J., Bullinger H.-J., *Kunststück Innovation*, Springer – Verlag, Berlin Heidelberg 2003.

[2] Ginalski J., Liskiewicz M., Seweryn J., *Rozwój nowego produktu*, Akademia Sztuk Pięknych w Krakowie, Kraków 1994.
Penc J., *Innowacje i zmiany w firmie*, Agencja Wydawnicza PLACET, Warszawa 1999.
Pomykalski A., *Innowacje*, Wydawnictwo Politechniki Łódzkiej, Łódź 2001.

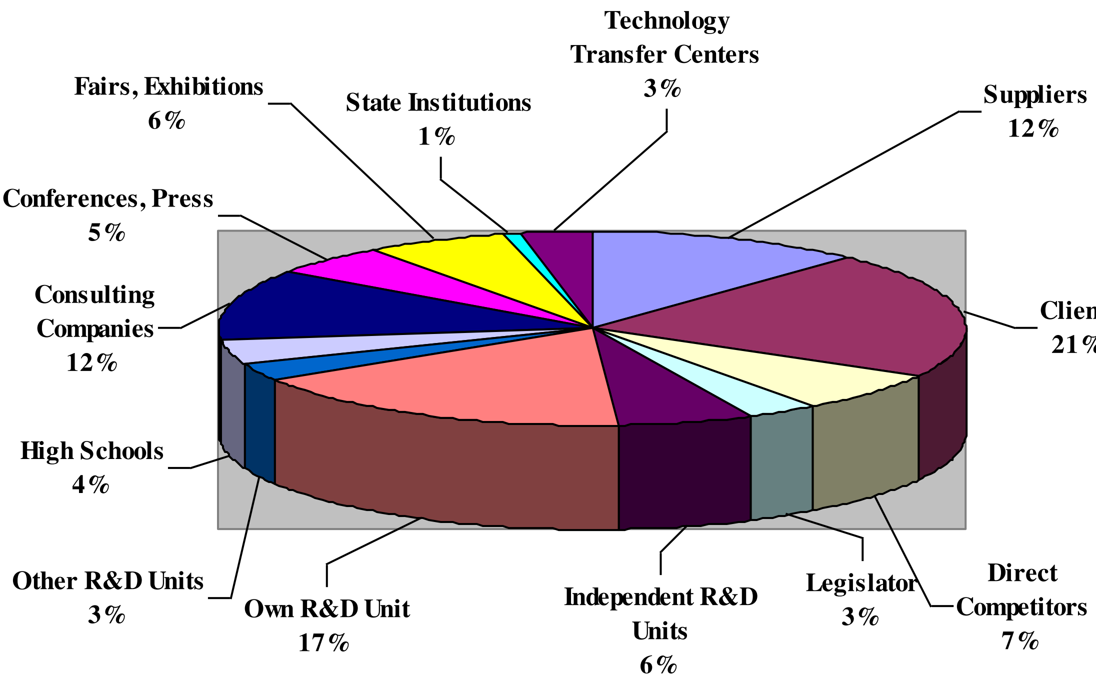
be introduced by regular employees without involvement of managerial staff. Although they are the effect of quality management and reengineering programs[3], they do not constitute a risk for existing business and management models, nor organization's strategic planning. They also show a relatively small economic impact.

The innovation oriented course of an organization is the effect of three reasoning phases of the creation process – research, incubation and collision. Factors encouraging each of these phases come from company's environment, namely from its clients, suppliers, competitors, educational institutions and a wide range of internal stimulators[4]. But the innovative process encounters also various obstacles. Foster and Kaplan provide a number of such impediments, *inter alia* fear of taking risks, strained short - time budget, lack of time, lack of management's support, bureaucracy, ignorance of clients', products' or market preferences, past successes, lack of cooperation between regions, companies or groups, policy of constant change as a threat to power[5].

Fig. 1 shows incentives to innovation seen from company's managerial level. It should be noticed that this reality usually finds its reflections in enterprise's strategic planning. The presented data comes from author's research in progress and should be treated as preliminary outputs only.

[3] Durlik I., *Restrukturyzacja procesów gospodarczych. Reengineering. Teoria i praktyka*, Agencja Wyd. Placet, Warszawa 1998.
Kun-Lin-Hsieh, Lee-Ing Tong, *Process Quality improvement of a quantitative response with dynamic characteristic*, Int. J. Adv. Manuf. Technol. (2005), 25, p. 1180 – 1190.
[4] Lowe P., *Zarządzanie technologią*. Śląsk Sp. z o.o., Katowice 1999.
[5] Foster R., Kaplan P., Twórcza destrukcja, Wydawnictwo Galaktyka Sp. z o.o., Łódź 2003.

Figure 1: Incentives to Innovativeness



Source: Own elaboration based on research in frames of project „*Badanie współzależności procesów geopolitycznych i działania korporacji międzynarodowych*", Cracow University of Economics

One should notice that the innovation barriers and incentives come from different levels of enterprise's environment. They can be caused by factors coming from closest operating environment, but also from host – country and global environments, when switching to international level[6].

3. Product Quality

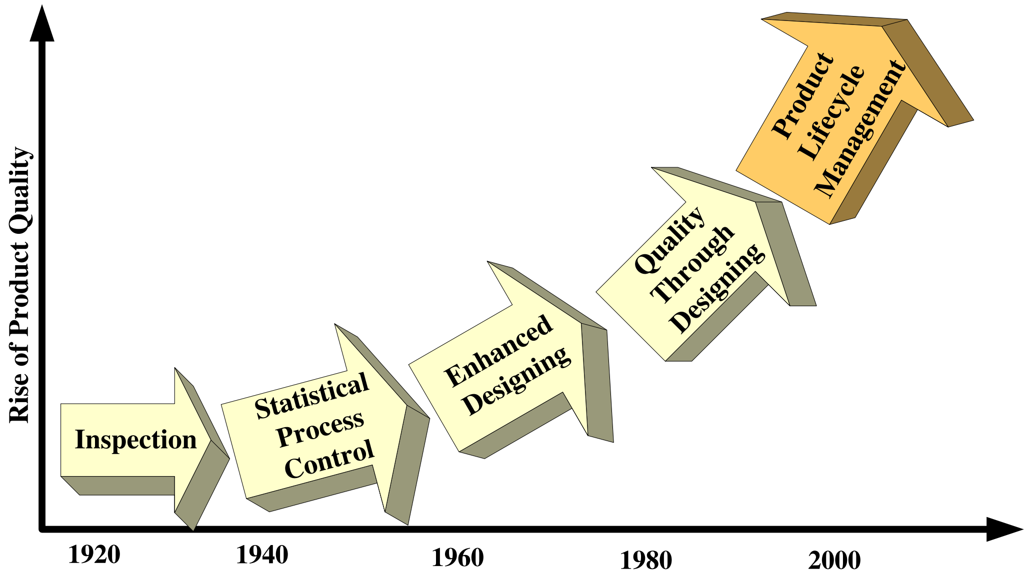
Defining the quality of a product, good or service is a difficult task. We can assume that the quality is a multi – criteria characteristic of the product under evaluation in relation to the predefined norms, standards and clients' expectations. Strong market competition is forcing the producers not only to prevent loosening the quality of their products, but even more – to raise its level constantly. It can be observed that many products show a higher utility, reliability and quality than their former generations. The author wants to precise that reliability is understood as the probability of fulfilling the product's functions in a predefined period of time. The example of motor vehicles can be cited: although many cars from the 60ties can still be used today (at least after some repair operations), the reliability of a modern car is relatively higher. Probably no one would presume that a modern compact car (i.e. Ford Focus) could be in service for 50 years, but we do not expect it, because its reliability has been planned within a 5 year time span. On the other hand the probability of its faultless functioning during these 5 initial years is much higher than the one of a ’64 Ford Mustang used to be. This dualism comes from contradictory producer’s and customer’s expectations. The producer expects the highest possible turnover and income, while the customer expects the most reliable product for the cheapest possible price. If the product quality becomes too high, the producer would go bankrupt, because quality costs money. Another reason is that the customer would have no need of purchasing newer product generations. On the other hand, if the customer’s satisfaction from the product is too low, he will buy the next one from producer’s competitors. Therefore a certain level of equilibrium between producer’s and customer’s expectations towards the product quality has to be reached. The tool used for this purpose is Product Quality Management (element of Product Lifecycle Management system – PLM), the essence and development of which will be presented in the verses below.

The development of quality control heads towards integration of designing and manufacturing processes (Fig. 2). This concept is the basis of Taguchi method[7]. It focuses on assuring quality already at the phase of product designing through identifying and controlling the critical variables and interferences of the process. This need comes from the fact that causes of deviations from the assumed quality level bear a strong influence on the product forming process and its characteristics, hence on producer’s costs and customer’s satisfaction.

[6] Gawlik R, Analysis of International Corporations Operating Environment with application of Analytic Hierarchy Process, in: „Zarządzanie Międzynarodowe w światowej transformacji – społeczno gospodarczej”, Wyd. UEK w Krakowie, Kraków 2007.

[7] Gawlik J., Kiełbus A., Wieloparametrowa ocena jakości urządzeń technologicznych z zastosowaniem funkcji strat Taguchi’ego. „Komputerowo zintegrowane zarządzanie” – praca zbiorowa pod red. R. Knosali, Oficyna wydawnicza Polskiego Towarzystwa Zarządzania Produkcją, Opole 2006, t. I, p. 401 – 410.

Figure 2: Development of Product Quality Management



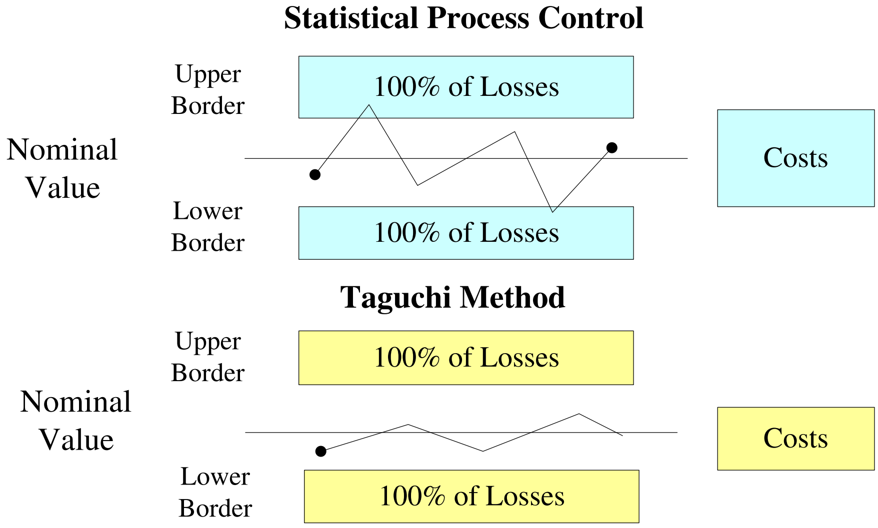
Source: Gawlik J., Kiełbus A., *Wieloparametrowa ocena jakości urządzeń technologicznych z zastosowaniem funkcji strat Taguchi'ego*, in: „*Komputerowo zintegrowane zarządzanie*" – praca zbiorowa pod red. R. Knosali, Oficyna wydawnicza Polskiego Towarzystwa Zarządzania Produkcją, Opole 2006, t. I, p. 401 - 410.

The Taguchi method bases on two main assumptions:

- Quality should be measured by the deviation from intended value and not by staying in frames of formerly defined latitude (differently from Statistical Process Control method – Fig. 3);
- Quality cannot be assured by inspections and modifications of faulty products, but has to be built through optimal designing of product manufacturing process – making it less susceptible for any noises, hence lowering the manufacturing costs in relation to SPC method[8].

[8] Kowalczyk J., *Taguchi Methods, Quality Engineering. Executive Briefing,* American Supplier Institute INC 1988, p. 4 - 5.

Figure 3: Graphic Interpretation of SPC and Taguchi Methods



Source: http://www.wtec.org/loyola/polymers/c7_s6.htm

Being an economic measuring tool directly linked with numerical ratios of process capacity and intervals of product quality tolerance, the Taguchi Loss Function says that "*the loss due to performance variation is proportional to the square of the deviation of the performance characteristics from its nominal value*[9]". It allows linking product quality with economic notions of cost and profit and shows the importance of quality Vs costs at products manufacturing. "A *minimal loss at the nominal value and an ever – increasing loss with departure either way from the nominal value*[10]." Its mathematical notation is the following:

$L(x) = k * (x - t)^2$, where:

$L(x)$ = loss at a point;

k = loss coefficient;

x = measured value;

t = target value.

Recapitulating, the Taguchi Loss Function provides basis for evaluation of cost constituents related to changes in product's quality. It can be used to justify investments into manufacturing technologies, rapid prototyping methods (verification of construction features at the prototype building stage), and development of systems for supervision of manufacturing

[9] http://elsmar.com/Taguchi.html
[10] Edwards Deming W., *Out of the Crisis*, MIT Press, Cambridge (MA) 2000, p. 141

processes. Investments into quality are not expected to bring profit in short term, but in longer perspective have a strong influence on improving production processes and therefore bringing the enterprise competitive advantages and making its position on the market stronger and more stable. Although the Taguchi Loss Function helps the enterprise maintaining its losses coming from the quality of manufacturing process on a minimal level, it does not point out which innovative solutions to chose for funding from an existing bunch of alternatives.

4. Evaluation of Innovative Undertakings

The aim of a project, which is an innovative undertaking, is to create new or develop existing product production possibilities in a given time period by applying appropriate investments and innovations. The planning phase allows preliminary evaluation of potential costs and income, which helps to determine the economic impact of the project. Project evaluation is based on measurable quantifiable technical or economic criteria and on non – measurable qualitative criteria, such as ergonomics, environment preservation, politico - social issues, etc. Measurable criteria are determined by their boundary values and have a very precise meaning. Non – measurable criteria have to be determined in a descriptive way and are rather subjective, however in order to make them comparable they need to be transposed into numbers. Such a transposition can be performed with use of AHP method described below.

Innovative activity in international enterprises can occur in several areas (Fig. 4).

Figure 4: Integrated Development of Innovative Activity in an Enterprise

Source: Ginalski J., Liskiewicz M., Seweryn J., Rozwój nowego produktu, Akademia Sztuk Pięknych w Krakowie, Kraków 1994

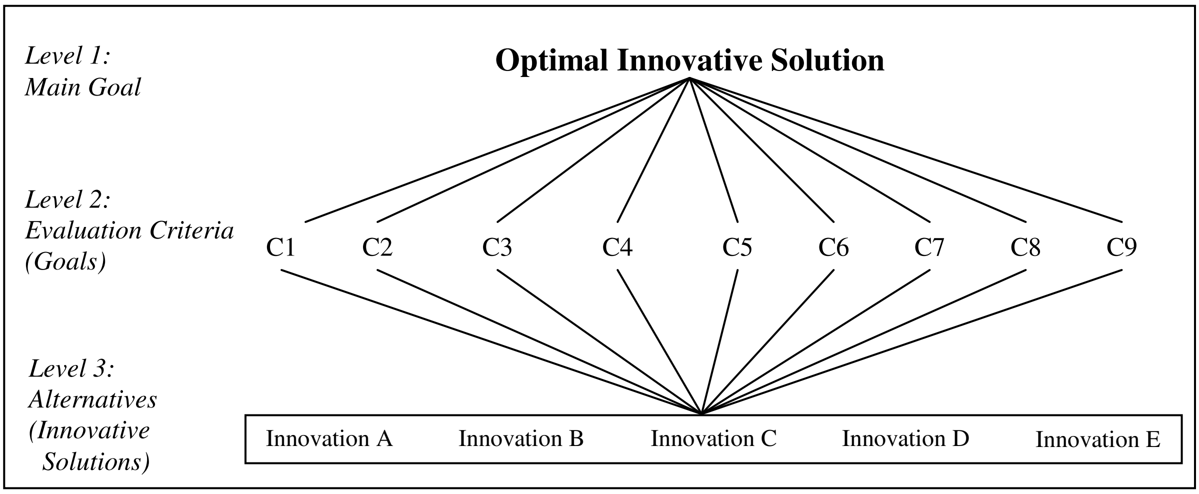
For the needs of evaluation of innovative undertakings in enterprises, the author proposes the application of Analytic Hierarchy Process method. Analytic Hierarchy Process (AHP) is a tool for multi – criteria decision making. Its three pillars are: decomposition of decision – making process, pairwise comparison of elements and priority synthesis.

The first step towards an AHP analysis is the construction of a hierarchical model. This stage helps defining the decision problem and its main goal (which is here the choice of optimal innovative solution). In the following step criteria that have the biggest impact on achievement of chosen goal have to be put in a hierarchical order. Examples of such criteria for analyzed innovative problem can be the following:

- Legal regulations of home country – operating environment;
- Technical possibilities of success – skills;
- Level of global technological advancement;
- Implementation time;
- Cost of innovation and other economic factors;
- Conformity to market needs;
- Potential economic profit;
- Other profits from implementation of innovation;
- Position of country of operation towards innovation – existence of pro - innovative policies, etc.;
- Intellectual property right and its enforcement – ethics in operating, host – country and global environments.

Criteria presented above have both qualitative and quantitative nature, which makes them difficult subjects of direct evaluation. They form the criteria level of AHP model (C1 - C9), the alternatives level are individual innovative solutions. The graphical form of analyzed AHP structure has been presented on Fig. 5.

Figure 5: Scheme of a Hierarchical Structure



Source: Own elaboration based on Saaty, T.L., *The Analytic Hierarchy Process*, RWS Publications, Pittsburgh 1996

The hierarchical model presented above consists of three levels:

1. Main Goal – the highest level;
2. Evaluation Criteria – the intermediary level, consists of determinants of each criterion;
3. Alternatives – the lowest level, consists of points – subjects to analysis and evaluation in conformity to the pre – chosen criteria. The innovative solution that will be implemented arises from this level.

Calculations leading to the choice of optimal innovative solution are performed by pairwise comparisons of relevance of each criteria and alternative, in relation to each determinant separately, basing on the same scale – Saaty's Fundamental Comparison Scale (Table 1.)

Table 1: Fundamental Comparison Scale

Verbal Scale	Numeric Values
Similar relevance, equal	1
Slightly more important, more preferred	3
Strongly more important, more preferred	5
Decisively more important, more preferred	7
Extremely more important, more preferred	9
Intermediary values, compromise	2, 4, 6, 8

Source: Saaty T.L., *Decision Making with Dependence and Feedback: The Analytic Network Process*, RWS Publications, Pittsburgh (PA) 2001

The last step towards obtaining a final complete analysis is to evaluate the relevance of criteria in relation to Main Goal, which means choosing the best way of implementing the innovative variant. It can be done by performing a similar AHP analysis to the one presented above.

Useful tools for the visualization of hierarchical structure and necessary calculations inside AHP model are provided by *Super Decision* and *Expert Choice* software. Both allow the enterprise's management to evaluate the sensibility of alternative solutions in relation to assigned priorities. Another important option is a possibility of forecasting the impact of chosen innovation variant on enterprise's long term strategy in case of change of relevance of primarily assumed priorities.

5. Conclusion

The article aimed at providing a tool for helping the managerial board of an enterprise to understand the importance of quality of manufacturing process and of final product. Balance between costs and product quality can be understood by analyzing the Taguchi Loss Function, which however does not point directly which innovative solution has to be chosen for development or implementation. Due to a large number of determinants of success of innovative undertakings, the choice of innovations becoming funding targets of an enterprise cannot be made *ad hoc*. As a tool providing help for optimal decision making in multi – criteria environments the author proposed the application of Analytic Hierarchy Process. Besides organizing and visualizing enterprise's priorities, this method allows to chose the appropriate innovative solution and to forecast its impact on enterprise's strategic planning when some of the criteria become subject to change or stop being relevant in future time periods.

Bibliography:

1. Durlik I., *Restrukturyzacja procesów gospodarczych. Reengineering. Teoria i praktyka*, Agencja Wyd. Placet, Warszawa 1998.
2. Edwards Deming W., *Out of the Crisis*, MIT Press, Cambridge (MA) 2000.
3. Foster R., Kaplan P., *Twórcza destrukcja,* Wydawnictwo Galaktyka Sp. z o.o., Łódź 2003.
4. Gawlik R, *Analysis of International Corporations Operating Environment with application of Analytic Hierarchy Process*, in: „Zarządzanie Międzynarodowe w światowej transformacji – społeczno gospodarczej", Wyd. UEK w Krakowie, Kraków 2007.
5. Ginalski J., Liskiewicz M., Seweryn J., *Rozwój nowego produktu*, Akademia Sztuk Pięknych w Krakowie, Kraków 1994.
6. Gawlik J., Kiełbus A., *Wieloparametrowa ocena jakości urządzeń technologicznych z zastosowaniem funkcji strat Taguchi'ego*, in: „*Komputerowo zintegrowane zarządzanie*" – praca zbiorowa pod red. R. Knosali, Oficyna wydawnicza Polskiego Towarzystwa Zarządzania Produkcją, Opole 2006, t. I, p. 401 - 410.
7. Koch J., Innowacje siłą napędową rozwoju. Materiały konferencyjne INTELTRANS'2004, Kraków 2004, p. 123 – 131.
8. Kowalczyk J., *Taguchi Methods, Quality Engineering. Executive Briefing*, American Supplier Institute INC 1988.
9. Kun-Lin-Hsieh, Lee-Ing Tong, *Process Quality improvement of a quantitative response with dynamic characteristic*, Int. J. Adv. Manuf. Technol. (2005), 25, p. 1180 – 1190.
10. Lowe P., *Zarządzanie technologią*. Śląsk Sp. z o.o., Katowice 1999.
11. Penc J., *Innowacje i zmiany w firmie*, Agencja Wydawnicza PLACET, Warszawa 1999.
12. Pomykalski A., *Innowacje*, Wydawnictwo Politechniki Łódzkiej, Łódź 2001.
13. Saaty T.L., *Decision Making with Dependence and Feedback: The Analytic Network Process*, RWS Publications, Pittsburgh (PA) 2001.
14. Saaty, T.L., *The Analytic Hierarchy Process*, RWS Publications, Pittsburgh 1996.
15. Warnecke H.-J., Bullinger H.-J., *Kunststück Innovation*, Springer - Verlag, Berlin Heidelberg 2003.