

**Edited by  
Jerzy Woźniak**

**Innovation management  
Theory and practice**

**Lodz University of Technology  
Monographs 2015**

# **Innovation management**

## **Theory and practice**

Edited by  
Jerzy Woźniak

**Lodz University of Technology**  
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# **I. Innovation management as a factor in the creation of competitive advantage within the enterprise**

**Jerzy Woźniak**

## **1. Introduction**

The twenty-first century is a time of the further developments in the area of industrial revolution and its attributes are for instance all kinds of innovative processes implemented at a rapid pace for the modern global organizations in order to gain a competitive edge on the market but only if they are able to implement innovations in an efficient way which are – in this case – the specific condition "*sine qua non*" for their success. Contemporary national economies, which were broadly discussed by M. Porter and were predicted to form the basis for gaining a competitive advantage<sup>1</sup>, become a driving force and mentor in the field of creating innovative changes. One of the obvious symptoms of this activity is for example spending increasing amounts from the state budget on activities within the area known as the Research and Development and to support all kinds of initiatives through which innovations arising in various areas of human activity are implemented to the economy. The processes of implementing innovations to the socio-economic practices of everyday life are the basic sphere of exploration of interdisciplinary research teams and individual researchers.

The European Union is another global player in the area of building an innovative economy in the current budget period and has been dedicating significant resources to the development of activities related to this issue.

## **2. The concept and classification of innovation**

Like most scientific terms, the concept of innovation derives from the Latin words "innovatio" which means "renewal" and "innovare" which stands for "renew"<sup>2</sup>. The etymology of this phrase in the Polish language suggests, therefore,

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<sup>1</sup> Porter M., Porter o konkurencji, Warszawa 2001, p. 191.

<sup>2</sup> Kopaliński W., Dictionary of Foreign Words and Phrases, Wiedza Powszechna, Warsaw, 1989, p. 231.

slightly different descriptive areas than those arising from their direct meaning. Today, the term of innovation is interpreted – in the current, its general sense – as a synonym for the word "novelty" while "renewal" is associated with words such as renovation, restoration or regeneration in Polish.

More recent definitions of innovation relate – to a greater or lesser extent – to the basic classification developed by J. A. Schumpeter, in which the author distinguished between different areas of interpretation of innovation and – at the same time – pointed out implicitly at the most important source of their creation<sup>3</sup>. The author suggested the following forms of innovation:

1. product – a new product or a product with new features,
2. new methods of production,
3. launching of a new market with the industry that supports it,
4. a new blank or raw material not yet used in the production,
5. new organization of the production process<sup>4</sup>.

The concept of innovation developed by J. A. Schumpeter points out – on the one hand – at the most important types of innovation occurring in the economy and on the other hand, it shows what appears to be important in the development of the economy and most accurately defines its competitiveness or feature updates understood very broadly.

The manual published by the OECD – "Oslo Manual" clearly refers to the typology of Schumpeter and lists the following main types of innovation:

1. *Product innovation (within the product) is the introduction of the product or service that is new or significantly improved in terms of their features or applications. This includes significant improvements in terms of technical specifications, components and materials, software, user friendliness or other functional characteristics.*
2. *Innovation within the process is the implementation of new or significantly improved methods of manufacturing or delivery. This includes significant changes in technology, equipment and / or software.*
3. *A marketing innovation is the implementation of a new marketing method involving significant changes in the project / product design or packaging, distribution, promotion and pricing strategy.*
4. *An organizational innovation is the implementation of a new organizational method in the enterprise's business practices, workplace organization or external relations<sup>5</sup>.*

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<sup>3</sup> Schumpeter J.A., Capitalism, Socialism, Democracy, PWN, Warsaw 1995, p. 110.

<sup>4</sup> Schumpeter J.A., The Theory of Economic Growth, PWN, Warsaw, 1960, p. 104.

The abovementioned classification applies primarily to the sphere of human activity, which we call the economy understood in a narrow way – "in the strict sense" that is, to industry and services. But it omits the sphere which refers to the socio-ideological human activity and is sometimes referred to as the economy in "broad terms"<sup>6</sup>. The main advantage of this classification is its considerable ability to implement the national and regional activities in the area of creating innovative behaviour as well as the formulation of statistical research compatible with the provisions of the OECD. In this context it is worth noticing that the basic criteria for assessing whether an activity is an innovation or not we include the fact that it is a significant change and a novelty for the company<sup>7</sup>.

Taking the important role of innovation in the modern economy into consideration it should be also pointed out that they shape the current socio-economic world in a fundamental way. Consequently, their classification only in the context of the economy is incomplete and needs to take into account their impact on the socio-ideological sphere of human life. Innovation can be hence classified in the following way:

1. for its social utility to the public,
2. to improve the quality and comfort of life of the individual,
3. for the possibility of creating new innovations,
4. to transform the socio-economic and political environment
5. and changes in the ecosystem of the planet.

Such division allows us a wider vision of innovation and their impact on different spheres of human life. The discovery and implementation for mass production of a new drug to civilization diseases of the modern world is one of many examples of important innovations of importance to the public. It turns out, however, that sometimes the manufacturer's particular interest can be more important than mass production and innovation of this kind becomes a luxury for the chosen few. Such a procedure seems justified because of the public welfare and immoral. It should be regarded as reprehensible and use all available and legal means in order to change that. For example – a manufacturer

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<sup>5</sup> OECD, Podręcznik Oslo Zasady gromadzenia i interpretacji danych dotyczących innowacji, MNiSW, wyd. 3, Zakład Wydawnictw Statystycznych, Warszawa 2008, pp. 155-160.

<sup>6</sup> St. Marciniak St. (ed.), Makro i mikroekonomia dla inżynierów, Warszawa 1995.

<sup>7</sup> Ibidem, p. 155.



can sell licenses for their own product and reap the benefits of global mass production at the same time.

Innovations implemented to improve the quality and comfort of human life such as clothing that protects us from rain or frost is one of the largest areas of modern business organizations. Most products and services are aimed at improving the conditions of human life. However, it is not always the case – sometimes they are real innovations that significantly affect the quality and comfort of human life (a type of clothing mentioned before) and sometimes only work in the field of psychology and artificially created needs of the market (fashion).

Internet is one of the most interesting innovations that create their next incarnations. It has become a generator of countless innovations that change the human beings and their surroundings. The Internet has changed the world. It became a fundamental source of information and it also helps to broaden our knowledge of the world around us thanks to which it has a substantial effect on our ability to create new ideas transformed into innovation.

Innovations transforming socio-economic and political environment can be called system innovations. They refer to such aspects as – for instance – fundamental changes in the social structure and economic policies of particular countries that are free-market democracies and totalitarian regimes and societies that are multicultural and open or closed and xenophobic – supporting fascist or communist ideology. This kind of innovation is accompanied by our civilization from its beginnings and take very different forms once they are introduced in a revolutionary way and another time in the evolutionary process. They refer to the above mentioned fundamental changes but also relate to the sphere of changes in social behaviour, for example in the area of cultural changes associated with the tradition of celebrating the customs or the way we deal with the elderly. Changes occurring during such processes such as industrialization and urbanization are other examples which can be included into the broad category of innovation.

Ecosystem is the last variable classification of innovation – today it seems to be one of the most important – changes in the ecosystem of the earth have become dangerous – the innovation that we implemented degraded our natural habitat and contributed to a real danger to the existence of our civilization and the world in which it operates. The negative effects of our careless activities can

be seen every day: air pollution – smog, climate change – melting glaciers, degradation of sources of drinking water, the destruction of soil – its sterilization, destruction of tropical forests and many other environmental problems that arose due to human activity. So now we have to create just the kind of innovation that will positively affect the revival of the ecosystem – and it seems to be the most important issue nowadays. However, in order to be able to do so, we have to educate the society by means of providing a certain level of knowledge, including high environmental and social awareness – is only connected with organic food and ecological homes, but it is also related to a way of thinking about the world and the universe, it is about the awareness that human beings use their knowledge, abilities and skills to create innovations that will either save the world or destroy it.

To sum up the above considerations regarding the concept and classification of innovation, it may be reasonable to quote the words of P.F. Drucker, who claims that as follows: *"We cannot yet develop the theory of innovation. We already know enough of to be able to determine when, where and how to look for the way to innovation in a systematic manner and how to assess the chances of success and the risks of failure. We already know to develop – even in form of an outline – the practice of innovation"*<sup>8</sup>. This practice innovation refers for example to the fact that *"the technical progress is made through inventions or discovery of new knowledge and innovation, ie. using the new knowledge in the production process"*<sup>9</sup>. In other words, innovation differs from the invention that it is a specific form implemented for the purpose of production process of the present invention – which is a novelty product of human activity characteristic in the way that as such had never occurred and is now prepared and can be reproduced in any quantity. In this context, P. Drucker explains that: *"The result of innovation is to create a new value. Novelty can only provide entertainment"*<sup>10</sup>. Innovation – is broadly understood as a novelty implemented to the economy or the company.

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<sup>8</sup> Drucker P.F, Innovations and Economy. Practice and Rules, PWE, Warsaw, 1992, pp. 40-45.

<sup>9</sup> Begg D., Fischer S., Dornbusch R., Makroekonomia, PWE, Warszawa 2007, p. 336.

<sup>10</sup> Drucker P. F., Zarządzanie w XXI wieku, Muza SA, Warszawa 2000, p. 87.

### 3. Management of innovation

Modern enterprises carrying out their mission in the global economy are obliged to create innovations permanently. Their activities in this area are subordinated to – on the one hand – gaining competitive advantage and ensuring their long-term position in the market and – on the other – the acceptance of their economic and social activity by all stakeholders – including for instance state institutions and social non-profit organizations pursuing a variety of goals remaining sometimes at odds with the vision of the market companies. Counter action taken against the background of socio-economic conflict is a task requiring enterprises to conduct in a way that would meet the expectations of all stakeholders, not expose them to loss of market position and further economic losses. Innovation is, in this case, the key factor which stimulates innovative solutions in the economy and which also contributes to the implementation of social expectations. An interesting example of this kind of innovative approaches, for example – the creation of hybrid and hydrogen-powered cars in which the drive is based on fuel cells or develop a method for the production of "graphene" which will probably trigger some big revolutionary changes in many industries. This kind of innovation has a positive impact on improving the image of companies and can be seen as an example of self-perpetuating spiral of innovation that contributes to gain a significant competitive advantage in the global market by such a progressive company.

In any enterprise – as well as in other areas of interpretation of its activities – there are three levels associated with innovation management:

- strategic level,
- tactical level,
- operational level.

Innovation management at the strategic level is primarily related to the determination of the main directions of changes in the company's activities in accordance with the assessments and expectations of consumers and based on the analysis of competitors' actions and cooperating entities. It focuses on

the determination of the main objectives of the company, in which innovations are to be implemented to a greater or lesser extent in all areas of the company. This assumption allows to create a vision of pro-innovation company which in advantage in terms of competition on the market and is in accordance with the basic assumptions of the development of modern businesses in a global economy<sup>11</sup>. At this level the following subjects need particular attention:

1. The main aims and objectives for the design of new products and services or creating product innovations,
2. new technologies or significant modifications in form of process innovations,
3. basic principles of creating activities in the area of marketing or marketing innovations and
4. concepts and methods for the efficient and effective functioning of the company that contribute to organizational innovations.

The development of a strategy for the company's activities in the area of product innovation is the basis for gaining its market advantage. It should be kept in mind that actions of this kind must be accompanied by work in all areas of the company. The new product will hit the market only on condition that the manufacturer will organize efficient and effective technology of its production and will develop an appropriate marketing strategy.

Innovation management at the tactical level is reduced to such planning activities of the company that the current activity will be effectively introduced in all its areas, thanks to changes which will be creating new solutions to streamline these processes. Thanks to it, it would be possible to create quantitatively and qualitatively measurable savings and to introduce pro-innovation and pro-efficiency solutions. This level is responsible for the detailed development of new products and services as well as planning and preparation of their manufacturing process.

Innovation management at the operational level are mainly reduced to such control of production processes which allow to do the best out of the use of the intellectual potential and experience of the employees in the process

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<sup>11</sup> Horizon 2012, The EU Framework Programme for Research and Innovation:  
<https://ec.europa.eu/programmes/horizon2020/>

of creating new solutions in the area of the current business. The processes of streamlining and rationalizing the company's activities at this level are the basic directive, by which any organization can gain a real competitive advantage and generate significant positive financial results. At this level, we verify the production by means of tactical assumptions made through their rationalization process and the introduction of various kinds of improvements.

While managing innovation, it has to be remembered that "every organization has different skills and a different expertise. Knowledge and skills make up its personality and determine its nature. Any organization – not only the one which belongs to the realm of business – needs one essential skill: innovation. It is necessary to carry out innovations within the in the company as well as suggesting the rewarding system for doing that. The starting point in launching innovative activities in organizations that have decided to take up this challenge (...), it is not their own action, but careful observation of all the news and innovations occurring in a given period in the industry"<sup>12</sup>. Such an approach to the implementation of innovations from the environment to the organization still requires one essential remark, namely, making sure about the effects of these activities on the ecosystem and abandoning those that degrade it.

Contemporary organizations are open systems, which are undergoing permanent changes associated with their primary objective which is implementing the knowledge and intelligence of human capital for its current operations. In this system, you can specify a number of complementary subsystems through which followed the processes of implementation of innovations. However, the fundamental role of managerial and integrating is played by deliberately established teams (sub-systems) composed of the most active and competent employees with a particular substantive knowledge and skills out of the teamwork. They identify the problem and proceed to the solutions that may give a completely new quality to the whole system. Most typically, such situation occurs when the implementation process is proceeding according to the following general scheme presenting formation of the innovation.

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<sup>12</sup> Drucker P. F., *Managing in the 21st century*, Muza SA, Warsaw, 2000, p. 124.

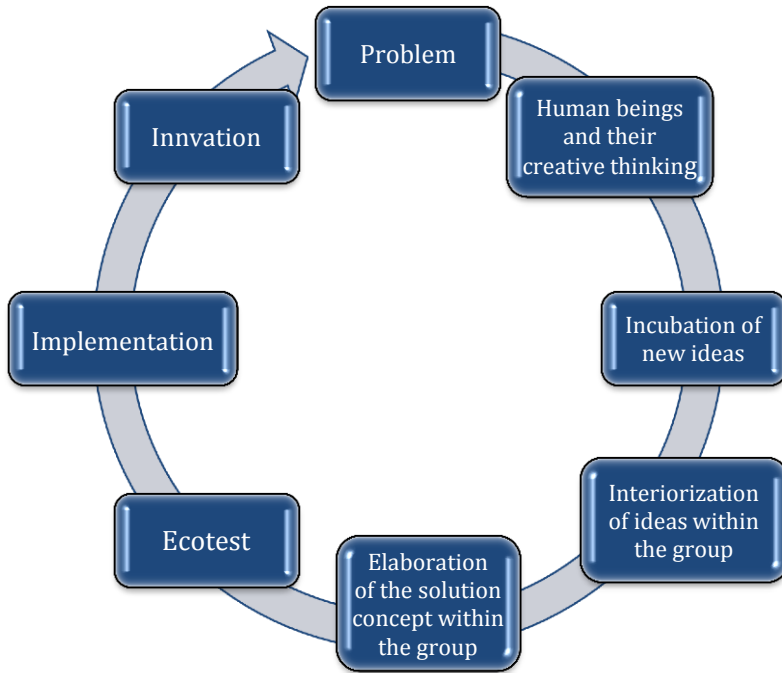


Figure I.1. The formation of innovation – a scheme

*Source: self-elaborated material.*

The basis of human action is to strive to meet emerging needs in his/her mind, which is a problem to be resolved. Man using their knowledge and "factors of production" (raw materials) available in the environment take numerous attempts to realize their needs, until it gives satisfactory results<sup>13</sup>. During the so-called "incubation" processes a human uses all his/her innate abilities and knowledge in order to shape and change the environment in a creative way. The realization of some needs – known as Maslow's hierarchy of needs – requires cooperation of the man with the group<sup>14</sup> which is then followed by the so-called "group interiorization of messages". Such group involves the joint assimilation of knowledge possessed by individual members of the group. Individual knowledge becomes synergetic sum – they possess some certain

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<sup>13</sup> Zimbardo P.G., *Psychologia i życie*, PWN, Warszawa 2005.

<sup>14</sup> Compare: Maslow vs. Zimbardo.

knowledge as a group<sup>15</sup> so that the team selects the best – ecological solution to the problem and is preparing an action plan with the determination of goals. Selecting ecological solutions assuming complete safety for the ecosystem, is nowadays a condition called "*sine qua non*" for further action to implement the solution. Ecotest is a kind of necessary action to verify the suggested solution to the problem – the introduction of innovations into everyday life practice. Summing up the above considerations, it has to be highlighted that a human being is – and will be – the most creative "initiator" of innovation – provided that he will think globally about the ecosystem in which he/she lives along with the next generation<sup>16</sup>. By nature human being is a creative and a social "animal" – a group one, open to all kinds of novelties which transform the process of collective innovation. It creates more or less open cultural community, so that developing intellectually – as a results of the exchange of information between other members of the group – is able to achieve the success and improvement of living conditions. In this case, it should be emphasized that the open innovation culture is a culture in which there is absolute freedom and openness to all, a culture of tolerance and freedom of expression, a culture of respect for other opinions and different habits, customs, etc. – only within the organizations that follow the aforementioned rules, innovative ideas can be created. We can transform our world in accordance with our global expectations thanks to such ideas.

Innovation management within the organization is the realization of such classic functions like planning and decision-making, organization and coordination, securing human resources, management control and supervision – aimed at efficient use of the organization's resources such as people, information, goods and finances<sup>17</sup>. Implementation of innovation begins with the planning process, in which we set key objectives necessary for its implementation. This is the most important moment in the process of innovation management as it is at this time

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<sup>15</sup> Woźniak, J. W., Communication competences of managers in the twenty first century, [in:] Creative Industry Manager – Technical knowledge + Non-technical skills, Kunert O. (ed.), Wydawnictwo Politechniki Łódzkiej, Łódź 2012.

<sup>16</sup> Steinmann H., Schreyogg G., Zarządzanie, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 1995, p. 75.

<sup>17</sup> Por.: Steinmann H., Schreyogg G., Zarządzanie, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 1995, pp. 20-22. Griffin R. W., Podstawy zarządzania organizacjami, PWN, Warszawa 1996, pp. 38-41.

passed with fundamental decisions that result in a new product or service and its success or failure on the market. Proper organization and coordination of activities in the implementation of innovations within the organization is another task carried out mainly on the tactical and operational level, and can significantly contribute to achieving the objective in an efficient manner. In contrast, an essential factor to make the process of innovation implementation a success involves people or intellectual resources responsible for all behaviours in the functional area of the company. It is a human being working in a group who creates a new reality in an organized way through their creative behaviour and thanks to that they can contribute to the enrichment of further innovative products and services to improve their life standard. The final stage of the implementation of innovations in the organization is closely associated with the level of operational management and focuses on motivating supervision and control of the accuracy of performed tasks and procedures.

Management of innovation in the organization cannot be reduced only to their implementation in the form of a new product or service, but also all functional areas of its operation. The organization creates technological, organizational or marketing innovations that contribute to a significant increase in its importance in the market and they are essential factors in creating the organization's competitive advantage.

The effective use of the company's new production technologies and modern machinery and equipment to improve the efficiency and effectiveness of production is still a major problem, which is not always able to cope with properly. It sometimes happens that modern machines bought for astronomical sums stand uselessly in production halls expecting to be launched and integrated into the production process. Such situations can be seen practically within all businesses and the reasons for this are very different and difficult to classify as for example they tend to be the result of a disease of the person responsible for launching, or the blizzard of various tasks to perform that makes it incapable of directing employees to new tasks, etc. Hence, the correct organization of activities in the area of new technologies is one of the key tasks of managers.

Innovations in the field of organizational activities have influence on improving the efficiency and effectiveness of the functioning of the organization in the market and are among the actions most commonly used in all areas of



management. One of the frequently used processes with significant potential for innovation is the restructuring of the organization, whose primary aim seems to be multiplying synergistic effect. By means of observing the behaviour of market organizations today, it can be said – with a high degree of probability – that most of them use the so-called "permanent restructuring" thanks to which they are able to quickly adapt to changing conditions in the economic environment and achieve better competitive position. All in all, we can assume that any – even the smallest innovative organizational change – may significantly improve the market position of each company operating that way.

Generally known as group marketing innovations implemented by the company is another sphere of its activities contributing to the efficient and effective functioning in the economic environment. Marketing innovations – which require a special highlight – are not just activities in sales, advertising and promotion of the product or service, but also those ones that are responsible for researching and shaping consumer behaviour. It largely depends on customers whether given goods or services will become an innovation or not. It all depends on the market which nowadays it is variable and requires special attention. Through its advertising and promotional campaigns, the company is trying to draw the market's attention to their goods or services. Such company can be successful but only if it knows the expectations and preferences of a certain market. Knowledge of the consumers' expectations and their proper sense, is the basis – the foundation of building a new product or service, which becomes the innovation market. The process of creating needs and consumer attitudes basically goes down to educate those customers who have not yet noticed changes in the market environment. Research and shaping consumers' attitudes towards a given product is one of the fundamental tasks of any organization that wants to achieve success on the market.

The success in the management of innovation in the organization depends on many factors mentioned above, but their efficient and effective implementation requires the development in the active mechanisms of organizational culture conducive to their implementation and the formation of the so-called "pro-innovative climate". According to Peter F. Drucker, *"in order to deserve the name of effective leadership change is required in the enterprise policy of systematic innovation. Not due to a need to introduce any innovation, but due to*

*the policy of systematic innovation directs the mindset of organizations and causes a desire deserving to be called a leader of change*"<sup>18</sup>. Policy of systematic innovation is likely to implement only the appropriate cultural environment in the organization. It is impossible to achieve without the initiative and commitment of all its employees and their creative attitude. The core of innovation in an organization is a human being and his/her coordinated actions among which is the foundation through which its operation generates more or less synergistic effect. Good cooperation among all its members working in a friendly and creative environment is one of the characteristics of what T. Kotarbiński described as "the whole, the components of which contribute to its success"<sup>19</sup>. When it comes to synergy, it can be said that it is the result of this kind of activity, and the more you apply the principles of praxeology into it, the greater it becomes and finds application to the rule of "general theory of efficient operation"<sup>20</sup>. The smooth operation of each organizational unit and each of its employee is a "sine qua non" condition effectively acquired a competitive advantage through the implementation of the policy of systematic innovation by the company.

Summarizing the above considerations, we can follow P. F. Drucker who claims that "the process of innovation is never risk-free (...). The process of innovation is not a "manifestation of genius". It is hard work, which should be regularly performed in every department of the company, at every level of management"<sup>21</sup>. And processes of innovation are multithreaded sequences of actions that we refer to such terms as implementation, alteration, stepping up, correction, improvement, progress, modernization, inventing new solutions or implementation of a different nature to the practice of everyday life in the company.

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<sup>18</sup> op. cit., Drucker P.F., p. 85.

<sup>19</sup> Kotarbiński T., *Traktat o dobrej robocie*, Zakład Narodowy im. Ossolińskich, Wrocław, 1982, p. 68.

<sup>20</sup> Ibid, p. 7.

<sup>21</sup> op. cit., Drucker P.F., p. 86.

## 4. Conclusions

Construction of sustainable competitive advantage – and thus innovation in the modern economy – is a challenge that seems to be very difficult to implement, because we live in a turbulent environment which is very immune to any diagnoses and prognosis, therefore the preparation of future activities related to the creation of new solutions in all strategic areas of the organization is difficult and almost always "contaminated by mistake". Such mistakes and errors cannot be avoided, so one must be prepared to change and verify these actions that eliminate or fix some possible mistakes. In other words, it requires to be more flexible in planning and setting goals and be able to adapt them to changing conditions and situations.

Modern organizations – enterprises pursuing their activities in the global economy which are open systems – respond to the expectations of the environment and implement them in the form of innovation, which – thanks to unlimited access to information about the various types of research and inventive and their efficient processing of the practical solutions – are implemented faster to the practice of everyday life. Innovations are measurable value to organizations which bring measurable financial effects, but not only – they also build the brand, product, contribute to the growth of the market value of the organization, build the foundation – the foundation of its competitive advantage in the market.

The most creative minds who are able to create new and innovative solutions include children. Their innovative minds know no barriers, limits and principles of creating innovations that are implicitly such barriers – where the created rules of procedure introduce strict rules which eliminates the ability to create real innovation. True innovations arise only where there is freedom of expression of thought and opinion, where you can speak in full voice what you mean, and where such citizenship attitude is provided. The inventor is sometimes "a child" in the skin of an adult who – on the contrary to preconceptions and judgements recognized by others as wrong or invalid, irrelevant and come up unexpectedly – introducing solutions for learning new values. Then they are processed by others who are trying to turn these inventions into practical mass

use in innovation. Their role is significant from the point of view of putting the invention into practice and also requires high skills and a creative mind like a researcher – scientist. In contrast, the effect of their work is a bit different – a solution showing a number of options for implementing the invention to practice every day. Innovators are the people who can effectively cooperate with partners in order to implement inventions for various applications. The more they come up with and implement, the greater the benefits for the economy and people.

In other words – to sum up all the above considerations – we can say the inventor is someone who discovers things being at the same time the creator of news indicating the way to solve the problem so far unknown and is the person who is able to find solution and practical applications for his/her findings and apply them in a creative way.

To sum up this discussion, the general rule has to be remembered – innovative thinking was the basis for discoveries of such geniuses of our world as Leonardo Da Vinci and Albert Einstein. Both of them were aware that their discoveries – that were supposed to bring a lot of good to the society – could be used for nefarious purposes by "bags that consume untold quantities of food". As DaVinci once wrote: *"It seems to me that the people who are ignorant, dumb and narrow-minded deserve such a beautiful body and a variety of organs such as thinking people gifted with great reasoning ability. For them the sack to adopt and donate food would be sufficient. Surely they cannot be regarded as nothing other than the wires of food, because, in my opinion, they do not belong to the human race, unless the voice and form; and the rest is far less than the cattle"*<sup>22</sup>.

Unfortunately, nowadays such harsh words characterize all those who cannot properly use the discoveries of such geniuses or – to make matters even worse – process them into evil. Humans far too often perform innovations just to fulfil the particular needs or desires of specific social communities, without thinking about the global consequences. We have tendency to think in a narrow-minded way, we do not consider things globally. As a result, various innovations produced by the man often threaten our global village – the lack of global thinking is the cause of most of the current socio-political and economic crises.

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<sup>22</sup> Suchodolski B., *Narodziny nowożytnej filozofii człowieka*, PWN, Warszawa 1968, pp. 273- 277.

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## **II. Methods of testing the innovative potential with in the organization**

**Jerzy Woźniak**

Companies achieving success in the global economy gain their competitive advantage through the operation of innovation. Increasingly, it turns out that from the very beginning, the main source of their success are new ideas or inventions boldly implemented into the real world economy. P.F. Drucker claims that *"the use of its own success, sooner or later will lead to real innovation. This leads itself to a stage where even the smallest actions aimed to use their own successes lead to serious, significant change, for example creating a product that turns out to be something completely new, different and innovative"*<sup>23</sup>. This kind of behaviour is not only noticeable among the world's potentates, who are on the list of the largest corporations, but also smaller companies, such as the Polish company called "Solaris Bus & Coach" associated with the automotive industry or "Digital Core Design" in respect of the new technology applications. Innovation activity has become a kind of standard implemented by the aforementioned companies.

Modern global economy sets many important tasks related to the functioning of businesses operating in its area – innovation seems to be one the most important. According to international organizations such as the OECD and Eurostat that systematically work on such issues as the collection of comparable data, innovation's definition is as follows: "This manual provides guidelines for collecting and interpreting innovation data in an Internationally comparable manner"<sup>24</sup>. Such actions make it possible to determine the directions of development of the global economy, indicate the trends and anticipate the innovation leaders and those who need help in the implementation of innovation within their own enterprise.

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<sup>23</sup>Drucker P.F., Zarządzanie w XXI wieku, Muza SA, Warszawa 2000, pp. 84-85.

<sup>24</sup>Oslo Manual "Guidelines for Collecting and Interpreting Innovation Data", a joint publication of OECD and Eurostat, 3rd Edition, OECD/EUROPEAN COMMUNITIES 2005.

## 1. Basic rules for testing the innovative potential of the organization

A holistic approach to exploring the potential of the innovative organization requires consideration of virtually all quantitative and qualitative conditions associated with its functioning in the economy. Rationale creating innovation in the so-understood approach come down, among others, to analyze the strategic, tactical and operational action plans and targets implemented in those areas. They are also associated with a statistical evaluation of investment in R & D (Research and Development) in relation to their end-effects involving the implementation of certain innovations. The situation in which the effects repeatedly exceed the expenditure indicates a high level of innovation of the company and vice versa – poor effects and a large outlay mean a relatively low level of innovation. This simple statistical method allows you to pre-determine whether we are dealing with a company which is well-prepared to deal with the diffusion of "news" – innovation in its four areas (productive, technological, organizational and marketing). However, in order to get to know its full potential in this area, an in-depth qualitative analysis must be carried out so as to see if – even by chance – we do not have to deal with the organization of innovative mainly in the field of marketing and organization. Expanded quantitative and qualitative analysis may be based, for example, on the so-called method of "InnoScore" developed by Fraunhofer Institute in Germany or such methods as Quicklook<sup>TM</sup> and In-Deph<sup>25</sup> or various methods related to the analysis of websites or web platforms of innovation audit<sup>26</sup>. These methods

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<sup>25</sup> compare: <http://www.innoscore-service.de/de/LaunchISS.html>., Mikołajczyk B., Pomiar i ocena innowacyjności MSP, [in:] Zarządzanie i Finanse, Journal of management and Finance, rok 11, nr 2, część 2. Wydział Zarządzania Uniwersytetu Gdańskiego, Sopot 2013, pp. 266-279; Gwarda-Gruszczynska E., Quicklook<sup>TM</sup> jako metoda oceny potencjału komercyjnego innowacji i technologii, [in:] Acta Universitatis Lodziensis Folia Oeconomica 234, Łódź 2010, pp. 265-275.

<sup>26</sup> comapre: Norek T., Platforma audytu innowacji jako przykład informatycznego narzędzia wspomagającego budowanie potencjału innowacyjnego regionu, [in:] Nierówności Społeczne a Wzrost Gospodarczy, Uniwersytet Rzeszowski, Katedra Mikroekonomii, zeszyt nr 22, pp. 141-151 Rzeszów 2011. [www.ai.wzieu.pl](http://www.ai.wzieu.pl); Kaczmarska B., Ocena poziomu innowacyjności przedsiębiorstw na podstawie zasobów internetowych, [in:] Innowacje w zarządzaniu i inżynierii produkcji, R. Knosala (ed.), Oficyna Wydawnicza Polskiego Towarzystwa Zarządzania Produkcją, Opole 2013, pp. 112-123.

complement each other and – what is more – in their area of interpretation, they take most of the factors influencing the innovation organization into account and – at the same time – refer to the classification included in the publication of Oslo Manuals:

***Factors relating to the objectives and effects of innovation***

- ***Competition, demand and markets***

- Replace products being phased out*

- Increase range of goods and services*

- Develop environment-friendly products*

- Increase or maintain market share*

- Enter new markets*

- Increase visibility or exposure for products*

- Reduced time to respond to customer needs*

- ***Production and delivery***

- Improve quality of goods and services*

- Improve flexibility of production or service provision*

- Increase capacity of production or service provision*

- Reduce unit labour costs*

- Reduce consumption of materials and energy*

- Reduce product design costs*

- Reduce production lead times*

- Achieve industry technical standards*

- Reduce operating costs for service provision*

- Increase efficiency or speed of supplying and/or delivering goods or services*

- Improve IT capabilities*

- ***Workplace organization***

- Improve communication and interaction among different business activities*

- Increase sharing or transferring of knowledge with other organisations*

- Increase the ability to adapt to different client demands*



*Develop stronger relationships with customers*

*Improve working conditions*

- ***Other***

*Reduce environmental impacts or improve health and safety*

*Meet regulatory requirements.*

*Relevant for: **Product innovations, Process innovations, Organizational innovations, and Marketing innovations**<sup>27</sup>.*

The classification presented above clearly indicates the main areas of statistical research on the innovation brought down to the objectives and effects. However, it skips those issues that are related to the so-called soft competencies of human resources and their motivations and knowledge level. Such matters are difficult to classify from the point of view of statistics and require substantive evaluation based on a qualitative analysis of individual cases of innovation in the practice of the company. An accurate description of the situation and the right course of action taken during the process of diffusion of innovations allows for comprehensive assessment of the innovation potential within a given company and points to its immanent features that cannot be included in the statistical formula. Among other things, these are connected mainly with the to the-so called factors hindering various activities contributing to innovation. These are described in the Oslo Manuals as follows:

*“Factors hampering innovation activities*

*Cost factors:*

*Excessive perceived risks*

*Cost too high*

*Lack of funds within the enterprise*

*Lack of finance from sources outside the enterprise:*

*Venture capital*

*Public sources of funding*

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<sup>27</sup> op. cit., Oslo Manual, p. 108.

*Knowledge factors:*

*Innovation potential (R&D, design, etc.)  
insufficient*

*Lack of qualified personnel:*

*Within the enterprise*

*In the labour market*

*Lack of information on technology*

*Lack of information on markets*

*Deficiencies in the availability of external services*

*Difficulty in finding co-operation partners for:*

*Product or process development*

*Marketing partnerships*

*Organizational rigidities within the enterprise:*

*Attitude of personnel towards change*

*Attitude of managers towards change*

*Managerial structure of enterprise*

*Inability to devote staff to innovation activity due  
to production requirements*

*Market factors:*

*Uncertain demand for innovative goods or services*

*Potential market dominated by established enterprises*

*Institutional factors:*

*Lack of infrastructure*

*Weakness of property rights*

*Legislation, regulations, standards, taxation*

*Other reasons for not innovating:*

*No need to innovate due to earlier innovations*

*No need because of lack of demand for innovations”.*<sup>28</sup>

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<sup>28</sup> op. cit., Oslo Manual, p. 113.

The barrier of factors related to costs in everyday practice appears to be a serious problem within the range of possibilities in the area of diffusion connected with innovation – however, sometimes it can be overcome thanks to the commitment of staff and individuals who – thanks to their knowledge and determination – are able to persuade all stakeholders (stakeholders) for a particular course of action. Cost constraints in the absence of other factors hindering innovation similarly to most factors listed in the Oslo Manuals that are only potential obstacles, but these can be reduced – or even eliminated completely – mostly by means of taking appropriate steps in the widely understood motivation and organizational culture to a large extent.

On the other hand, factors relating to knowledge can become a serious problem that can actually influence the innovative capacity of the company. The lack of skilled and committed staff (Lack of qualified personnel) and ossification organization (Organisational rigidities within the enterprise), a low level of organizational culture are the essential issues – the main reasons for limiting the innovative activities of the company. These are the factors that can be described as substantial barriers to implementation of innovation at the level of quality and contribute to a number of limitations in this regard. It should be remembered that without committed – properly motivated and competent – staff with a high level of knowledge, there is no real innovative activity of the company and it leads to the end of its actions.

All things considered, it can be said that a holistic analysis of the innovation potential of the company can be reduced to two basic directions of the procedure, namely quantitative (statistical) and qualitative research based on a retrospective analysis of a particular case.

## **2. Statistical analysis of the innovation potential of the organization**

The innovative potential of the organization is its peculiar tendency to effect positive change in the four directions of its activity, namely: productive, technological, organizational and marketing. A company with high innovative potential is an organization that is able to exploit all opportunities to gain competitive advantage through the proper utilization of internal factors that

create the attitudes and behavior of pro-innovation and the implementation of external sources of information within this area<sup>29</sup>.

Statistical analysis of the innovation potential can be brought down to the use of various measures of innovation assessment of the company in the context of retrospective studies aimed, inter alia, to assess the funding for existing innovative activities in the four abovementioned areas of business, to determine their effectiveness by analyzing expenditures in relation to the results, on study profitable growth and employment and so on. Specific pattern of such a test is the aforementioned textbook "Oslo Manuals" which was developed by the OECD and the European Commission and which sets out guidelines for this kind of research and aims at systematizing them. The application of the presented proposals seems reasonable because it allows to gather complex collection of comparable data from several countries and global organizations can contribute to the formation of different kinds of lists and rankings<sup>30</sup>. In this context, it appears advisable to introduce some improvements in the area of these surveys and their classifications results in three business areas surveyed on businesses or strategic, tactical and operational level. Strategic area is the level of activity of each company which is a subject for numerous interpretations and considered to be the most important for the final effect related to the implementation of the basic tasks within the company<sup>31</sup>. With a high degree of probability it can be said with that, indeed, actions in this area contribute most heavily to the company's overall success and competitive advantage and innovation on the market. However, it should not be forgotten that without appropriate complementary activities in the tactical and operational field, such success is impossible to achieve.

It turns out that – especially in the least appreciated and often too much formalized, systematized and normalized the operating area – there are many fundamental processes that determine the success of the whole enterprise

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<sup>29</sup> compare: Żoźniewski A., Potencjał innowacyjny polskich małych i średniej wielkości przedsiębiorstw, PARP, Warszawa 2005, p. 65.

<sup>30</sup> compare: INNOBAROMETER 2015 - THE INNOVATION TRENDS AT EU ENTERPRISES REPORT European Union, 2015 available online: <http://ec.europa.eu/COMMFrontOffice/PublicOpinion/index.cfm/ResultDoc/download/DocumentKy/67409>

<sup>31</sup> Stabryła A., Zarządzanie strategiczne w teorii i praktyce, PWN, Warszawa 2005, pp. 11-16.

projects. Only during the implementation of the production of individual employees they are able to capture these shortcomings and mistakes that were undetected at the level of both strategic and tactical planning. This is a production stage where a series of individual employees and then consumers will be able to see what has been left out in the planning of the project and carry out the construction of a prototype of the product. The more accurately any product or technology is verified in the everyday practice as well as the organization and management of its production process and marketing activities, the greater the end result – concentrated on gaining competitive advantage – will be.

Proper preparation of the organization's activities at the tactical level is the basis for the creation of real innovative achievements. This functional area of the company is the glue between strategic thinking and management crew, it is also the place where – on the one hand – there is a confrontation of ideas and practices, and on the other – there is a lot of space to clarify and refine the innovative activities of the company. Proper planning of company's innovative purposes at the tactical level contributes significantly to the success of their implementation, and the errors and shortcomings at this level contribute to the failure regardless of the best ideas and intentions of the companies.

The verification of statistical data discussed above divided into three levels of management of the company makes it possible to identify specific weaknesses in the whole process of the implementation of innovation to everyday day life practice and allows the company to prepare activities concentrated on quality.

Understanding of statistical data is the basis for determining the main trends in the area of innovation activities of specific companies, industries, sectors or – at the end – of local (national) and global economy as it is a "sine qua non" condition for holistic analysis of the innovation potential of the selected entity.

### **3. Substantive assessment of the innovative potential of the organization**

The next step in the assessment of the innovative potential of the company is the substantive post factum analysis of the existing implementations, and the test related to current projects – in this particular field. Constructive criticism

and evaluation processes along with a detailed statement of the reasons for hindering or omissions in the implementation of particular projects make it possible to define a comprehensive and in-depth knowledge of the innovation potential of the company. Such process ought to be supplemented by qualitative and quantitative research on managers and staff based on standardized observations of nonverbal behavior and "a questionnaire" in form of a structured interview for managers and employees who do not perform those particular functions within a company. To determine whether there is the so-called innovative climate a given enterprise or not and to what extent is expected to be the main problem with this kind of research. In other words, it is all about examining the organizational culture of the company or enterprise and determine whether it is pro or anti innovative. In this context, it has to be remembered about the popular phenomenon<sup>32</sup> described in classical literature. It is a problem related to the fear of novelty and the fact that most of the innovations implemented within the organization is perceived this way. The examination of the entire staff of the company is, therefore, one of the essential elements that enable to determine the actual level of innovation potential of the company. For specific issues requiring clarification in this case, among others – the following issues has to be included.

In the area of information resources:

- the level of accumulated knowledge among employees,
- the level of knowledge of managerial staff,
- the so-called hard skills of executives and crew,
- the so-called soft skills of managers and employees,
- the analysis of the organizational structure for efficient transmission of information with a particular emphasis on news from the area of innovation,
- formal rules for implementing innovative changes
- cooperation with the external and internal environment, including working with key stakeholders in the wider environment of the company, their approach – the general climate manifested by an attitude towards innovation,

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<sup>32</sup> Griffin R.W., Podstawy zarządzania organizacjami, PWN, Warsaw 1996, pp. 398-401.

- customer's expectations towards the organization – whether there is a positive attitude to change and whether the clients expect news and put pressure on a company to implement novelties,
- the network of business contacts,
- past achievements – the effectiveness of the implementation of innovation – the quantity and quality of the implementation in a successful or an unsuccessful way within the last five years – long term approach creates conditions for a more objective assessment;

In the area of physical resources:

- the condition of machinery park and production infrastructure of the company,
- plans of purchasing new tools, machinery and other equipment required for the modification of production,
- the analysis and the planned changes in production technology,
- concepts and assumptions for the development of a company, including, among other things, plans for its expansion or reconstruction;

In the area of financial resources:

- the current financial condition of the company,
- the sources of funding innovative changes and the knowledge of the cooperating entities,
- the current costs of successful and unsuccessful diffusion of innovation,
- the analysis of financial expenditures to actual results,
- the planned costs in the area of innovation absorption,
- the internal capital of a company in the field of R & D (testing + development)
- macro and microeconomic situation of the company's environment;

In the area of human resources:

- approach to changes suggested within the organization – openness to new ideas – analysis of the attitudes of pro-innovation and the level of resistance to innovation – broadly understood as a change in operation within the area of organization in the company,

- general attitude – "top management" and crew motivation related to innovation,
- the nature of leadership in the company – pro or anti-innovative,
- the level of satisfaction with their work so far among the crew,
- the level of integration of the crew,
- age,
- pro-innovation culture.

The aforementioned classification of analytical problems related to holistic assessment of the innovation potential of the company was presented in the context of the four classic resources, which allows to fully reflect the most important tasks of this kind of evaluation. A full examination of the innovative potential of a specific company comes down to analyse its behavior in all areas and at all levels of its activity and requires considerable time and significant investment. Therefore, the end result balances such expenditure and allows to formulate a complete diagnosis and plan of action to improve its procedures in this area of its business which results in gaining its competitive edge in the market.

Holistic analysis of the innovation potential of the company should be subordinated to the old classical principle derived from the concept of H. Fayoli, H. Münsterberg, M. Parker Follet, E. Mayo et al., and the mainstream of "human relations", talking about the role of workers in the process of diffusion of innovation. The man and his involvement is essential to gain competitive advantage and to implement innovation. Other resources are the means to an effective actions, and their nature contributes to the fact that the purpose is realized faster and more efficiently – which means that we are more effective in achieving our goal thanks to such resources as material and financial ones. In contrast, human resources and information should be considered together, because the information becomes useful only when a person uses it to achieve their objectives, which are – or should be – the company's goals at the same time.

Substantive assessment of the innovation potential of the company comes down to multithreaded analysis of external and internal factors that create a specific behavior of a given company on the market. It takes place on the basis of quantitative and qualitative analysis of these behaviors in the strategic, tactical and operational areas of its business. It should be subjected to four basic



groups of analysis: study environment, resources, the level of R & D and innovation diffusion. The following scheme of this research process may be illustrated this way:

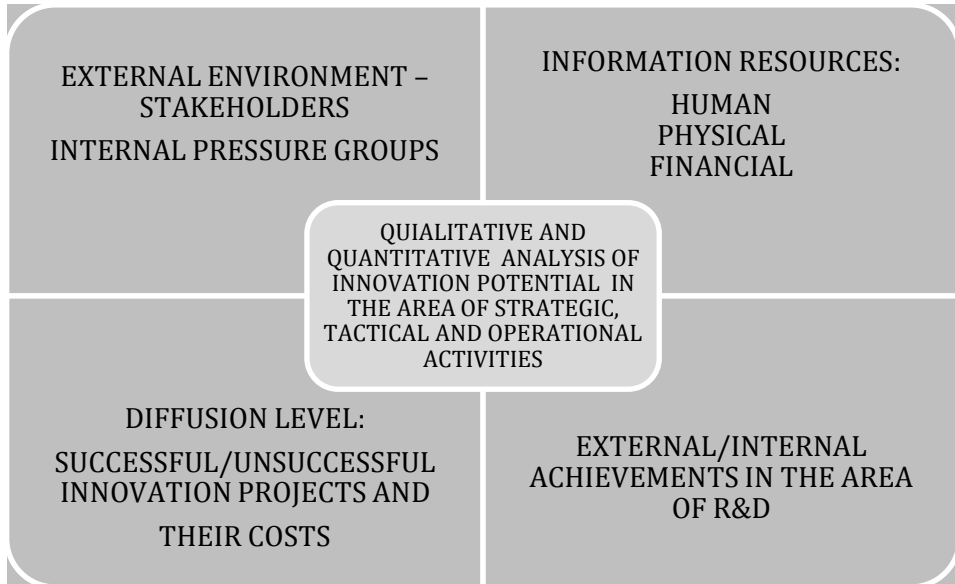


Figure II.1. The holistic scheme of the innovative potential of the organization

*Source: self-elaborated material.*

The diagram illustrating the holistic scheme of the innovative potential of the organization is on the one hand a simple representation of all necessary activities related to its research, but on the other – it includes a variety of general terms, which contains a considerable number of interpretation factors that are essential for reliable diagnosis of a given phenomenon. This classification requires taking systematization of the OECD manual presented herein into account – "Oslo Manuals" and to supplement it order to identify the key internal and external factors that determine the innovation potential of the company.

And hence, within the fundamental internal factors affecting the company's innovative potential we can include:

- strongly motivated crew and its accumulated knowledge,
- a high level of approval for the changes,
- adequate financial resources,

- appropriate physical resources,
- pro-innovation leadership open to change and suggestions of the crew,
- efficiently and effectively functioning production,
- functional organizational structure,
- a well-functioning and efficient marketing team and distribution,
- effective and efficient R & D department,
- pro-innovative company culture.

As regards the basic external factors affecting the company's innovative potential, we can include the following ones:

- a positive climate in the company's environment – acceptance of changes
- openness to innovation,
- financial support for innovative activities,
- ensuring adequate expenditure on activities in the area of R & D (Research + Development)
- promoting knowledge and achievements in the field of R & D,
- support for the diffusion of innovation in the economy,
- transparent and stable law,
- accommodating administration institutions and local government,
- a well-developed and well-functioning transport and logistics infrastructure,
- stable socio-economic situation of the region, the country and the wider environment.

Detailed analysis of the determinants of innovative activity of the company is the subject of numerous studies, the comprehensive approach suggested, among others, by D. Samson. The author distinguished between the following factors: strategy, leadership, change, customer focus, pro-innovative organizational culture, alliances, knowledge and entrepreneurship, quality processes, learning, innovation orientation<sup>33</sup>. Researchers whose publications followed the abovementioned one focused on interorganizational enhancers of innovative processes, including for instance: leadership vision, an appropriate organizational

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<sup>33</sup> Gloet M., Samson D., Knowledge management to support systematic innovation capability, 2013 [online, accessed: 2014-03-12]. Retrieved from: [http://www.hicss.hawaii.edu/hicss\\_46/bp46/ks4.pdf](http://www.hicss.hawaii.edu/hicss_46/bp46/ks4.pdf).

structure, recruitment, willingness to engage in the innovation process, the ability to conduct group work and willingness to learn and adapt new solutions<sup>34</sup>.

To sum up, the main task during the substantive analysis of the innovation potential of the company is to determine its ability to smooth and effective implementation at the three levels of its management which are: a strategic, a tactical and an operational level. It ought to be remembered that – in this particular case – the lack of efficient and effective action on any of the levels of enterprise of the management clearly leads to the negative effects of the implementation of any innovation. Having said that, the analysis of the innovation potential of the selected company should start with an analysis of "ex post facto" actions that have been taken in this area so far and to determine their effectiveness. The lack of effective diffusion of innovation in the company indicates unambiguously the low degree of innovation and the company requires in-depth analysis of this situation, among others, based on the suggested solutions.

Full, comprehensive diagnosis of the innovation potential of the company supported by the ensuing corrective measures or reinforced by existing positive actions in this aspect contributes to a significant growth of innovative actions of the companies, thus allowing it to acquire permanent – as it has already been written – competitive advantage on the market.

## 4. Conclusions

Exploring the potential of the innovative organizations in a holistic approach is one of the most important recommendations in the design of specific diagnostic tools in the modern economy and contributes explicitly to develop efficiently and effectively functioning as a subject on the market which is the company. The use of a broad diagnostic platform covering its scope to a number of statistical and technical analysis allows to develop coherent and comprehensive overview of the company and has a positive effect on the processes of its restructuring by means of contributing to its development and

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<sup>34</sup> compare: Tidd J., Bessant J., Pavitt K., [w:] Janusz W., Koziol K., *Determinanty działalności innowacyjnej przedsiębiorstw*, PWE, Warsaw 2007.

building its market position. High innovative potential of the organization is – in this case – the primary trigger of possible changes that can be described as permanent restructuring which are actually a peculiar form of innovative processes.

Modern companies operating in turbulent environments are exposed to many unpredictable situations, and to counteract the negative effects resulting from it, is one of the most frequent challenges in their current activities in the market. The high level of innovation in these enterprises is one of the factors that are essential to counteract the negative effects of their activities efficiently and allows for quick and efficient counteracting these negative phenomena in the market due to the rapid introduction of changes or diffusion of innovation. In summary, it appears advisable to adopt the following thesis: the greater the potential for innovation of the company is, the greater the chance of winning its lasting market advantage and dominant position in the economy.

It should be remembered that the only irreplaceable and necessary – as the most creative factor affecting the innovation potential of the organization – is the human being. It is the man and his unyielding will which can be referred to as a "sine qua non" condition for the implementation of any innovation. Engaged and motivated, a man significantly contributes to the creation of new quality called innovation and is the driving force that stands behind the progress of our civilization.

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### **III. Innovative development and application of new concepts in the field of control and measure the effectiveness of maintenance of small and medium-sized enterprises**

**Dorota Bartochowska**

Major system changes and technological developments in Poland contributed significantly to the development of small and medium-sized enterprises. The vast majority of business entities comprise small and medium-sized enterprises. Such companies employ a small number of employees as they have relatively little capital at their disposal. Hence, the rationalization and efficiency of processes carried out in these companies is a high priority.

Innovations are measurable value to organizations bring measurable financial and not only – build the brand of the product, contribute to the growth of the market value of the organization , build the foundation – the foundation of competitive advantage<sup>35</sup> .

Globalization and turbulent environment changes also impose the achievement of a high level of competitiveness and active competition on the sector of small and medium-sized enterprises. The activities of small and medium-sized has a significant impact on the development of modern economies. Despite many restrictions put on small companies, these seem to grow so rapidly, bravely fighting for space on the market using their potential as they are often large entities based on creativity and innovation. The support for small and medium-sized enterprises, reducing barriers to development and minimizing possible obstacles can bring significant benefits to the economy.

According to Czechowski (2007) small and medium-sized enterprises can be distinguished by seven market factors that make up for this sector and make such an enterprise stronger in relation to large companies. These are: the lack of bureaucratic organizational structure, an easy way of transmission of information within the enterprise, a positive impact on fast pace of development, the accuracy of solving problems and the ability to adjust to some current changes

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<sup>35</sup> Woźniak J., Innovation management as a factor in the creation of competitive advantage, [in:] Innovation Management - Theory and Practice, Monografia Politechniki Łódzkiej, Łódź 2015.

flowing from the external environment, responsiveness to changing market trends, the ability to seize new market opportunities, fast pace in adapting of new technologies, use of funds, launched exclusively in order to support of economic development, effective use of knowledge and experience of various market specialists<sup>36</sup>. The effective implementation of the objectives can use their intrinsic ability of dynamic, emphasize flexibility in the formulation of strategies and the importance of being flexible, pro-innovation and focused on the use of the results of possible cooperation<sup>37</sup>.

The specificity of SME management focuses primarily on qualitative and quantitative distinction between these enterprises and some larger enterprises. In the sphere of organization and management literature emphasizes the dominant role of the owner, the lack of strategic management, limited possibilities of using information systems and a large percentage of actions based on intuition in this sector<sup>38</sup>.

According to Soloducho-Pelc (2012)<sup>39</sup>, the specifics of small businesses makes the process of planning less formal and more intuitive, the time horizon of the strategy gets shorter and the planning system becomes easier.

Pro-innovative character of small and medium-sized enterprises is an issue which is rarely discussed in the literature – on the contrary to innovation related to the larger entities. It results from the fact that small and medium-sized enterprises – to a greater extent – rely on informal and – therefore difficult to measure – a range of research and development activities and these are less likely to use external sources of knowledge (consulting services and licenses) than their larger counterparts. This phenomenon reflects the reduced ability of SMEs to absorb external knowledge<sup>40</sup>. Nevertheless, companies in the

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<sup>36</sup> Czechowski L., Małe i średnie przedsiębiorstwa na rynku turystycznym. Wyższa Szkoła Turystyki i Hotelarstwa w Gdańsku, Gdańsk 2007, p. 15.

<sup>37</sup> Niemczyk J., Filozofie i szkoły strategii, [in:] Krupski R., Niemczyk J., Stańczyk-Hugiet E. (ed.), *Koncepcje strategii organizacji*, PWE, Warszawa 2009, p. 22.

<sup>38</sup> Lachiewicz S., Matejun M., *Specyfika zarządzania małymi i średnimi przedsiębiorstwami*, [in:] Matejun M. (ed.), *Zarządzanie małą i średnią firmą w teorii i w ćwiczeniach*, Difin, Warszawa 2012, pp. 13-45.

<sup>39</sup> Soloducho-Pelc L., *Planowanie strategiczne w małych przedsiębiorstwach – historyczna czy nowoczesna koncepcja zarządzania? Współczesne zarządzanie*, 4/2012.

<sup>40</sup> Perez-Bustamante G., Knowledge management in agile innovative organizations, *Journal of Knowledge Management*, t. 3, nr 1, 1999.

abovementioned sector implement innovations and use them as a part of gaining and maintaining its position on the market.

Implementation of innovations and innovative solutions in SME is not easy for many reasons. Because of limited resources and capabilities, these companies usually face many difficulties. Numerous studies conducted on small and medium-sized enterprises point to significant barriers which companies have to deal with in the process of innovations implementation. Some of the significant barriers to the implementation of innovations specific to SMEs are:

- the lack of a proper strategy,
- limited financial resources,
- limited human resources,
- poor management of possible change, and thus innovation.

The aforementioned barriers combined with fewer resources significantly limit innovation of these companies in different ways and in different areas. Small and medium-sized enterprises should, therefore, seek simpler, less capital-intensive, but equally effective solutions that set new directions of activity and development, contributing to the their goals, also in the field of maintenance (table III. 1).

Table III. 1. The selected factors in the area of UR

<i>The selected factors in the area of UR</i>	<i>Enterprises/businesses</i>	
	<b>Small</b>	<b>Medium-sized and large</b>
<b>The strategy of UR</b>	No assumptions and strategic concepts involved; oral conception is allowed	Rather formalized strategy
<b>The type of UR strategy applied</b>	Rather reactive	Rather proactive
<b>The use of new concepts for improving organizational productivity (such as TPM)</b>	<u>Up to a limited degree</u>	<u>With a wide range of use</u>
<b>The ability to change the strategic objectives in a dynamic way</b>	The lack of flexibility	Dynamic, assuming changes within the workflows
<b>The governing process</b>	<u>The owner – an entrepreneur</u>	<u>Managers</u>
<b>The type of organization structure</b>	<u>Usually linear or functional</u>	<u>Varied</u>
<b>Delegating of tasks and supervising entitlements</b>	<u>Up to a limited degree</u>	<u>With a wide range of use</u>



<b><u>The degree of task formalization</u></b>	<u>Small</u>	Large
<b><u>Flexibility of the organization structure</u></b>	<u>Large</u>	<u>Small</u>
<b><u>The way of exchanging information</u></b>	<u>Short, direct</u>	<u>Formalized, long</u>
<b><u>Work division</u></b>	<u>Low</u>	<u>High</u>
<b><u>The amount of employees</u></b>	<u>Small</u>	<u>Huge</u>
<b><u>The contribution by multispecialty, qualified workforce</u></b>	<u>Big</u>	<u>Very little</u>
<b><u>Communications and interaction between employees</u></b>	<u>Between all of the employees</u>	<u>Mainly within working groups</u>
<b><u>The governing process</u></b>	<u>The owner – an entrepreneur</u>	Managers
<b><u>Information system</u></b>	<u>Not sufficient</u>	<u>Formalized, well-developed</u>
<b><u>The role of UR planning</u></b>	<u>Almost none</u>	<u>Of utmost importance</u>
<b><u>The role of intuition in the process of making decisions</u></b>	<u>Huge</u>	<u>Very little</u>
<b><u>Making group decisions</u></b>	<u>Hardly ever</u>	<u>Often</u>
<b><u>The degree of formalizing and realization of the procedures</u></b>	<u>Low</u>	<u>High</u>
<b><u>The kind of materials applied</u></b>	<u>Universal</u>	<u>Specialist</u>
<b><u>The possibility of cost reduction along with the increase of the productivity</u></b>	<u>Very little</u>	<u>High</u>
<b><u>Development of new technologies and methods applicable in the area of UR</u></b>	<u>High</u>	<u>Low</u>
<b><u>Supply and material economy</u></b>	Not sufficient	Rather optimized
<b><u>The efficiency of delivery</u></b>	<u>Poor</u>	<u>Strong</u>
<b><u>The opportunities of investment and development</u></b>	<u>Almost none; limited financial possibilities</u>	<u>Very likely</u>

Source: self-elaboration.

One of the most important areas affecting enterprises to the company's results are the processes of control and measure the effectiveness of the company's operations. Innovative and effective solutions in this area greatly facilitate the functioning of the company. An increasing number of companies

are able to achieve a competitive advantage adapting to the market's requirements by means of the use of tools for continuous improvement of the efficiency and effectiveness of processes.

Monitoring and measurement of the effectiveness of management in the enterprise is important because it brings together both the participants' attention on the most important matters organizations and helps organizations streamline processes at the same time. Measuring efficiency is a system that allows to estimate the effects of the actions, evaluate the effectiveness of resource usage as well as the extent to which the measures taken correspond to the politics and intentions of the organization – in this sense becomes a part of the organization in its dimension of the process, including the integration and rewarding.

One of the important processes that improve the efficiency of enterprises is maintenance

More and more attention is paid to the system in different contexts: efficiency, economic, qualitative, quantitative, energy and their result in the form of realization of the goals<sup>41</sup>.

Unfortunately, most of the small businesses are directed mostly on carrying out the plan and the production schedule instead of improving the efficiency of their processes maintenance. There is a lack unified and consistent methods for controlling in such areas where measurement of the financial and economic and technical individual processes resulting in a thorough analysis showing the impact of certain actions on the achieved target and the relationship between them.

In the period between 2013 and 2015, a series of studies were performed on the systems' maintenance in twenty locations across the enterprises from construction business in Poland. Such analyzes were intended to help to improve the productivity of respondents machinery and the equipment as well as to create their own plan to improve economic performance in the maintenance of machinery and equipment within the enterprise. Among the surveyed companies, micro-enterprises were dominant (10). The remainder of the study population were small (6) and medium-sized enterprises (4). The study was conducted in companies of a similar variety and technical state operated

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<sup>41</sup> Burnos A., BalticBerg Consulting, Efektywność utrzymania ruchu, Agro Przemysł, nr 2/2012.

machines. For the purpose of the studies the categorized interview was conducted with the range variety of questions. Due to the scope and the prognostic importance, the studies were conducted with the help of various experts with specialist knowledge and experience (maintenance managers, machine operators and employees of financial services). Due to the complicated matter of research and an extensive range of functioning of enterprises surveyed, during the research it was not possible to apply the pool questionnaire only. Due to obtain the proper assessment in a given factor, the researcher was required to carry out a number of activities:

- provision for inspection documentation relating directly or indirectly to the test agent,
- observations made while being in the company,
- freely interview with the management and staff of the company and to use the obtained information, conversations, facts, events and possible suggestions affecting the final evaluation factor.

Because of the enormous significance in the process of control and measuring of productivity in the development of all enterprises, the article is precisely focused on searching for innovative systematic solutions of business efficiency monitoring as an important component of the whole system to analyze and evaluate their achievements. It allowed to create tools that were used for easier analysis and evaluation of the factors that are investigated. The measure of resource efficiency indicators of productivity.

Productivity is a measure of well-characterized operations company, and especially efficient use in the field of all resources at its disposal. Observation and analysis of productivity in the enterprise is a tool for effective management. It helps to evaluate the overall performance of a given enterprise compared to other companies, especially within the same industry. By assessing the productivity it is possible to identify the so-called "weak spots", to formulate programs which aim is to improve productivity, developmental trajectories and anticipation for the foreseeable future and strategic plans of the company.

The aim of measuring and improving productivity in the enterprise is more dynamic economic efficiency, achieving the needed competitive advantage both in the domestic and international markets and – above all – to contribute to

recognize and consider the needs of the employee. The main subject of productivity is a man, his creative potential that pushes to the continuous innovation of products or services, production processes, organization and work culture<sup>42</sup>.

The level of productivity and its changes depend on many interrelated and time-varying factors which are complementary. One can therefore make an attempt to systematize and identify those that are the most important in a particular organization<sup>43</sup>.

Classification of the factors affecting the productivity should help to identify projects that should be treated as a quick ad hoc measures which bring immediate or short-term effect and plan long-term projects, which will be introduced gradually, or in the long term period. Improving the productivity of some selected technical objects can become a source for companies to improve financial results, increase competitiveness and provide a better image of the company in its environment.

The study on twenty companies – conducted by the author of this article – allowed to assess and characterize the current state of the maintenance system within the organizations surveyed and helped to determine which elements of the organization have a significant impact on the development of productivity. In order to monitor the organization of the maintenance within companies successfully, it was necessary to select some significant categories inherent within the enterprise such as the strategy of the organization, the structure the organization and division of labor in activities planned for maintenance, procedures and specifications, system flow of information, technical infrastructure and organizational culture in the process of improving the productivity of respondents' machinery and equipment which have been tested. For the purpose of a thorough analysis of the impact of these different categories at raising productivity in each of the 7 identified enterprises, the factors which characterize a given category in the most best possible way were distinguished. This concept is based on such defining and describing strategies, procedures and

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<sup>42</sup> Donarski J.A., *Rozwój ruchu produktywności w Polsce. Wizja nowej kultury pracy*. Wyd. Instytutu Pracy i Spraw Socjalnych, Warszawa, 1999, p. 65.

<sup>43</sup> Kozioł L., *Istota i ocena produktywności*, [in:] L. Kozioł (ed.), *Prace z zakresu zarządzania. Zeszyty Naukowe Małopolskiej Wyższej Szkoły Ekonomicznej w Tarnowie*, z. 5, Tarnów, 2004, pp. 63-73.

shape of the structure, where appropriate relationships and forms lead to increases in productivity. Then the quality of operations of organizational maintenance within those categories was assessed.

The paper evaluates and assesses some individual factors on a scale of 0÷4, resulting in a current picture of these factors in the surveyed enterprises. A rating of "0" is reserved for the factor that was not present and was understood as "no data". The result indicated the desirability of measures to enhance the productivity of maintenance, especially those whose rationalization largely affect the functioning of maintaining traffic and measured its influence on the productivity of the company.

Efforts to improve productivity **are more efficient through the use of good tools of process, systems and programs which support the service maintenance of a given company**. For the analysis and diagnosis of studied factors that may possibly improve productivity in the surveyed enterprises, special tools were developed in order to record and process the overall data. It would be worth to apply the so-called "both-threaded" approach to solve the problem:

1. Creating a database application for registration of the survey data and the issue of fundamental results necessary for analysis, including the statement related to the method used data analysis (Figure III.1 and III.2).
2. Export data from the database to a spreadsheet designed in such a form that it allows the multidimensional evaluation of partially processed data and issue charts and lists of appropriately selected composition, illustrating best-studied phenomenon.

### III. Innovative development and application of new concepts in the field of control and measure...

Identyfikator: 9  
 kategoria: Strategia  
 czynnik: Poprawne monitorowanie realizacji strategii i modyfikowanie jej stosownie do nowych, zmieniających się uwarunkowań

ocena	opis oceny	
0	Brak strategii, brak monitoringu	9
1	Monitoring w dużej mierze akcyjny	9
2	Monitoring akcyjny, wymuszony sytuacją	9
3	Monitoring nieregularny, ale wystarczający	9
4	Cykliczny monitoring, opracowany jako zróżnoważona karta wyników	9

Figure III.1. The criteria of the production improvement and the overall assessment

Source: self-elaboration.

Kod\_bet: WBT20    Zatrudnienie: 7

Mieszalnik: elba    Produkcja betonu 1:

Siłosy: 4x100    Produkcja betonu 2:

Układ podawania kruszywa: Wachlarzowy    Produkcja betonu 3:

System odmiaru składników: wagowy skomputeryzowane    Klasa betonu: B7,5-B50

Sterowanie węzłem produkcyjnym:     Konsystencja:

Wyposażenie dodatkowe: stacja recyklingu    Zaprawy:

	Strategia	System organizacji	Planowane działania	Specyfikacje i procedury	System obiegu inform.	Zasoby	Kultura organizacyjna	Oceny łącznie
	0	19	21	16	19	18	25	118
1. zwiększenie ilości produkcji:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
2. poprawa efektywności czasu pracy maszyn:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3. obniżenie kosztów:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4. poprawa funduszu czasu pracy pracow.:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Figure III.2. The criteria of the production improvement and the overall assessment

Source: self-elaboration.

The performance of tests based on the methodology applied for this purpose, provided a number of important conclusions, which – in practice – will allow to monitor possible changes in UR processes:

1. Most activities comprising UR in the practice of small companies are the actions based on intuition, good and bad experiences and the behavior of employees. Sometimes, however, it may happen that they are applied as a result of strategic decisions, supported a specific science of exploitation and thoughtful methodology. In Poland – especially within the sector of small and medium-sized businesses – such actions are still quite rare.
2. Strategies for the development of industrial enterprises do not take into account the impact of the problems related to the maintenance of machinery and equipment as strategic and systemic issues.
3. The vast majority of enterprises did not have any strategy as a part of maintenance or declare no formalize this strategy.
4. Studies have shown that within most small businesses there is a lack of control and the measurement of the effectiveness of UR actions taken.
5. Decisions related to the maintenance and spending money in small businesses are taken mainly by business owners who have true knowledge about their own devices, and the scope of necessary action from the point of view of the effectiveness of the company, but do not use it properly. In this case the production plans seem to be decisive for them as the excess savings and a lack of perspective (or strategic) thinking usually win.
6. Efforts oriented on rationalizing processes related to UR within the companies – if any like that exist at all – they are usually initiated in an ill-considered way, unsupported by any knowledge resulting from earlier analyses summarizing the past effects of the work of machines or people and the methods applied in the whole process.
7. The actions UR had not been clearly defined and planned or are carried out inadequately. Deadlines for the implementation of maintenance plans are not always met. The basis for timing of maintenance of machinery and technology equipment production are dictated by the production.
8. Technical maintenance associated with the production process has a special character, there are no facilities of maintenance and repair, enterprises have to deal with limited possibilities of purchasing expensive control

equipment and measurement as well as the storage of spare parts, so that – in many cases – the work cannot be implemented within the time limits. Because of these limitations, it is even impossible to react immediately on the failures that occurred in the meanwhile.

The study also pointed out at **insufficient formalizing of activities** in the area of maintenance, **poor flow of information** in the processes of maintenance causing many organizational and decision-making consequences.

The results of the research made it possible to analyse issues from the area of maintenance management in individual companies in terms of efficiency and the kind of actions taken and strategies of UR applied within a given enterprise as well as control of these processes, evaluation of the conditions and exploration the possibilities and scope of the improvement of the system maintenance. The resulting description can be for instance the basis for optimizing management activities related to UR due to the effective implementation of tasks and preparation for the implementation of certain system solutions<sup>44</sup>.

In order to assess productivity within certain enterprise, a parallel analysis was applied to use. The final evaluation of the results presented in the aforementioned study were made by means of using a special spreadsheet. For this purpose, a sheet designed tentatively was called "a productivity cockpit". Its structure is designed so that a single image gather the most important summary results of the survey and all other data for assessing whether the method works in practice. With a palette possible to calculate indicators selected those that demonstrate productivity in the selected area of research in the best possible way.

Productivity was expressed here by measures of character quotient, wherein the numerator is expressed in any production effect (number of devices produced and delivered to the recipient, the value of marketed production, assessed value added etc.) and the denominator size of the resources or resources used to obtain this effect (for instance the effective working time machine, the amount of production, etc.).

The aforementioned spreadsheet allows you to monitor the level of productivity achieved by using selected indicators in any of 3-year intervals

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<sup>44</sup> Bartochowska D., Ferenc R., Utrzymanie ruchu w niewielkich firmach, Monografie Politechniki Łódzkiej, Łódź 2014.



chosen and show it in the context of scoring of the quality of the maintenance organization for some factors affecting the level of productivity. Its structure was designed in such way that a single image gather the most important summary results of the survey and all other data are used for assessing whether the method really works in practice.

Within the sheet some graphs were collected so as to show the change of selected indicators of productivity. Charts were constructed in the way that it makes possible to estimate the status indicator visually on the background values recognized as bad (red colour), relatively good (yellow colour) and good (green colour).

On the right side of the "cockpit", it is possible to notice a chart showing the value of a disc of points obtained by the method used. The graph is scaled to the maximum value obtained in this study (Fig. III.3).

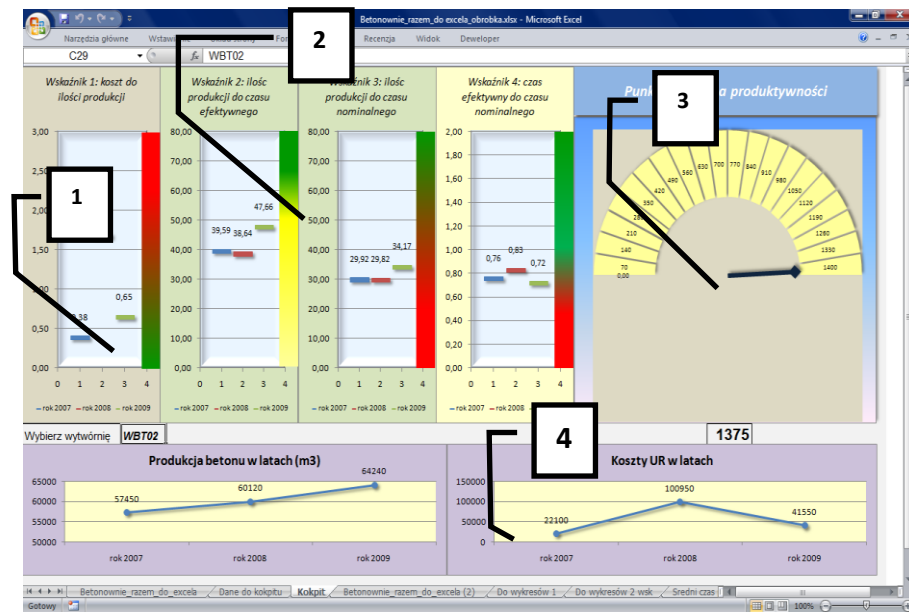


Figure III 3. A productivity cockpit

Source: self-elaboration.

On the bottom of the sheet the two graphs are presented:

- The first graph posing the volume of production during the period of 3 years,
- The second graph showing maintenance costs respectively in the years to come.

For the purpose of the productivity analysis within the surveyed companies, four indicators were suggested:

1. The ratio of maintenance costs per unit of production,
2. The ratio of production in relation to the time efficiency,
3. The ratio of production in relation to the nominal time,
4. Load indicator label, understood as the ratio of the nominal effective time.

1. The first indicator shows the cost of maintenance per unit of production. A significant increase in maintenance costs may point out at the high costs of unplanned downtime caused by unexpected failure, inspections and maintenance, etc. On the other hand, these same factors may be the reason for inability to perform the approved production plans, come down to poor performance of specific machines and a high level of their decapitalization, and thus cause an increase in the indicator.

2. The primary indicator of the intensity in the use of working time is the ratio of production volume compared with the working time of machines:

$$W_2 = HR / TM$$

where:  $W_2$  – an indicator of the intensity of the use of machinery,

WP – produced production,

TM – effective working time machine.

3. The indicator measures the use of working time machine relative to the resource FIT time. It is calculated as:

$$W_3 = HR / NC$$

where:  $W_3$  – the rate of production time,

EC – effective working time,

NC – nominal operating time.

4. Evaluation indicator of the intensity of the use of machinery is an indicator of the production working time. It is calculated as:

$$W_4 = HR / NC$$

where: WP – produced production,

NC – nominal operating time.

As an effective working time we understand time in which the machine was actually used in the production. For a nominal working time we consider the total time needed to start the machine<sup>45</sup>.

The choice of sets of economic measures, including measures of productivity, mainly depends on the subject to analysis and evaluation. No dissemination and value patterns in companies and the rich diversity of indicators measuring the productivity create difficulties related to the selection of appropriate indicators of productivity.

The database evaluated in accordance with the methodology applied in this case uses the information that come from the general management system and such influence has an impact on productivity. The application uses a spreadsheet to hold the data and then is reflected in the so-called "productivity cockpit" created for the purpose of this paper.

Studies have shown that companies with the highest potential productivity (with the best score and quality of the maintenance organization) achieved the highest rates of productivity of the machines. The present measurements and analysis of productivity show where to look for possible improvement within the organization and tell us how it is possible to achieve such improvement.

In business practice different methods of productivity are usually based on multi-ratio models combined with the use of indicators of profitability and profitability. As it often happens, these models are quite complicated to use in the area of a small business, that is why small businesses need simpler and cheaper, but – at the same time – equally effective solutions.

## Summary

Analyzing their business operations, numerous enterprises mainly use the basic tools of financial analysis. That is why the innovative use and the development of new concepts in the field of control and measurement of efficiency is a very valuable option.

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<sup>45</sup> Bartochowska D., Organizacja utrzymania ruchu w procesie poprawy produktywności, Przegląd Papierniczy, I, SIGMA-NOT Sp. z o.o., lipiec 2010.

The indicators of productivity can be treated as the measure of resource efficiency. Modern organizations – if they want to be more competitive – must demonstrate greater productivity with less resource commitment at the same time. A measure of productivity in certain circumstances may be more suitable than the commonly known principle of maximizing of profits and minimizing of the costs.

The increase of productivity within various businesses – conditioned by systematic approach to the problem of maintaining machinery and equipment – can possibly integrate the companies providing maintenance system together with the overall management system. In companies with a higher potential for productivity growth, such productivity will depend on the missing links. On the contrary, in companies with low potential productivity management system should be reconstructed by job category specified in the evaluation of management of productivity.

Productivity can be interpreted as a measure of the efficiency of a given organization, in terms of the results to the ratio of resources used for this specific purposes; as the mentality of progress, expressed in organizing and supporting all range of projects aimed at continually improving the efficiency of the organization, improving its market position and increasing employee satisfaction with their working conditions and quality of life<sup>46</sup>.

The issues of modern science related to the organization and management strongly emphasize the importance of analyzing and measuring productivity for the smooth functioning of the company. By applying this measurement companies seek new ways to improve their productivity, make a selection and evaluation of solutions in terms of best use of resources and production capacity.

According to Loska<sup>47</sup> (2011), effective implementation of the objectives of the UR can be – and should be – the subject to quantitative evaluation and, consequently, of corrective action. The assessment should relate to the characteristics of objects and ongoing operational processes.

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<sup>46</sup> Kelly A., *Maintenance Strategy*. Butterworth Heinemann, UK 1997.

<sup>47</sup> Loska A., *Przegląd modeli ocen eksploatacyjnych systemów technicznych*. Opole – Konferencja Komputerowo Zintegrowane Zarządzanie, Oficyna Wydawnicza Polskiego Towarzystwa Zarządzania Produkcją, 2011.

Within each group of factors you can locate the measure (indicators) describing and assessing some aspects of operational facilities or technical systems, as well as the operation of maintenance services. In practice, these measures should be an effective tool for:

- evaluating characteristic values for quantitative assessment of the technical facilities and maintenance staff,
- making comparisons between different organizational units or divisions of companies in certain intervals, making improvement activities based on the results of analyzes of the use of the contents of measurement.

The greater importance to maintenance seen as an important process in the organization and conviction of its significant participation in shaping the economic performance of the company will increase the rank of activities to improve productivity in this subject area.

Measuring of productivity, monitoring and evaluation processes of maintenance without information support is simply pointless. On the market there are many different programs to support the monitoring process though they are usually complex computer applications and their installation, exploitation and range of supported information exceeds the capabilities and expectations of small and medium-sized enterprises.

The company which operates on several devices does not need to monitor sophisticated software. The tool that can be sufficient is the database based on common programs available in every enterprise (spreadsheets, simple relational databases – one of such possibilities is to use at least such popular programs as MS Office, MS Access, MS Excel – the spreadsheet). By means of these applications, various users can monitor selected aspects of maintenance processes without limitations.

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## **IV. The evaluation of the effectiveness of strategic plans for UR**

**Dorota Bartochowska**

In each of the areas of business management one can traced back for different ways applied in order to improve efficiency through appropriate strategy, its implementation and properly designed control system.

A kind of supplement and development approach measurement of productivity for companies that want to monitor their effectiveness and objectives effectively, based on an optimized system of measures – may be implementation of the Balanced Scorecard Kaplan and Norton's called BSC (Balanced Scorecard) for short and implemented to monitor maintenance processes. Traditional financial measures used in the enterprise are insufficient. Management of modern enterprise requires managers perception of its business from different points of view simultaneously<sup>48</sup>.

It is very helpful in determining the direction of rationalization projects undertaken to maintain productivity as well as a very important factor in the ongoing process of rationalization of the organization.

This concept requires a strong commitment of employees and substantial organizational effort is used, especially for companies strategically oriented on BSC. BSC is one of the most important tools of strategic controlling. The use of this methodology for the processes of maintenance does not require large costs or number of organizational changes. Its introduction may be effective in achieving the objectives and economic effects, as well as in the diagnosis implemented actions of UR, monitor possible development and progress in the system of exploitation, motivating and the system of assess the cost of the services, technicians and other employees of their results.

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<sup>48</sup> Wnuk-Pel T., Zrównoważona karta dokonań jako system pomiaru działalności i zarządzania strategicznego, [in:] Rachunek kosztów i rachunkowość zarządcza, Sobańska I. (ed.), C.H.Beck, Warszawa 2006.

Polish companies are rarely used BSC. The main constraints in implementing this method are lack of knowledge about the methods of the BSC and the fear of additional tasks and complication.

Implementation of BSC in large enterprises is more time consuming and costly. In smaller companies the implementation of the BSC allows to: spend less, take less time, enable relatively easy communication between employees or cause far less resistance of a given organization. However, due to the complexity of the method itself, according to the authors it would require strong commitment and precise accuracy of the measurement, and control the implementation of the objectives set<sup>49</sup>.

A strategy for smaller companies is less formal and more intuitive, which makes the time span of the whole applied strategy shorter and simpler in reference to the planning system. Due to its ability to react quickly to changes in the environment and the possibility of a prompt correction of plans to make changes in the strategy of small business, such procedures are not difficult at all. No formal strategic planning of a given entrepreneur erroneously treat it as a response to the changing environment that forces you to react quickly and as a consequence, it usually prevents planning. This approach most often results from a lack of adequate knowledge about strategic planning<sup>50</sup>.

Balanced Scorecard (BSC) is a tool used mainly for supporting of the implementation process strategy. It allows, within its four perspectives, to capture the most significant business objectives and to monitor their implementation in a sustainable way. The main idea of this system is the use of financial and non-financial indicators to assess the current state of the organization. BSC assumes the strategy presentation in the form of a set of measurable objectives necessary to implement the company's mission. These targets are included in the four perspectives (Fig. IV.1): Financial, customer's, internal processes as well as growth and learning.

The method suggested by two Americans – Robert p. Kaplan and David P. Norton, the so-called “Balanced Scorecard” (BSC) is a management concept that

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<sup>49</sup> Waszczyk M., Kubka J., Wewnętrzne trudności strategicznej karty wyników a wielkość przedsiębiorstw, [www.waszczyk.pl/publikacje/Waszczyk\\_Kubka\\_BSC\\_1\\_4\\_PL.doc](http://www.waszczyk.pl/publikacje/Waszczyk_Kubka_BSC_1_4_PL.doc)

<sup>50</sup> Soloduch-Pelc L., Planowanie strategiczne w małych przedsiębiorstwach – historyczna czy nowoczesna koncepcja zarządzania? *Współczesne Zarządzanie*, 4/2012.



allows to locate the measurement mechanism within the plan for the long-term strategy of the company enterprise management system and is a kind of alternative proposal to the traditional systems of measurement – it describes and explains what should be measured in a given company in order to evaluate the effectiveness of the company in implementing the strategy in the best way possible<sup>51</sup>. This is a method that allows to control implementation, progress and the degree of realization of strategic plans relatively easy thanks to a system of targets and indicators. The implementation of Balanced Scorecard is a multi-stage action and a continuous process at the same time<sup>52</sup>.

The purpose of using key indicators UR is primarily the acquisition of current and historical measurements of operating properties and the relationships between them in order to confront the values obtained from the design values and with the values obtained from observations of other operating systems or other technical objects, so that one is able to perform the so-called "benchmarking"<sup>53</sup>.

UR BSC directs its attention to effects of the system's maintenance activities: availability, reliability, costs, energy consumption, systemic improvement and employee characteristics. The key actuation points become objectives related to a strategy, specifying where the maintenance management pillar must act to succeed in its strategy<sup>54</sup>.

Performance indicators also help in the diagnosis of implemented actions of management, operation and maintenance, monitoring change and progress in the system of exploitation or motivating and the account for the technical and managerial staff with the results achieved<sup>55</sup>.

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<sup>51</sup> Świdorska G. (ed.), *Rachunkowość zarządcza i rachunek kosztów*. t. II, Warszawa 2000.

<sup>52</sup> Ossowski M., *Strategiczna karta wyników w przedsiębiorstwie zarządzającym portem morskim*. Zeszyty Naukowe Uniwersytetu Szczecińskiego, nr 765, *Finanse, Rynki Finansowe, Ubezpieczenia* nr 61 (2013).

<sup>53</sup> <http://www.industrial-monitor.pl/dzialalnosc-wydawnicza/leksykon-utrzymania-ruchu/efektywnosc-w-zarzadzaniu-ur>

<sup>54</sup> Biasotto E., Dias A., Ogluari A., *Balanced scorecard for TPM maintenance management, BSC application on TPM management: a case study in process industry*. Dissertation (Master)-Santa Catarina's Federal University, Technological Center, Mechanical Engineering Department, Florianópolis, 2006b.

<sup>55</sup> <http://serwerownie.org/index.php/continuuus-improvement>

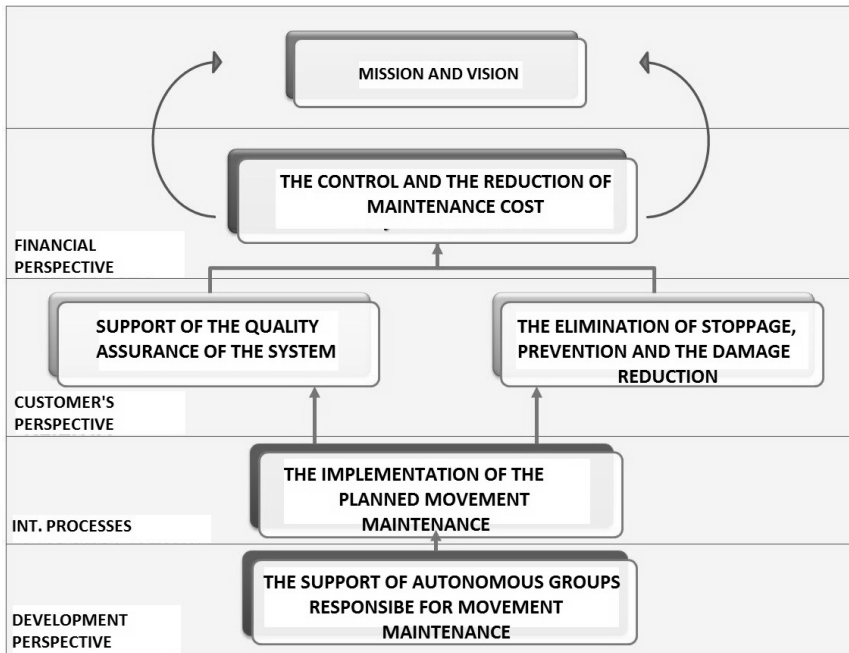


Figure IV.1. Planned Maintenance Pillar strategic planning map<sup>56</sup>

One of the most significant values to be taken into account when analyzing the financial perspective is the one of the maintenance costs. The values consist of maintenance costs the internal resources of labor costs, cost of spare parts and consumables as well as the cost of external services. Depending on the adopted division and applicable cost accounting, the overall costs or expenses UR selected areas or machines can be estimated. The quantity of incurred maintenance can be influenced by many factors such as a kind of technical system, the strategy of UR or correct calculation and the grouping of costs. UR cost analysis is one of the basic tools to assess the effectiveness of technical and production departments.

<sup>56</sup> Biasotto E., Dias A, Ogliari A, Balanced scorecard for TPM maintenance management, BSC application on TPM management: a case study in process industry. Dissertation (Master)-Santa Catarina's Federal University, Technological Center, Mechanical Engineering Department, Florianópolis, 2006b.

In order to analyse **internal customer's perspective** within the UR it would be reasonable to select and apply indicators the values of which have to – as a result – form the basis for optimizing the decision-making process and improve the quality of execution of UR activities. Within the application of this perspective, the task of UR services – in relation to the internal customer and the way they are manufacturing the cells – is **to ensure the reliability and availability of the machinery in order to meet the requirements of production services**. An internal customer – manufacturing cells – require constant and trouble-free availability of operated devices.

For the long-term and stable development the rationalization of costs and the internal customer's perspective discussed before seem to be insufficient. The expenses covering the research and development or introduction of new systems technologies ought to be taken into account. To succeed, the following aspects should be included in the overall successful performance of a given enterprise: skills development of the employees, modern information technologies and relevant organizational procedures – in other words: the plane of development and internal processes.

### **The evaluation of the effectiveness of UR services possible to achieve by means of using the BSC method**

To improve the efficiency of maintenance services , and thus to improve the economic condition of companies strategically oriented method was used BSC. For the purposes of registration and analysis of the data suggested the spreadsheet as an effective tool to support the use of the method.

The concept of using a sheet to monitor the situation in the system's technical design is based on two notebooks:

1. A notebook used to record data related to the hardware, inspections and failures together with relevant statistics.
2. A notebook used to record data on the effects of actions performed by technical services based on the modified BSC method.

The two applications mentioned above are designed to capture and register the actions taken in handling and supervision at the machine park of the company and monitor the achieved results.

Due to the limited possibilities of presenting the whole concept described in this publication – which aim is to assess the effects of the activities of UR services – an Excel® spreadsheet shows an application containing the implementation of the BSC method<sup>57</sup>.

**The implementation of the BSC method addressed with IT tools (spreadsheet) processes maintenance of small and medium-sized enterprises. For the following four perspectives, namely optimization of costs, internal customer's expectations, change of internal development and innovation some strategic objectives were set: each of these planes should be characterized by selected targets and measures, the proposals of which are described in the next part of this article.** The notebook is formed by the sheets related to specific prospects and these are merged by the "Title" sheet. The application was created by means of Excel® 2007.

### **Targets and measurements**

A careful definition of objectives to be achieved and assigning them to particular measurements is the first task to be performed before the implementation of "BSC method" to the practice of the company. The targets may be varied, but – at the same time – adjusted to the specificities and expectations of a given organization. The following sections include the suggestions of the objectives connected with the functioning of the UR service for possible use in the construction and completion of this sheet.

### **The outlook: Expectations of an internal client**

Within this perspective, the task of UR services in relation to the internal customer – which are the so-called production cells – is to provide and improve availability and reliability of the technical infrastructure to meet the requirements of production services. An internal client – production cells – require constant availability and fault-free operating equipment. This general objective may, however, be broken down into a number of specific objectives related to – for instance – particular devices.

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<sup>57</sup> BSC method – the description of this method is available in literature and in the popularizing publications – therefore we make a reference to the basics of the BSC method.

Table IV.1. The outlook: Expectations of an internal client – the examples of goals and measurements

<i>The goal</i>	<i>Measurement</i>	<i>The expected value</i>	<i>The unit of measure</i>
<i>1. Obtaining of a particular OEE indicator</i>	<i>Calculated OEE value</i>	<i>Value</i>	<i>Current OEE value</i>
OEE indicator cannot be calculated for the whole unit or every device separately			
<i>2. Obtaining of a specific value MTBF – average uptime device</i>	<i>MTBF taken from the notebook recorded or calculated from other sources</i>	<i>The value indicating the expected value of the indicator MTBR in days or hours</i>	<i>Days or hours</i>
<i>3. Obtaining of a specific value MTBF – mean time to the possible failure occurrence</i>	<i>MTBF taken from the notebook recorded or calculated from other sources</i>	<i>The value indicating the expected value of the MTBF in days or hours</i>	<i>Days or hours</i>
<i>4. Obtaining of a specific ratio MTTR – mean time to failure removal</i>	<i>MTTR taken from the notebook recorded or calculated from other sources</i>	<i>The value indicating the expected value of MTTR in hours or minutes</i>	<i>Hours or minutes</i>
<b>Objectives 1-4 should be defined separately for each device</b>			
<i>5. Obtaining the reduce in the amount of equipment failure and / or component</i>	<i>The amount of failure of the device / component</i>	<i>Maximum number of emergency events in the month / year</i>	<i>The amount of events</i>
<i>6. Obtaining the reduce in the amount of equipment failure and / or sub-lasting than ..... minutes</i>	<i>The amount of failure causing interruption in the availability of production lasting over a minute .....</i>	<i>Maximum number of emergency events in the month / year</i>	<i>The amount of events</i>
<i>7. Obtaining reduce losses due to failures in the module .....</i>	<i>The sum of loss caused by the component failure (in minutes)</i>	<i>Maximum amount of minutes</i>	<i>The amount of minutes</i>
<b>Objectives 5-7 should be defined separately for each device</b>			
<i>8. Achieving of full compliance inspections planned and executed (device) a. the rate of the inspections that were carried out in relation to the inspections which are planned</i>	<i>a. The ratio of the carried out inspections (the type) planned.  b. The ratio of time spent on the inspections planned</i>	<i>100%</i>	<i>%</i>

#### IV. The evaluation of the effectiveness of strategic plans for UR

<p>b. the ratio of time spent on inspections conducted in relation to the inspections planned</p> <p>c. indicator of the amount of maintenance exceeding the duration (separately for each type of inspection)</p>	<p>c. The amount of Inspections for exceeding the duration (broken down into daily, weekly, monthly, ...)</p>		
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Source: self-elaborated work.

\* OEE indicator (Overall Equipment Effectiveness) is an international standard for measuring the effectiveness of the use of machinery and equipment.

It is connected with three indicators: **the availability of machines and equipment** (lowered by failures, but also by retooling and setting machines), **performance** (resulting in the possibility of using machines) and **quality** (measured by the relationship between a good and a faulty produce). This paper focuses on the observation and improvement of only one indicator decisive on the final size of OEE – its availability. Therefore, in order to get acquainted with the methodology of calculating OEE, it would be helpful to get familiar with the extensive literature on this subject<sup>58</sup>.

#### The outlook: The optimization of costs – example goals and measurements

Table IV.2. Selected differences between maintenance of operating between small, medium-sized and large enterprises

Goal	Measurement	Expected value	A unit of measurement
<p>1. Obtaining the UR's costs reduction ..... (zl or %)</p>	<p>The value of UR costs</p>	<p>The expected value of UR or % of the cost reduction</p>	<p>zl or %</p>
<p>2. The improvement in the share of costs in relation to UR</p> <p>a. the overall production costs</p> <p>b. the value of net production</p> <p>c. UR costs per unit of production (pc. n pcs., tons, meters, ...)</p>	<p>a. The ratio of UR to the total production costs</p> <p>b. The ratio of UR to the value of net production</p> <p>c. The ratio of cost per unit of output UR</p>	<p>The expected value of the indicator</p>	<p>The number (indicator)</p>

<sup>58</sup> OEE – OEE indicator (Overall Equipment Effectiveness) is an international standard for measuring the effectiveness of the use of machinery and equipment.

<i>3. The reduction of the failure's costs</i>	<i>The value of failure's costs</i>	<i>The maximum expected cost of failure</i>	<i>zł</i>
<i>4. The reduction of the material's costs</i>	<i>The average value of materials and spare parts</i>	<i>The expected and the accepted average value of materials and spare parts</i>	<i>zł</i>
<i>5. The reduction of the energy costs</i>	<i>The average cost of energy consumption per machine / device</i>	<i>The expected reduction in the average cost of energy</i>	<i>zł</i>
<i>6. The reduction the cost of operating the supply of consumables and spare parts</i>	<i>The average cost of supplying/deliveries</i>	<i>The expected reduction in the average cost and the level of costs to which we aim at</i>	<i>zł</i>
<i>7. Preventing the destruction of machinery and equipment</i>	<i>Losses resulted from the faulty handling or devastation of the machine/device</i>	<i>Expected and acceptable level of loss caused by the aforementioned</i>	<i>zł</i>

Source: self-elaborated work.

The optimization of costs the performance of departments UR may have a lot of specific goals depending on the specifics of the industry and the service organizations of UR. However, it can be said that its direct aim should be:

1. Restriction of costs through the effective removal of the causes of loss.
2. Reducing costs through the rational management of UR (understood as people, equipment and materials).

### **Perspective: Internal changes**

Internal developments should be directed to optimize the operation of UR services, in particular on the implementation of systemic changes involving the improvement of the flow of information about the situation in the operation of machinery and equipment, regularity and correctness of the activities of UR services, better organization of work and increase the competence of the staff.

Table IV. 3. Perspective: Internal changes – example goals and measurements

<i>Goal</i>	<i>Measurement</i>	<i>Expected value</i>	<i>A unit of measurement</i>
<p>1. Improving monitoring of the situation in terms of UR on machines/devices</p> <p>a. separately staging the implementation of individual steps and/or parts of the system</p> <p>b. Evaluation of the system among services workers UR</p>	<p>The progress of implementation of the support system to monitor the situation in the field of UR</p>	100%	% of the progress
<p>2. Achieving full compliance inspections planned and executed (device)</p> <p>a. The rate of the carried out in relation to the planned</p> <p>b. The ratio of time spent on inspections in relation to the planned</p> <p>c. indicator of the amount of maintenance exceeding the duration</p>	<p>a. The ratio of the carried out (the type) planned.</p>	100%	%
<p>3. The control of maintenance activities</p>	<p>The degree of realization of maintenance and autonomous actions, for example expressed in %</p>	100%	in %
<p>4. Providing IT support</p>	<p>The progress of the implementation and operation of applications supporting the work of the services such as UR expressed in %</p>	100%	in %
<p>5. Better organization of spare parts and supplies</p> <p>a. The lowering of the average inventories of spare parts</p> <p>b. The improvement in inventory turnover associated with UR</p>	<p>in zlotys or %</p> <p>value of purchases for the month / average value of the stocks section parts</p>	<p>the nominal value or %</p> <p>the number</p>	<p>in zlotys and %</p> <p>the number</p>
<p>6. Monitoring the trends of frequent faults to allow the determination of the causes – the definition of a particular fault</p>	<p>The frequency of occurrence</p>	<p>The reduction by %</p>	in %



<i>Single objectives – their performance enables the rationalization of UR labor services – in the longer term assessment is subject to the continuity of their implementation</i>			
<i>1. Determining the documents regulating the schedule (frequency) and the types of activities UR and times of their implementation</i>	<i>The degree of implementation of the plan objectives in this area</i>	<i>100%</i>	<i>% of the overall progress</i>
<i>2. Determine the current state of equipment – identify needs repair, a state in terms of spare parts, technical condition of machinery and equipment</i>	<i>The degree of implementation of the plan objectives in this area</i>	<i>100%</i>	<i>% of the overall progress</i>
<i>3. Determine the completeness of machinery and equipment to the extent necessary for the services of UR</i>	<i>The degree of implementation of the plan objectives in this area</i>	<i>100%</i>	<i>% of the overall progress</i>
<i>4. Determination and planning of preventive measures related to the nature of production and method of operation of machines and equipment</i>	<i>The degree of implementation of the plan objectives in this area</i>	<i>100%</i>	<i>% of the overall progress</i>
<i>5. The arrangements for monitoring of energy consumption (by machinery and equipment), water, waste water emissions, consumables (lubricants, fuels)</i>	<i>The degree of implementation of the plan objectives in this area</i>	<i>100%</i>	<i>% of the overall progress</i>
<i>6. Determination of principles and methods of training related to the UR (handling equipment, control of the correctness of work, signaling damage and failure)</i>	<i>The degree of implementation of the plan objectives in this area</i>	<i>100%</i>	<i>% of the overall progress</i>
<i>7. Determination of the action plan related to EU requirements in the operation of machinery and equipment</i>	<i>The degree of implementation of the plan objectives in this area</i>	<i>100%</i>	<i>% of the overall progress</i>
<i>8. Defining the standard requirements for maintenance of the devices in order to achieve high availability of supplies</i>	<i>Better organization and plans (systematic improvements)</i>		<i>The level of realization expressed in %</i>

Source: self-elaborated work.

**Perspective: Development and innovations**

This perspective is also associated with the industry and the strategic development of the company. However, it is worth making a careful analysis of the current situation related to the operation of dealing with maintenance also in respect of equipping them with the full documentation of the machinery and equipment used, complete the documents regulating the work of these services and directions of innovative changes.

Table IV.4. Perspective: Development and innovations – example goals and measurements

<i>Goal</i>	<i>Measurement</i>	<i>Expected value</i>	<i>A unit of measurement</i>
<i>1. The implementation of the computerized monitoring system activities UR</i>	<i>The progress of implementation expressed in %</i>	<i>100%</i>	<i>% of the overall progress</i>
<i>2. Implementation of regular training to improve staff competence UR (support strategic skills and systems)</i>	<i>The number of training courses in a given period of time, for example the number of training hours per employee per year</i>	<i>The number of training hours/the average number of hours per worker</i>	<i>The number/the timing</i>
<i>3. Design changes in the performance of departments UR for improvements</i>	<i>The measure here may be the progress of the project in relation to the planned date of completion or execution of the tasks planned for the month</i>	<i>100%</i>	<i>% of the overall progress</i>
<i>4. Implementation of new technical solutions in hardware supervised in order to enhance its efficiency and productivity.</i>	<i>The measure here may be progress of the project in relation to the planned date of completion</i>	<i>100%</i>	<i>% of the overall progress</i>
<i>5. Launching of the new machinery/device and</i>	<i>The measure here may be the progress of the project in relation to the planned date of completion</i>	<i>100%</i>	<i>% of the overall progress</i>
<i>6. Implementation of innovation proposed by the services of UR</i>	<i>The measure here may be the progress of the project in relation to the planned date of completion</i>	<i>100%</i>	<i>% of the overall progress</i>

Source: self-elaborated work.

The paper attempts to implement the method and apply it to the needs for the assessment of the effectiveness of the support services of UR. In Figure IV.2 we can see the screenshot of a control sheet illustrating the use of BSC methods.

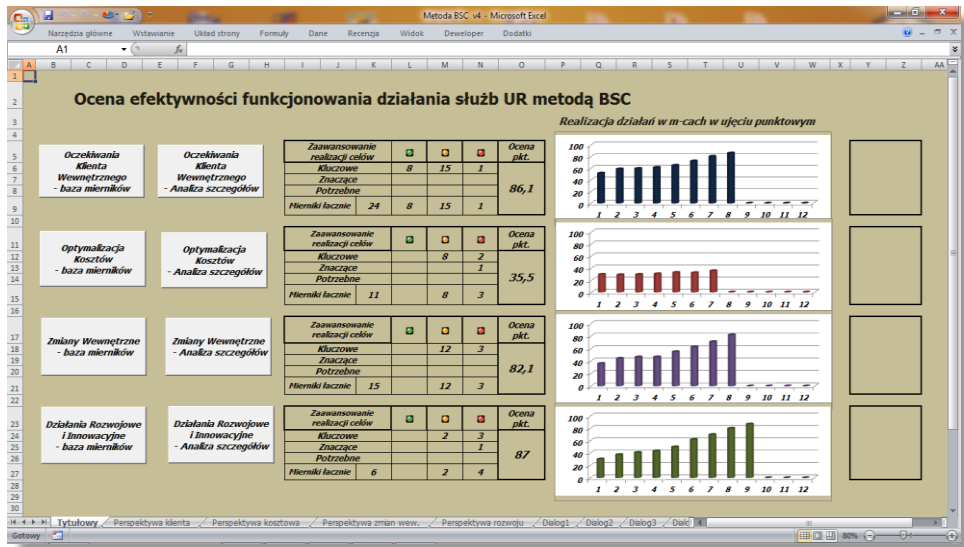


Figure IV.2. Screenshot – a control sheet – BSC method

Source: self-elaborated work.

The proper implementation of this method along with the use of "BSC method" application makes it possible to:

- 1) form a definition and registration of strategic objectives to be implemented in each from four perspectives:
  - a. **identify and define the goals**, define metrics related to the objectives and specifying the unit of measurement, the expected value of the meter, the trend to obtain the expected value,
  - b. **share goals and measures** the impact of the implementation of the strategy related to the activities of UR services to key, meaningful or necessary,
  - c. **record on a monthly value** of each meter along with the size of the graphic signalling deviations from the expected value,

- 2) prepare a detailed analysis of each objective and the meter showing a list of all the collected data together with an evaluation (Fig. IV.2), and in particular:
  - a. The clear extract data from a table of objectives and indicators of the state of implementation of this measure, a graph showing the distribution of the implementation of the meter in months, with trend curve (with the possibility to adapt it using the tools Excel®) and a bar graph showing the change in the value of the meter in months against the expected,
  - b. indicator indicating the evaluation of the implementation of the measure in the three-color scale (green, yellow and red) in order to draw attention to the possible risks,
  - c. Data about the importance of the purpose and the meter, the current value of the meter and with a comment to this value (which is expected in this gauge),
  - d. the level of implementation of the measure by weight points (progress meter in proportion to the weight specified for the expected value),
  - e. build mechanisms necessary to help navigate the application and the selection of objectives and indicators,
- 3) obtain aggregate data to assess progress of the plans in the individual perspectives in line with the method of BSC, and including:
  - a. clear tables summarizing the current situation in each term, and in particular:
    - advancement of attaining objectives and related of these measures broken down into key, meaningful and necessary with signalling the current state of the meter in a three-color scale,
    - the status of implementation of the perspective – total, calculated with assigned weights, taking into account the stage of completion,
    - chart showing the implementation of the approach point (as above) but in a month,
  - b. indicator errors in handling sheet indicating messages error situations that require the intervention of the person handling the application,

c. allowing the system buttons to move to any perspective – the table of objectives and indicators, or to analyse the details (Fig. IV. 3).

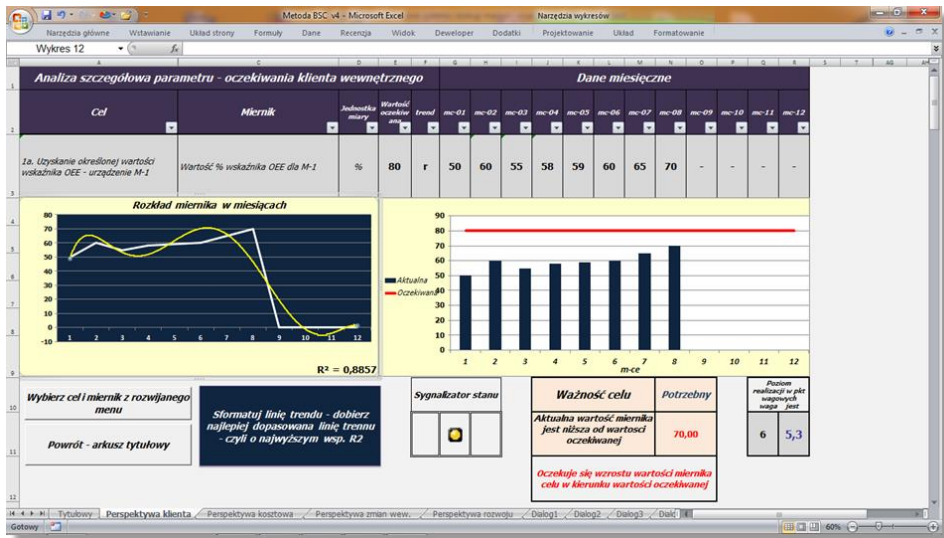


Figure IV.3. An example of detailed data analysis (for the chosen goal and measurement)

Source: self-elaborated work.

A suggestion of the use of prepared application is relatively efficient, but also a relatively simple tool to monitor the situation in the functioning of the UR services using the method, which seems to be the most suitable for this task. Designed sheet after careful thought and define the objectives and measures should be an effective tool for monitoring their implementation and controlling UR services to ensure the implementation of current plans and strategic<sup>59</sup>.

However, it requires a good definition of objectives and determine the accompanying measures, which is not an easy task and can make it difficult to implement. It should, however, take this effort because in the long run will receive as much food for the analytical assessment of what is happening in the field of labour services UR and on this basis we can introduce corrective actions, even if they change the criteria purposes.

<sup>59</sup> Bartochowska D., Ferenc R., Utrzymanie ruchu w niewielkich firmach, Monografie Politechniki Łódzkiej, Łódź 2014.

Selection of the appropriate measures and focus on some key priorities is fundamental and it is not an easy task. It should, however, be examined in detail and thanks to it there would be possible to create extensive material for evaluation and analysis processes UR, and on this basis, improve and implement corrective actions, even if in the future will change the selected parameters.

## Summary

If we want to effectively manage fixed assets in the organization, this activity requires delineation of a long-term strategy in this area UR. Unfortunately, many businesses today is experiencing a crisis of lack of vision "and strategy for UR, measuring its implementation and effectiveness of its use.

The vast majority are just smaller companies. There is no place here for efficient process control, measurement systems selected or comprehensive monitoring.

In practice new concepts of management and the use of deliberate monitoring concept are almost rare. Limited resources, lack of time and centralized position of chief hinder any measurement and control in small and medium-sized enterprises

Maintenance of technical infrastructure businesses require the use of appropriate methods, management tools, and proper organization of the services responsible for its implementation<sup>60</sup>. Rational exploitation of technical facilities, as part of the assets the company is the source of saving raw materials, energy and capital as well as the basic strategy to help you make profits. There is a need and the need for new solutions to monitor the effectiveness of maintenance of small and medium-sized enterprises. The increasing complexity and variability of operating conditions of today's organizations requires constant search for ways to recognize and reduce uncertainty in action, as well as improve the efficiency of all the organization's resources. An example of this search can be an alternative application of the method BSC in small and medium-sized enterprises for the purpose of improving the efficiency of UR.

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<sup>60</sup> Antosz K., Stadnicka D., Mierniki oceny efektywności funkcjonowania maszyn w dużych firmach: wyniki badań <http://www.ein.org.pl/sites/default/files/2015-01-15p.pdf>[retrieved: 28.02.2015].

Controlling the processes of maintenance using the BSC allows you to link data quality with the costs and time of implementation of operations UR and is very helpful in determining the direction of rationalization projects undertaken in the maintenance of traffic as well as a very important factor in the on-going process of rationalization of the organization. Selection sets the BSC indicators, including indicators efficiency mainly depends on the subject to analysis and evaluation. No dissemination and value patterns in companies and the rich diversity of metrics to measure the effectiveness creates difficulties related to the choice of appropriate indicators.

**The idea of the proposed IT support is intended to ensure the monitoring system of a given enterprise and the situation in the operated machine park with a suggestion of methods to assess the effects of measures undertaken by the technical service.** Designed application should effectively support the activities of the technical services company and is addressed to small and medium companies, which have not yet benefited from electronic systems that support these activities. The spreadsheet has its limitations and specificity, which makes it difficult or even impossible to create a very elaborate and multi-threaded applications easy to operate. The application in Excel® may be in many cases a sufficient tool for stimulating action of people employed in the operation of the system's technical and become the beginning to build a system of full surveillance system operated machinery. For using a spreadsheet is also supported by the fact of its popularity and the large number of users who can successfully navigate the application using Excel® capabilities. This should encourage the dissemination of the use of IT support in companies that do not have large tradition and experience in their use.

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## **VII. Project "e-mature" – innovative method of reporting and evaluation data**

**Konrad Szumigaj**

### **1. Issues topic**

On the threshold of the twenty-first century, Poland is faced with the enormity of the challenges of social and technological. From meeting them depends on the competitive position of the country in the international arena, ensuring the material well-being of Polish families, strengthening their economic autonomy and increase the sense of security.

A key task for Polish is the inclusion in the process of building the information age through the use of modern information society technologies, creating conditions to ensure direct access to information, development of public awareness and the development of its intellectual potential and economic. Due to the process of integration with the European Union there is a need to adapt Polish solutions and standards for the emerging modern society based on information technologies<sup>61</sup>.

The idea of an information society is inextricably linked to the Internet (New Lisbon Strategy). Internet – an open computer network worldwide – was created for military and scientific purposes. The enormous possibilities offered by this means of communication in marketing and advertising company, and then – with the spread of low-cost computer hardware, high-speed data processing – as a quick means of communication (e-mail, instant messaging platforms, C2C, and more recently, telephone communications) and easily accessible source of information, educational, professional, tourist, commercial, political and practical, as well as entertainment, however, resulted in a rapid increase in public interest in the Internet as a tool to facilitate daily life (use of banking services, commercial, administrative). On the other hand, became an important part of business: suppliers of information portals, entrepreneurs referring in this way business

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<sup>61</sup> e-Polska – Plan działań na rzecz rozwoju społeczeństwa informacyjnego w Polsce na lata 2001-2006, p. 5.

contacts (B2B platform Business-to-Business and B2C Business-to-Customer), participating and organizing online auctions, providing commercial services (eCommerce ), tourism (eTourism) and others<sup>62</sup>.

Today, the Internet has become a medium that simplifies and replaces many of the activities carried out so far in other, less automated way. More and more tasks related to the functioning of society, it becomes possible to perform using the Internet, it is easy to cite here filing tax returns or sending documents to the Social Insurance. Thanks to modern technology, the activities carried out so far can be done cheaper, faster, automated and in a much more accessible form.

The electronic form of conducting examinations solves most of these problems. First of all, reducing the costs of the examination because beyond a one-time expense for hardware, software and maintenance following exams can already be done with minimal operating costs. Moreover they disappear also the costs to be incurred to pay teachers checking examination papers, because the system itself will analyse and verify the work of providing the student the result immediately after the exam giving person with much greater peace of mind. Moreover, providing questions for examiners units is fully automated and works on the principle of asymmetric encryption key derived from the certificate issued by an authorized certification body. With this approach, the questions arrive safely to the recipient without the possibility of steal. Another element, which allows for electronic examination is to collect statistical data on the duration and number of repetitions of individual steps in the process of solving the exam. With such data will be possible to develop new and better jobs for the test takers, and constantly improve teaching.

Projects co-financed by the European Union under the European Social Fund (in the case of "e-matura" was a Priority III High quality of education system, Measure 3.3 Improving the quality of education) required the beneficiaries to collect data. These data (Table VII.1 and Table VII.2) accounted for most of datas, but they had a big impact on subsequent analysis of the individuals involved in the project.

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<sup>62</sup> Strategia rozwoju społeczeństwa informacyjnego w Polsce na lata 2007-2013, 2007, p. 5.

Table VII.1. Questionnaire participant of the project "e-Matura"  
Data participant who receives support under EFS

1. Last name	
2. Name	
3. Sex	
4. Social security number	
5. Date of birth	
6. Place of birth	
7. Education	
8. Adress	
8.1. Place	
8.2. City/village	
8.3. Street	
8.4. House number	
8.5. Apartment number	
8.6. Postal code	
8.7. Woivodeship	
8.8. County	
9. Mailing address	
9.1. Place	
9.2. Street	
9.3. House number	
9.4. Apartment number	
9.5. Postal code	
9.6. Voivodeship	
10. Contact information	
10.1. Home phone	
10.2. Mobile phone	
10.3. e-mail	
11. judgment of the degree of disability (YES/NO)	
11.1 requires guardian (YES/NO)	
12. Status Labour Market (unemployed, inactive professionally employed *)	
13. Completed training co-financed from EU structural funds (program name, project name, the entity implementing the project, the full name of training, duration of training):	
14. Care for children up to 7 years or caring for a dependent person (YES/NO)	

\* In the case of the status of persons employed should be specified on what basis such exists employment according to the tab. 2 look below.

Table VII.2. Status of the labor market

Employed in	Micro company Means a person employed in enterprise employing from 2 to 9 persons and whose annual turnover and / or annual balance sheet total does not exceed 2 million.
	small company Means a person employed in enterprise employing 10 to 49 persons and whose annual turnover and/or annual balance sheet total does not exceed 10 million.
	medium company Means a person employed in enterprise employing 50 to 249 employees and whose annual annual turnover not exceeding EUR 50 million. And/or annual balance sheet total not exceeding EUR 43 million.
	Big company Means a person employed in the company, which does not qualify for any ww.kategorii companies.
	public administration Means a person employed in the administration state and local government and in their organizational units
	Outside organization Means a person employed in the organization NGO under the Law on public benefit activities and wolantariacie

## 2. Reports

The report has been prepared in such a way that through the obligatory data required by the European Union managed to get as much information to help you prepare not only the correct evaluation of the project but also improve project management system. The reports were prepared for both the recipient and the person managing the project.

### 2.1. The report of the examination tests

After selecting the appropriate tab reports the teacher who supervises – teaches the class the students can view the results of their students online.

## VII. Project "e-mature" – innovative method of reporting and evaluation data

Not only does not have to check the work but also receive an overview of all student data.

A sample report is shown in figure number VII.1.

The screenshot shows a web-based test report interface. At the top, there are dropdown menus for 'Test' (E-matura-kwiecien2013-maturzysci) and 'Tura' (Matura 2013 maturzysci). A button labeled 'Generuj raport "e-matura"' is visible. Below this is a table of students with columns: Id, Imie, Nazwisko, Klasa, wynik, Data, Numer Podejcia, Czas (min). A second table on the right shows columns: Id, Lp, Wynik, Max wynik do uzyskania. A third table at the bottom left shows columns: ID, LP, Średni wynik, Średnia wejść, Średni czas odpowiedzi (sek). A red box highlights a math problem: 'Dany jest ciąg geometryczny:  $a_n = \frac{2}{3^n}$ . Wtedy ilorz ciągu jest równy:' followed by four options: A)  $\frac{2}{3}$ , B)  $\frac{2}{3}$ , C)  $\frac{1}{3}$ , D)  $\frac{4}{27}$ .

Figure VII.1. Test Report

Description of the report:

1. Examination and round for which the report is generated
2. Button to generate a global summary report – a report that compares the results of the school with other schools and is generated in the form of a pdf document.
3. List of students in the school teacher, who wrote selected test and their results, and the time of writing.
4. After selecting a student from the list of point number 3, you can view the partial results.

5. After selecting the partial result included a preview of the questions selected by the student response.
6. Includes the average performance of students in the selected schools from each job for a specific test.

## 2.2. The report student

This report presents the achievements the student and is available from the student panel. Data for this report sets the teacher and the person who manages the project.

Id	Lp	Wynik	Liczba wejść	Czas odpowiedzi
4557	1	0	1	75
4553	2	0	2	135
4541	3	0	2	126
4542	4	0	2	89
4550	5	1	2	212
4534	6	1	2	107
4544	7	0	2	182
4560	8	2	2	181
4530	9	1	2	47
4540	10	1	2	21
4548	11	1	2	60
4539	12	0	2	21
4531	13	1	2	178

Figure VII.2. The report student performance

### Description report

1. Allows you to select class.
2. Allows you to select the person in the class.
3. Allows you to select a test round number and approach the selected person.
4. Shows the partial results selected person.
5. Rearranges the final result and the total time solving exam.
6. In the teacher – List of surveys teacher has the opportunity to fill in the questionnaire assigned to him by the administrator.

In addition, the survey report was created – drawing VII.3 and VII.4.



Figure VII.3. List of surveys teacher

After the start of the survey, the teacher should fill in the questionnaire. After filling in all the questions the teacher should complete the survey by clicking "Finish".



Figure VII.4. Questionnaire

Users who can use the data to various analyses are:

1. Pupils and students of secondary schools.
2. Teachers and teacher of mathematics in secondary schools.

In addition, the use of the product, in particular an extensive reporting system:

- a. The directors of secondary schools for the purpose of diagnosis, the work of teachers and pupils' achievements.
- b. Local authorities supervising the work of schools.
- c. Education authorities supervising the work of schools, for example CKE, OKE, Departments of Education, etc. ORE.
- d. Universities.
- e. Parents of students.

### **3. The method of collecting the data in the computer system of the e-baccalaureate and the possibility of their analysis**

The database in the information system e-baccalaureate is a typical database systems OLTP (On-Line Transaction Processing). It is optimized to ensure concurrency and simultaneity – allow simultaneous examination as the largest group of users. Many users of the system to answer questions which will collect answers and additional information such as response time. For this purpose, the data are stored in a standardized database. Questions, possible answers, answers, exam results, the data the students are in separate tables related relationships. In addition, to ensure maximum flexibility of the system a lot of information is stored in tables with attributes. This allows fast – without changing the model database – storage of additional information on the question, the user like.

Distribution of information on many tables, which provides high concurrency and attribute tables cause difficulties in data analysis. For example, selecting information about students and the time spent answering questions from the test results in the need to link multiple tables using the SQL language. Therefore, for the analysis of the collected data was prepared table, which stores data collected for analysis. For the tests carried out before June 2012 data granularity with which they are stored in the analysis are presented in Table VII.3.



Table VII.3. Selected column of view – combined with multiple tables

Social Security number	Number of School	Number of class	Number of exam	The total number of points	Test time	Test name	Number of test	Number of question	Number of point	Time question	Entry question
9XXXXXXXXXX	XX	XX	7XXX	26	44	Kwiecień 2012	139	2184	1	246	1
9XXXXXXXXXX	XX	XX	7XXX	26	44	Kwiecień 2012	139	2185	1	36	1
9XXXXXXXXXX	XX	XX	7XXX	26	44	Kwiecień 2012	139	2186	0	115	1
9XXXXXXXXXX	XX	XX	7XXX	26	44	Kwiecień 2012	139	2187	0	15	1
9XXXXXXXXXX	XX	XX	7XXX	26	44	Kwiecień 2012	139	2188	0	89	2

Source: own.

For the purposes of this publication, social security number, the exam to school and class ID in Table VII.3 have been changed in order to prevent identification of the examinee. The Social Security database, id exam and other values are kept unchanged. The data are generated CSV enabling their further processing with a spreadsheet, for example, using Microsoft Excel. With the development of the project is changing the relational model database, which was designed among other things to support multiple versions of questions, open questions and multimedia. Because of the changes it has become impossible to generate a query that generates the resulting vector described above. Each exam requires a specific set of SQL queries. As a result of this work for the completed exams data has been generated in the form of the above vector. The data presented in Table 1 are the basis for analysis and conclusions. Size collected it can be analysed in terms of dimensions, such as:

- school,
- class,
- region,
- the type of school,
- answers to questionnaires.

For all exams prepared for analysis are stored further details of every "input" in question:

- The time spent in an "entrance",
- Information is answered in the "input" is the correct answer.

Thanks to the preparation of the data in the form of data from Table VII.3, it is possible to analyse data in accordance with the techniques of hiding under the name of Business Intelligence.

A dynamic for change, however, give a real chance that Poland will be able to achieve the objective pursued by the strategy "Europe 2020", namely the share of people with higher education in the population aged 30-34 will increase to at least 40% in the next 10 years<sup>63</sup>.

Given pursued by CKE initiative "e-assessment" involving decoupling during external examinations of the physical presence of examiners seems fully justified that also this body will be user of the product and will be able to use the system in order to introduce the tasks of examination, results reading and collecting statistical data. In the school year 2012/2013 to carry out the matriculation examination in mathematics allocated 15 million zł.

## 4. Reporting

Current database management systems provide many mechanisms for analysing the collected data. Databases store more and more data, the analysis of which – to make decisions, reasoning, search depending contained therein – is becoming increasingly difficult. Software providers enrich the mechanisms of data analysis – this applies to both the SQL and additional software that comes with database servers. These mechanisms can successfully be used for reporting and inference systems, remote examination by analysing the collected results of answers, time spent on the task. The e-baccalaureate is not only for examination with open and closed questions, but also for the diagnosis of math students<sup>64</sup>.

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<sup>63</sup> *Spółeczeństwo w drodze do wiedzy – raport o stanie edukacji 2010*, Instytut Badań Edukacyjnych, 2011, p. 33.

<sup>64</sup> S. Wiak, D. Jeske, M. Krasuski & R. Stryjek, *Modern distance examination using the latest technology – the E-matura project*. 2nd World Conference on Technology and Engineering Education, Ljubljana, Slovenia, 5-8 September 2011.

The information system e-Baccalaureate is based on Database Management System Microsoft SQL Server 2008 R2, so we will focus on the possibilities of data analysis using database servers from Microsoft.

Analysis of data collected in databases. In database systems analysis of the collected data is possible:

- Systems OLTP (On-Line Transaction Processing), which are designed for efficient transaction processing during the current business system. The aim of OLTP systems to store data while ensuring concurrency and set the number of transactions (number of transactions per unit of time – usually a second).
- Systems OLAP (OnLine Analytical Processing), which are used for multidimensional data analysis, inter alia, for the following purposes: Analyses of historical data, Analyses of the current data, Analyses of trends about the financial health and profitability of the company, Management of human resources and inventory, Anticipation of trends, Predictions about the reactions of customers, Many of the others. Management of human resources and inventory, Anticipation of trends, Predictions about the reactions of customers, Many of the others. One of the elements serving more comfortable analyzing data are data warehouses. A data warehouse is a large set of data to support decision-making. Features Data Warehouse:
  - stability data – data is not deleted. It is stored not only the current version of the record, but the story changes. For this purpose different methods of storing the history of changes: Always keep a complete history of changes and modification date, or time, to when the force version of the record, Always keep only the previous record – and the date when it was changed to the current value, used is the dimension of time.
  - each stored information has a time stamp of a specific particle size, for example: by day, month, year month, year for only one year by year quarter. It is possible to store data at the same time at different levels of detail – grain.
  - the harmonization of data from different sources – other operational bases, text files and other data warehouses, spreadsheets.
  - the data are organized thematically – the so-called data marts (Data marts).

- update the data in the data warehouse is not done on a regular basis – it is carried out periodically at a period of time.<sup>65</sup>

Selected benefits of data warehousing:

- Analysis data are executed in a server operation – not interfering with the operations of the system, for example in the case of handling cash store.
- Access to historical data and records the history of changes (even a dozen or more years).

The information system e-matura in the course of the examination collects not only answers, but also the time it took for the student to answer the question, how many times you come back to the question that the answer turned out to be correct (if the student changed his answer in the job), how long it took the student solution to the test. The collected data can therefore be used not only to check the student's test and evaluation issue, but also a detailed analysis in terms of reach even for the most accurate analysis of the "paper work Matura". Traditional exams do not give answers to questions such as: how long it took the student to answer the question, or how often the student returned to this question. What's more, the information is available immediately after the exam<sup>66</sup>. The method of collecting the data in the information system e-matura and the possibility of their analysis.

The database in the information system e-matura is a typical database systems OLTP (On-Line Transaction Processing). It is optimized to ensure concurrency and simultaneity – allow simultaneous examination as the largest group of users. Many users of the system to answer questions which will collect answers and additional information such as response time. For this purpose, the data are stored in a standardized database. Questions, possible answers, answers, exam results, the data the students are in separate tables related relationships. In addition, to ensure maximum flexibility of the system a lot of information is stored in tables with attributes. This allows fast – without

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<sup>65</sup> J. Surma, Business Intelligence – systemy wspomaganie decyzji biznesowych, PWN, 2009.

<sup>66</sup> S. Wiak, D. Jeske, M. Krasuski, R. Stryjek, *Komputerowe wspomaganie diagnozy matematycznej uczniów przy użyciu Business Intelligence w systemie informatycznym e-matura*, rozdział w monografii: *System informatyczny zdalnego testowania wiedzy na przykładzie projektu e-matura z matematyki*, Wydawnictwo Naukowe PWN.

changing the model database – storage of additional information on the question, the user like.

Distribution of information on many tables, which provides high concurrency and attribute tables cause difficulties in data analysis. For example, selecting information about students and the time spent answering questions from the test results in the need to link multiple tables using the SQL language. Therefore, for the analysis of the collected data was prepared table, which stores data collected for analysis. For the tests carried out before June 2012 data granularity with which they are stored in the analysis are presented in Table VII.3.

The e-matura can be used to diagnose the merits, using the collected data. By diagnosing we understand mathematical knowledge and mathematical skills – it may take place for the student, class, school, type of school, city, region or country<sup>67</sup>. Inference is done for three groups of users. The first group of target users applying for diagnosis are mathematical authorities – Ministry of Education, the Central Examination Commission, superintendents and school boards. The result of inference are the answers to questions such as:

- What is the current level of knowledge of students in a given subject (currently for math)?
- In what types of schools is the lowest level of knowledge.
- In which regions of Polish science students (high school graduates) is the smallest and the largest?
- Which areas of knowledge makes the students the most trouble.
- How student performance affects the size of the village?<sup>68</sup>
- The second group of target users are teachers. Each of the teachers after logging into the system has access to:
  - diagnosis program areas that require additional work on the class level and for each of the students individually. The teacher has the ability to assign tasks to students on the basis of e-tutoring module (module that is discussed later in this chapter);

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<sup>67</sup> S. Wiak, D. Jeske, M. Krasuski, Rafał Stryjek, *Distance Examination with Computer Aided Analysis - e-matura Platform*, Lecture Notes in Artificial Intelligence.

<sup>68</sup> S. Wiak, D. Jeske, M. Krasuski & R. Stryjek, *Computer-aided mathematical analysis of graduates – Business Intelligence in the e-matura project*. 2nd World Conference on Technology and Engineering Education, Ljubljana, Slovenia, 5-8 September 2011.

- information and professional level students presented against average in the country or in the region. The comparison can take place within the same type of school, in the same city, and regardless of its type;
  - current control increases the knowledge of individual students.
- The teacher has access to diagnosis mathematical only their students.

The third group of users are students, who have access to:

- knowledge areas that require additional work,
- information on the progress of science.

A collection of selected parameters that are used in the analysis and presentation of results of educational attainment is as follows: easy task/test – the ratio of the number of points obtained by the student/s to a maximum number of points available for the task or test. The following example will return the student ease of the test. It is also possible to obtain easy task by adding to the grouping question id, gap (the area of variability) – the difference between the highest and the result obtained by the group of students during the test, variance – arithmetic mean of the squared deviations of the results obtained by the students from their mean value, standard deviation – a measure of the dispersion of results, allowing to identify a range of results<sup>69</sup>.

### **Analysis, reasoning and reporting module e-tutoring**

Module e-tutoring can:

- assigning tasks to do at home as homework,
- independent work of students by solving tasks from the area who have chosen or the whole curriculum,
- organization test is created by the teacher. It is made available only during certain hours and can be password protected – so that access is possible only after the receipt of the additional password,
- organization of competitions – test as in the case tests only available at certain times.

In the case of e-tutoring tasks that are not resolved under the supervision of a teacher they can be solved – hence the data they collect can be used to apply in a limited way. They are reasonable analysis of data collected during

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<sup>69</sup> [www.cke.edu.pl](http://www.cke.edu.pl), *Wyniki szkół ze sprawdzianów i egzaminów 2002-07 oraz matury, 2007.*

tests and during competitions conducted through the platform. What's more, the system based on the collected data shows the student information, which areas require additional effort. The teacher receives information about the correctness of the task by the students, also about who has solved homework. The form of the report presents the teacher to the test for the student:

- how much time a student spent on a given question,
- which turned out to be the most difficult task,
- how many times the student back to this question,
- total score.

About the test/homework is presented a report to the class or school including:

- the average number of points for a task,
- average time spent on the test solution,
- average result for the test.

The teacher can also monitor the progress of individual students, whole class or school and how they are changing their progress over time. This is done with the division into individual arts of the programs.

Uczniowie										
Id	Imie	Nazwisko	Klasa	wynik	Data	Numer Podejśc	Czas (min)	Id	Lp	wynik
13472			2A	43	2012-12-13	Podejście 1	97	3933	1	1
13473			2A	45	2012-12-13	Podejście 1	147	3943	2	5
13474			2A	27	2012-12-13	Podejście 1	98	3930	3	1
13475			2A	32	2012-12-13	Podejście 1	116	3931	4	1
13476			2A	27	2012-12-13	Podejście 1	111	3938	5	5
13477			2A	39	2012-12-13	Podejście 1	158	3902	6	1
13478			2A	46	2012-12-13	Podejście 1	64	3911	7	1
13479			2A	42	2012-12-13	Podejście 1	126	3928	8	1

Figure VII.5. Report for test

119	3909	14	0			
73	3939	15	3			
	3916	16	1			

Wzór na n-ty wyraz ciągu ma postać  $a_n = (-1)^2 \cdot n + 3$ .

Ciąg  $(a_n)$

A) jest arytmetyczny

B) jest geometryczny

C) jest naprzemienny

D) nie jest geometryczny i nie jest arytmetyczny

Figure VII.6. shows the system given the answer, for which the report shows

**Raport testu**

Test: Uczeń

Klasa: 2A

ID	Imię	Nazwisko	Id	Lp	Wynik	Liczba wejść	Czas odpowiedzi
13470	██████████	██████████	3934	1	1	3	60
13471	██████████	██████████	3929	2	1	10	203
13472	██████████	██████████	3897	3	1	8	130
13473	██████████	██████████	3910	4	0	9	95
13474	██████████	██████████	3911	5	1	10	129
			3935	6	1	14	145
			3940	7	2	18	291
			3917	8	1	13	196
			3909	9	1	22	192
			3928	10	1	16	135
			3943	11	2	29	513
			3915	12	1	17	249
			3913	13	0	15	82

Test: Proba\_matura\_grudzien\_2012

Tura: Matura grudzień 2012

Podjęcie: Podjęcie 1 2012-12-13 09:17:00

Wynik końcowy: 43

Łączny czas rozwiązywania: 97

Figure VII.7. Report for students



### The report in the form of "paper"

The collected data also allow you to generate a report to the printed version. Extensive reports are automatically generated, printed and sent to teachers in individual schools.

## 5. The following example reports on the test e-matriculation examination in mathematics consists of two parts:

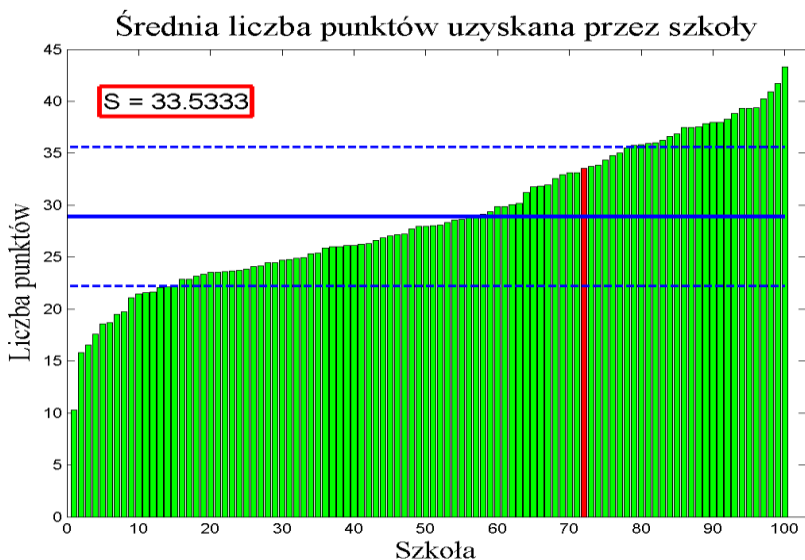
Part 1: the average results obtained by all schools – general and broken down into individual tasks.

Part 2: Specific results obtained by your students (score and the number of views of individual tasks).

On the charts below the red color corresponds to a particular school. Other schools were green.

At the same time it should be noted, each school receives ONLY YOUR OWN report.

The average number of points-all schools: **28.90**, standard deviation: **6.68**



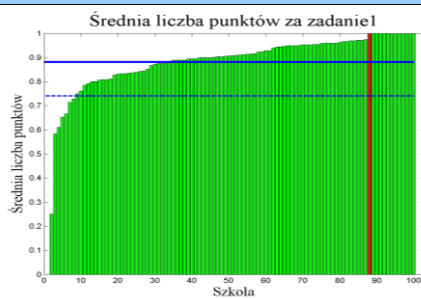
Number of task	Issue/chapter	Number of points for the task	The average result of all schools	The average score in your school
Task 1	Podzielność liczb całkowitych	1	0,90	1
Task 2	Obliczenia procentowe	1	0,93	1
Task 3	Rozwiązywanie układów równań	1	0,78	1
Task 4	Wzajemne położenie prostych	1	0,60	0,8
Task 5	Wzajemne położenie prostych	1	0,45	0,6
Task 6	Znajdowanie równania prostej	1	0,63	0,9
Task 7	Równanie z wartością bezwzględną	1	0,69	0,933
Task 8	Dziedzina wyrażenia wymiernego	1	0,32	0,433
Task 9	Równanie wymierne	1	0,29	0,167
Task 10	Rozwiązywalność układu równań	1	0,71	0,767
Task 11	Zadanie z treścią – wnioskowanie	1	0,92	0,967
Task 12	Zadanie z treścią – wnioskowanie	1	0,90	0,933
Task 13	Zadanie z treścią – wnioskowanie	1	0,51	0,3
Task 14	Zadanie z treścią – wnioskowanie	1	0,56	0,8
Task 15	Rozwiązywanie nierówności – wnioskowanie	1	0,32	0,4
Task 16	Nierówność z wartością bezwzględną	1	0,38	0,267
Task 17	Przekształcanie wyrażeń algebraicznych	1	0,73	0,967
Task 18	Obliczenia procentowe	1	0,93	0,967
Task 19	Obliczenia procentowe – zadanie z treścią	1	0,79	0,8
Task 20	Obliczenia procentowe	1	0,91	0,967
Task 21	Obliczenia procentowe	1	0,77	0,833
Task 22	Okrąg opisany na trójkącie – związki miarowe	1	0,60	0,467
Task 23	Kula wpisana w sześcian – związki miarowe	1	0,57	0,7
Task 24	Objętość i pole powierzchni prostopadłościanu – związki miarowe	1	0,61	0,733
Task 25	Elementy statystyki – średnia z próby	1	0,73	0,9
Task 26	Nierówność kwadratowa	2	1,34	1,333
Task 27	Funkcja kwadratowa – postać kanoniczna	2	1,09	1,4
Task 28	Wyrażenia wymierne – sprowadzanie do wspólnego mianownika	2	0,36	0,167
Task 29	Działania na wielomianach	4	2,10	2,9
Task 30	Własności funkcji – wnioskowanie z wykresu	5	4,17	4,333
Task 31	Trapez – związki miarowe	3	1,96	2,7
Task 32	Równanie kwadratowe z parametrem – wnioskowanie	3	0,86	0,767
Task 33	Pole i obwód trójkąta jako funkcja długości boku	2	0,66	0,7
Task 34	Istnienie figur płaskich o zadanych własnościach	2	0,70	0,633

## VII. Project "e-mature" – innovative method of reporting and evaluation data

### Task 1

Wskaż liczbę podzielną przez 6.

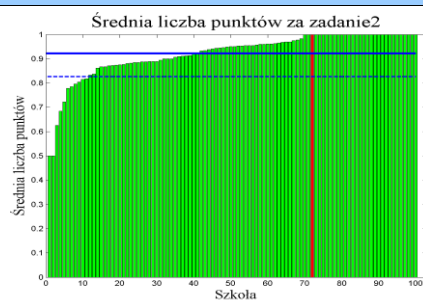
- A) 17861786
- B) 1234123412341234
- C) 15713571357
- D) 248248248



### Task 2

95% z liczby 140 wynosi

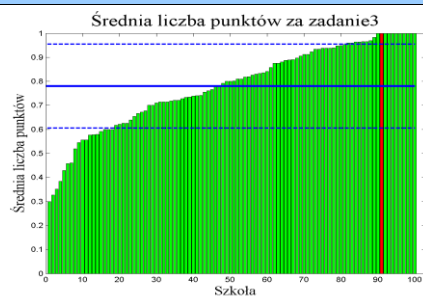
- A) 133
- B) 147
- C) 7
- D) 136



### Task 3

Rozwiązaniem układu równań  $\begin{cases} x + 2y = 7 \\ x - y = -2 \end{cases}$  jest

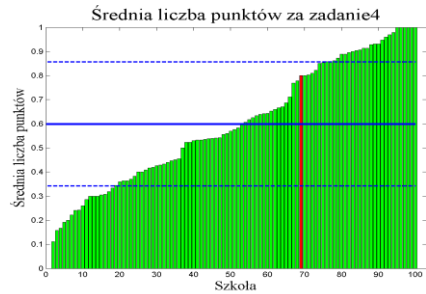
- A)  $x = 3, y = 1$
- B)  $x = -11, y = 9$
- C)  $x = 0, y = 2$
- D)  $x = 1, y = 3$



### Task 4

Wskaż równanie prostej równoległej do  $y = -2x + 3$

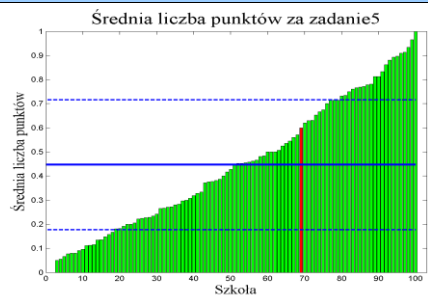
- A)  $y = 3x - 2$
- B)  $y = -\frac{1}{2}x + 3$
- C)  $y = -2x + 7$
- D)  $y = \frac{1}{2}x + 4$



### Task 5

Wskaż równanie prostej prostopadłej do  $y = -\frac{1}{3}x + 4$

- A)  $y = 3x + 5$
- B)  $y = -\frac{1}{3}x - 4$
- C)  $y = -3x + 4$
- D)  $y = -3x + 2$

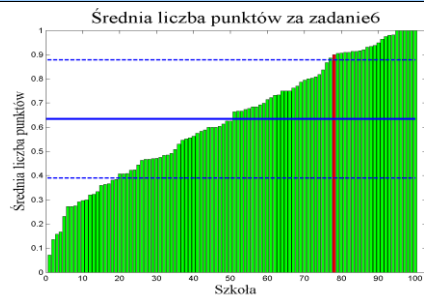


### Task 6

Wskaż równanie prostej przechodzącej przez punkty

$A(0, 3), B = (1, 5)$

- A)  $y = x + 3$
- B)  $y = x + 6$
- C)  $y = 2x + 3$
- D)  $y = 3x + 5$

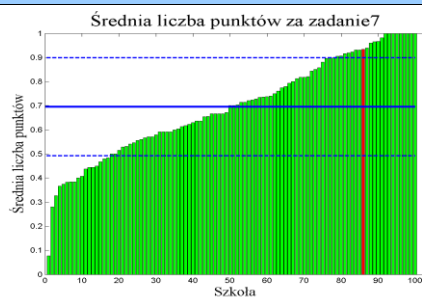


## VII. Project "e-mature" – innovative method of reporting and evaluation data

### Task 7

Rozwiązaniem równania  $|x - 3| = 1$  jest

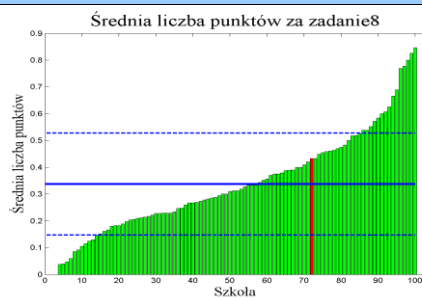
- A) tylko  $x = -4$
- B) tylko  $x = 2$
- C)  $x = -2, x = -4$
- D)  $x = 2, x = 4$



### Task 8

Dziedzina wyrażenia wymiernego  $\frac{x-3}{x^2+9}$  jest

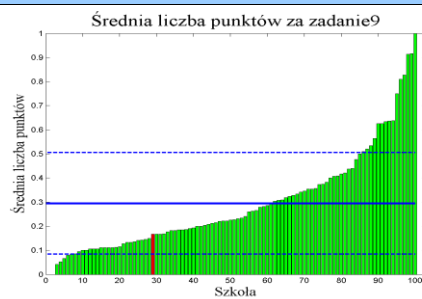
- A) zbiór pusty
- B) zbiór liczb rzeczywistych
- C) zbiór liczb rzeczywistych z wyłączeniem  $x = 3$
- D) zbiór liczb rzeczywistych z wyłączeniem  $x = 3$  i  $x = -3$



### Task 9

Rozwiązaniem równania  $\frac{x-6}{x^2-36} = 0$

- A) jest zbiór pusty
- B)  $x = 6$
- C)  $x = -6$
- D) jest nieskończenie wiele liczb

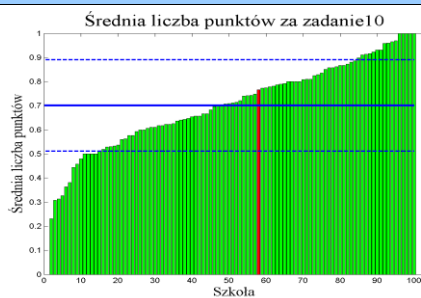


### Task 10

Układ równań 
$$\begin{cases} x + 2y = 6 \\ 2x + 4y = a \end{cases}$$

ma rozwiązanie wtedy i tylko wtedy, gdy

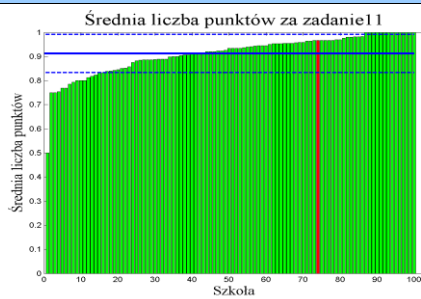
- A)  $a = 6$
- B)  $a = 12$
- C)  $a = 10$
- D)  $a = -12$



### Task 11

Mama i tata mają razem 84 lata. Tata jest starszy od mamy o dwa lata. Ich córka Ania urodziła się w 2000 roku, gdy tata miał 31 lat. W którym roku tata będzie miał 67 lat?

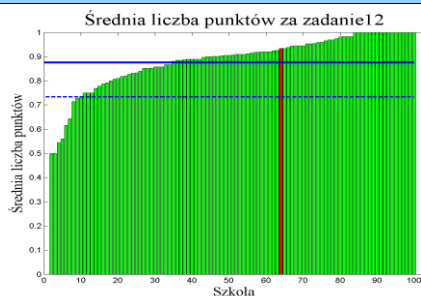
- A) 2035
- B) 2036
- C) 2037
- D) 2038



### Task 12

Mama i tata mają razem 84 lata. Tata jest starszy od mamy o dwa lata. Ich córka Ania urodziła się w 2000 roku, gdy tata miał 31 lat. W którym roku urodziła się mama?

- A) 1967
- B) 1968
- C) 1970
- D) 1971

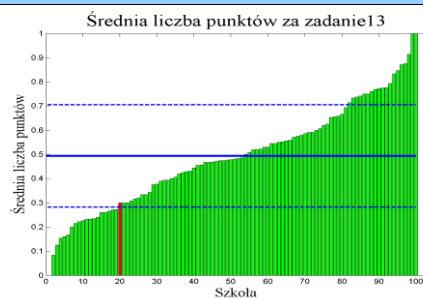


## VII. Project "e-mature" – innovative method of reporting and evaluation data

### Task 13

Mama i tata mają razem 84 lata. Tata jest starszy od mamy o dwa lata. Ich córka Ania urodziła się w 2000 roku, gdy tata miał 31 lat. W którym roku dojdzie do sytuacji, że gdyby Ania była o rok starsza, to miałyby dwa razy mniej lat niż mama

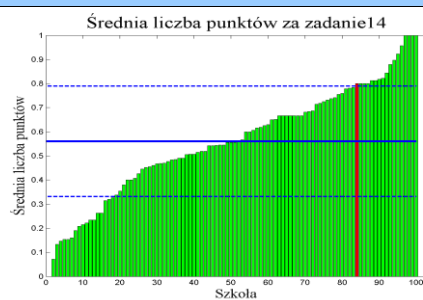
- A) 2025
- B) 2026
- C) 2027
- D) 2028



### Task 14

Mama i tata mają razem 84 lata. Tata jest starszy od mamy o dwa lata. Ich córka Ania urodziła się w 2000 roku, gdy tata miał 31 lat. Za ile lat mama, tata i Ania będą mieli razem 111 lat.

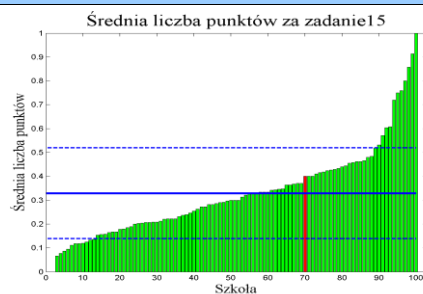
- A) 5
- B) 10
- C) 15
- D) 20



### Task 15

Rozwiązaniem nierówności  $x^2 \leq -x^2$  jest

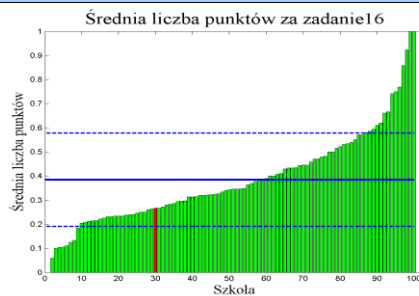
- A) zbiór pusty
- B) zbiór wszystkich liczb rzeczywistych
- C) zbiór liczb nieujemnych
- D) tylko  $x = 0$



### Task 16

Rozwiązaniem nierówności  $|x - 3| > -1$  jest

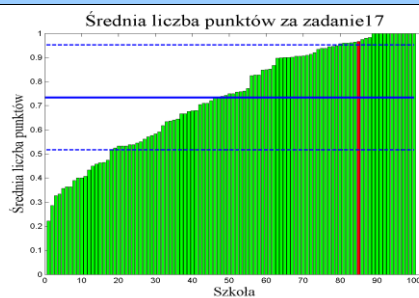
- A) zbiór pusty
- B) zbiór wszystkich liczb rzeczywistych
- C)  $(-2, 4)$
- D)  $(-\infty, 2) \cup (4, \infty)$



### Task 17

Wskaż wyrażenie równoważne wyrażeniu  $(2a^2 - 3b^2)^2$

- A)  $2a^2 - 12a^2b^2 + 3b^2$
- B)  $2a^4 - 12a^2b^2 + 3b^4$
- C)  $4a^2 - 6a^2b^2 + 9b^2$
- D)  $4a^4 - 12a^2b^2 + 9b^4$



### Task 18

Wiadomo, że 30% pewnej liczby wynosi 18. Jej 70% to

- A) 60
- B) 42
- C) 18
- D) 78



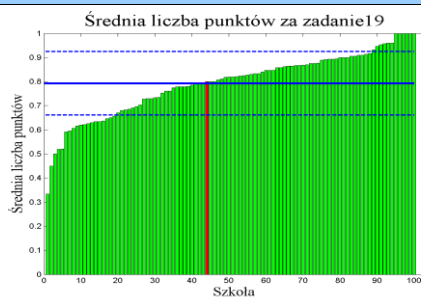


## VII. Project "e-mature" – innovative method of reporting and evaluation data

### Task 19

W niedzielnych wiadomościach podano: "W dniu dzisiejszym cena benzyny była najwyższa w tym roku". Następnego dnia - w poniedziałek cena benzyny spadła o 0,3%, a we wtorek wzrosła o 0,3%. W którym z tych trzech dni cena benzyny była najwyższa?

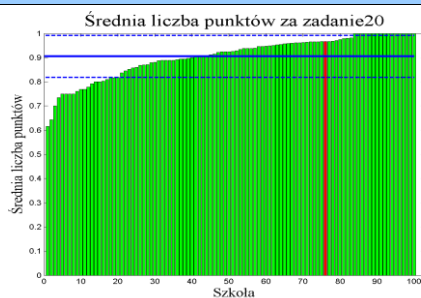
- A) w niedzielę
- B) w poniedziałek
- C) we wtorek
- D) nie da się określić w którym dniu cena była najwyższa.



### Task 20

Wiadomo, że 20% pewnej liczby wynosi 40. Jaka to liczba?

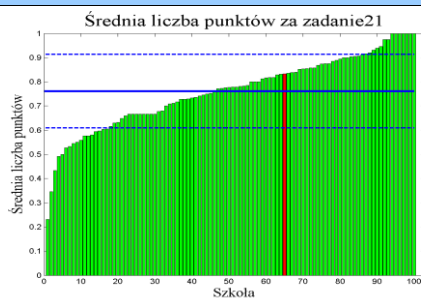
- A) 8
- B) 2
- C) 80
- D) 200



### Task 21

Ile procent liczby 20 stanowi liczba 80.

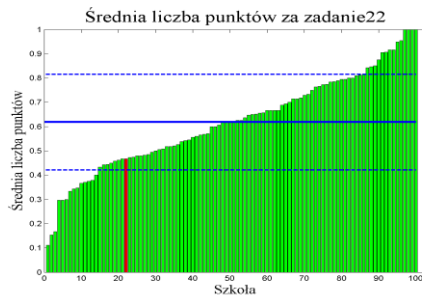
- A) 400%
- B) 40%
- C) 25%
- D) 160%



### Task 22

Promień okręgu opisanego na trójkącie prostokątnym wynosi 5. Wtedy długości przyprostokątnych są równe

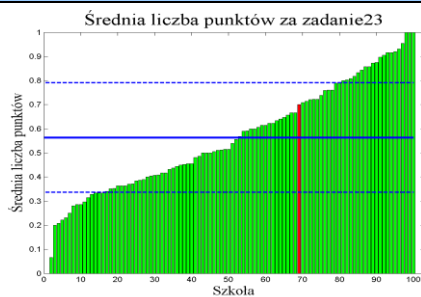
- A) 3, 4
- B) 2, 3
- C) 6, 8
- D) 1, 9



### Task 23

Objętość kuli wpisanej w sześcian wynosi  $36\pi$ . Wtedy pole powierzchni całkowitej sześcianu jest równe

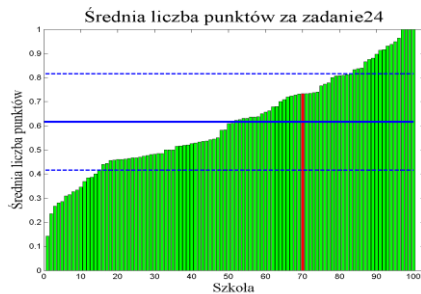
- A) 216
- B) 108
- C) 36
- D) 72



### Task 24

Pole powierzchni całkowitej sześcianu jest równe 18. Objętość tego sześcianu wynosi

- A)  $\sqrt{3}$
- B)  $3\sqrt{3}$
- C) 27
- D) 9

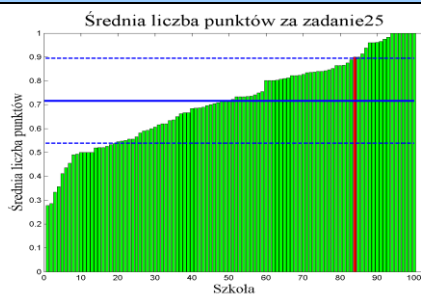


## VII. Project "e-mature" – innovative method of reporting and evaluation data

### Task 25

Dane są liczby: 2,2,2,2,3,1,3,1,x dla których średnia arytmetyczna jest większa niż 2. Wtedy

- A)  $x < 2$
- B)  $x = 2$
- C)  $x > 2$
- D)  $x$  jest dowolną liczbą

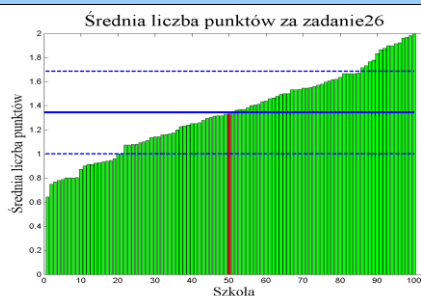


### Task 26

Uzupełnij.

Rozwiązaniem nierówności:  $-x^2 + 7x - 6$    $> 0$

jest zbiór  $x \in (1, \text{  })$ .



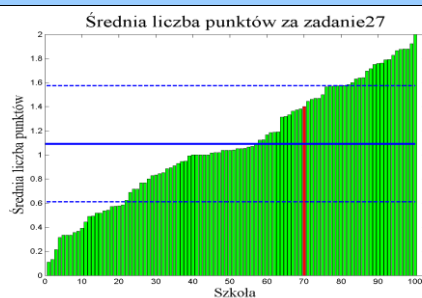
### Task 27

Dana jest funkcja kwadratowa

$$f(x) = x^2 + 6x + 7.$$

Podaj jej postać kanoniczną.

$$f(x) = (x - \text{  })^2 + \text{  }$$

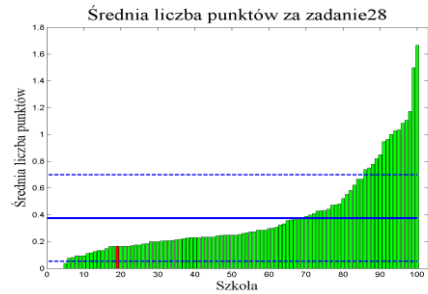


### Task 28

Uzupełnij przekształcenie dla  $x \neq 2$  i  $x \neq -2$ .

$$\frac{x}{x-2} - \frac{1}{x^2-4} + \frac{1}{x+2} =$$

$$= 1 + \frac{1}{x^2-4} \cdot (\text{dropdown} \cdot x + \text{dropdown})$$



### Task 29

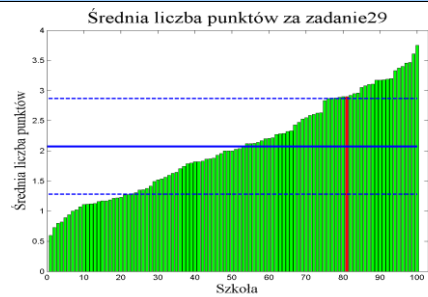
Dane są dwa

wielomiany:  $W(x) = x^3 + x + 1$ ,  
 $G(x) = x^2 - x + 2$ .

A. Iloczyn wielomianów  $W(x) \cdot G(x)$   
 jest stopnia

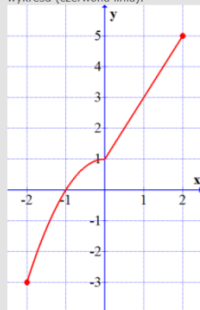
B.  $W(x) - 2G(x) =$   
 $x^3 - 2x^2 + \text{dropdown} x + \text{dropdown}$

C. Równanie  $W(x) = 1$  w zbiorze liczb  
 rzeczywistych

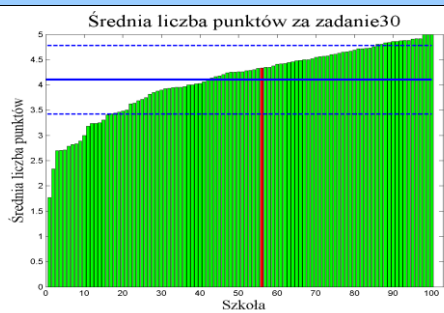


### Task 30

Funkcja  $y = f(x)$  dana jest za pomocą poniższego wykresu (czerwona linia).



- A. Miejscem zerowym funkcji  $f$   
 jest  $x = \text{dropdown}$
- B. Funkcja  $f$  jest
- C.  $f(\text{dropdown}) = 3$
- D. Dziedzina funkcji  $f$  jest zbiór  
 $\langle \text{dropdown}, \text{dropdown} \rangle$



## VII. Project "e-mature" – innovative method of reporting and evaluation data

### Task 31

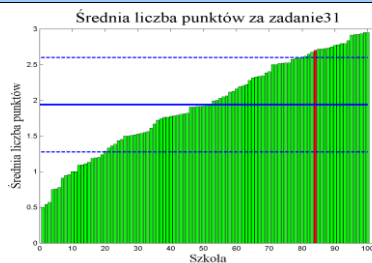
Dany jest trapez równoramienny ABCD, którego kąt ostry wynosi  $45^{\circ}$ , a podstawy mają odpowiednio długości 4 i 8.

Wtedy

A. Kąt rozwarty trapezu ABCD ma miarę  stopni.

B. Pole trapezu ABCD wynosi

C. Długość jednego ramienia trapezu ABCD wynosi   $\cdot \sqrt{2}$



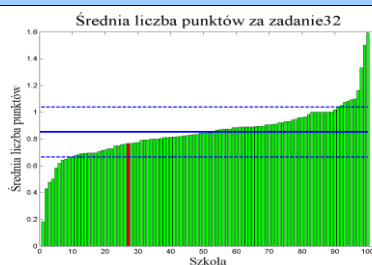
### Task 32

Dane jest równanie kwadratowe

$ax^2 + ax + c = 0$ , które ma dwa różne pierwiastki i  $a > 0$ . Wtedy

A. Średnia arytmetyczna pierwiastków równania jest równa .

B.  $a$    $\cdot c$



### Task 33

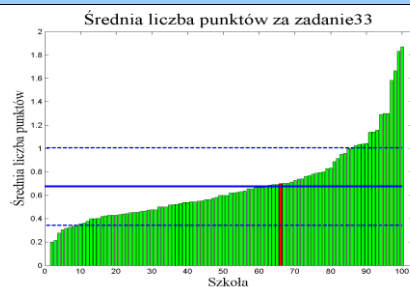
Dany jest trójkąt równoramienny, którego podstawa ma długość  $x$  ( $x > 0$ ). Funkcja wartości pola powierzchni trójkąta wyraża się wzorem  $f(x) = \frac{x^2}{3}$ . Wtedy

A. Funkcja wartości wysokości trójkąta w zależności od długości podstawy trójkąta  $x$  wyraża się wzorem:

$$g(x) = \text{input} \cdot \frac{x}{3}$$

B. Funkcja wartości obwodu trójkąta w zależności od długości podstawy  $x$  wyraża się wzorem:

$$h(x) = \text{input} \cdot \frac{x}{3}$$

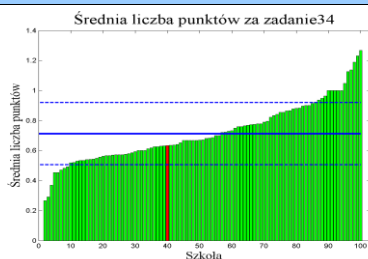


### Task 34

Rozważmy trójkąt ABC, którego długości boków są kolejnymi liczbami naturalnymi.

A. Wtedy  $k > \text{input}$ , gdzie  $k$  oznacza długość najkrótszego boku.

B.  o własności podanej w zadaniu.



## **Detailed results of students**

Attention:

- The characters "\ n" in the line score means that the student did not give any response in a given task.
- The column "Date / Time" determines the start time of the e-exam.
- Line marked with the abbreviation "Disp". Is the number of views the task.

Lp.	Last name and name	Date/time	Info	Task/Score/Time/views																												Score						
1.	.....	2012-04-20 08:27	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 1	z5 1	z6 1	z7 1	z8 1	z9 1	z10 1	z11 1	z12 1	z13 0	z14 1	z15 1	z16 1	z17 1	z18 1	z19 0	z20 1	z21 2	z22 1	z23 1	z24 1	z25 1	z26 2	z27 2	z28 0	z29 4	z30 4	z31 5	z32 9	z33 3	z34 3	Together 41 60
2.	.....	2012-04-20 08:14	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 1	z5 0	z6 1	z7 1	z8 0	z9 0	z10 1	z11 1	z12 1	z13 1	z14 0	z15 2	z16 1	z17 1	z18 1	z19 1	z20 1	z21 1	z22 1	z23 0	z24 0	z25 1	z26 1	z27 0	z28 1	z29 6	z30 4	z31 5	z32 3	z33 3	z34 0	Together 28 55
3.	.....	2012-04-20 08:28	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 2	z5 1	z6 1	z7 2	z8 1	z9 1	z10 2	z11 1	z12 1	z13 1	z14 1	z15 0	z16 2	z17 1	z18 1	z19 1	z20 1	z21 1	z22 2	z23 1	z24 1	z25 2	z26 2	z27 1	z28 3	z29 2	z30 8	z31 5	z32 4	z33 6	z34 2	Together 25 65
4.	.....	2012-04-20 09:59	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 0	z5 1	z6 1	z7 1	z8 0	z9 0	z10 1	z11 1	z12 1	z13 1	z14 0	z15 1	z16 1	z17 1	z18 1	z19 1	z20 1	z21 0	z22 0	z23 2	z24 1	z25 1	z26 2	z27 0	z28 2	z29 5	z30 5	z31 5	z32 3	z33 3	z34 3	Together 30 54
5.	.....	2012-04-20 08:14	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 2	z5 0	z6 1	z7 1	z8 0	z9 0	z10 1	z11 1	z12 1	z13 1	z14 1	z15 1	z16 1	z17 1	z18 1	z19 0	z20 1	z21 0	z22 1	z23 1	z24 1	z25 0	z26 2	z27 2	z28 2	z29 4	z30 5	z31 3	z32 2	z33 1	z34 1	Together 25 54
6.	.....	2012-04-20 08:27	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 1	z5 1	z6 1	z7 1	z8 1	z9 2	z10 1	z11 1	z12 1	z13 0	z14 1	z15 1	z16 1	z17 1	z18 1	z19 1	z20 1	z21 1	z22 1	z23 1	z24 1	z25 1	z26 2	z27 2	z28 2	z29 4	z30 3	z31 5	z32 3	z33 1	z34 0	Together 40 51
7.	.....	2012-04-20 09:51	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 2	z5 0	z6 1	z7 1	z8 0	z9 2	z10 0	z11 1	z12 1	z13 1	z14 0	z15 1	z16 2	z17 1	z18 0	z19 1	z20 1	z21 1	z22 0	z23 1	z24 2	z25 3	z26 2	z27 0	z28 2	z29 8	z30 5	z31 4	z32 2	z33 3	z34 0	Together 29 66
8.	.....	2012-04-20 09:59	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 0	z5 1	z6 1	z7 2	z8 1	z9 1	z10 1	z11 1	z12 1	z13 1	z14 1	z15 1	z16 1	z17 1	z18 1	z19 2	z20 1	z21 2	z22 1	z23 1	z24 1	z25 2	z26 2	z27 3	z28 4	z29 9	z30 3	z31 5	z32 3	z33 1	z34 0	Together 33 68
9.	.....	2012-04-20 09:51	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 1	z5 1	z6 1	z7 1	z8 0	z9 1	z10 0	z11 1	z12 1	z13 1	z14 1	z15 2	z16 0	z17 1	z18 1	z19 1	z20 1	z21 1	z22 1	z23 1	z24 1	z25 1	z26 2	z27 3	z28 2	z29 3	z30 4	z31 5	z32 3	z33 2	z34 1	Together 33 56
10.	.....	2012-04-20 09:51	Task/ Scor/ Display	z1 3	z2 2	z3 2	z4 3	z5 2	z6 3	z7 2	z8 1	z9 2	z10 2	z11 2	z12 2	z13 2	z14 1	z15 2	z16 1	z17 1	z18 1	z19 1	z20 1	z21 1	z22 1	z23 1	z24 2	z25 1	z26 4	z27 1	z28 2	z29 4	z30 4	z31 5	z32 3	z33 1	z34 1	Together 39 72
11.	.....	2012-04-20 08:14	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 0	z5 1	z6 1	z7 1	z8 0	z9 1	z10 1	z11 1	z12 1	z13 1	z14 1	z15 1	z16 1	z17 1	z18 1	z19 2	z20 1	z21 1	z22 1	z23 1	z24 1	z25 1	z26 2	z27 2	z28 2	z29 4	z30 8	z31 2	z32 2	z33 1	z34 0	Together 25 55
12.	.....	2012-04-20 08:28	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 1	z5 0	z6 1	z7 1	z8 0	z9 1	z10 1	z11 1	z12 2	z13 1	z14 0	z15 1	z16 2	z17 1	z18 1	z19 1	z20 1	z21 1	z22 1	z23 1	z24 1	z25 1	z26 3	z27 2	z28 2	z29 3	z30 5	z31 2	z32 7	z33 3	z34 0	Together 34 61

13.	..... .....	2012-04-20 09:51	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 0	z5 1	z6 1	z7 1	z8 0	z9 0	z10 1	z11 1	z12 1	z13 1	z14 1	z15 0	z16 0	z17 1	z18 1	z19 0	z20 1	z21 1	z22 0	z23 1	z24 1	z25 0	z26 2	z27 1	z28 0	z29 3	z30 2	z31 3	z32 1	z33 1	z34 0	Together 30 50
14.	..... .....	2012-04-20 08:41	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 0	z5 1	z6 1	z7 1	z8 0	z9 0	z10 1	z11 1	z12 1	z13 1	z14 1	z15 1	z16 2	z17 2	z18 1	z19 1	z20 1	z21 1	z22 1	z23 1	z24 1	z25 1	z26 3	z27 2	z28 2	z29 4	z30 9	z31 3	z32 3	z33 0	z34 2	Together 33 59
15.	..... .....	2012-04-20 08:14	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 0	z5 0	z6 1	z7 1	z8 1	z9 0	z10 1	z11 1	z12 1	z13 3	z14 1	z15 0	z16 1	z17 1	z18 1	z19 0	z20 0	z21 1	z22 1	z23 1	z24 1	z25 1	z26 2	z27 2	z28 2	z29 12	z30 5	z31 7	z32 6	z33 5	z34 1	Together 33 72
16.	..... .....	2012-04-20 08:33	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 1	z5 1	z6 1	z7 1	z8 1	z9 1	z10 1	z11 1	z12 1	z13 1	z14 1	z15 1	z16 1	z17 1	z18 1	z19 0	z20 1	z21 1	z22 1	z23 1	z24 1	z25 1	z26 2	z27 2	z28 4	z29 7	z30 5	z31 3	z32 8	z33 3	z34 3	Together 41 62
17.	..... .....	2012-04-20 08:29	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 1	z5 1	z6 1	z7 1	z8 0	z9 0	z10 0	z11 1	z12 1	z13 1	z14 0	z15 0	z16 1	z17 1	z18 1	z19 1	z20 1	z21 1	z22 0	z23 1	z24 1	z25 1	z26 2	z27 3	z28 2	z29 4	z30 5	z31 3	z32 2	z33 3	z34 1	Together 29 52
18.	..... .....	2012-04-20 08:13	Task/ Scor/ Display	z1 2	z2 2	z3 3	z4 3	z5 2	z6 2	z7 2	z8 2	z9 2	z10 2	z11 2	z12 2	z13 2	z14 0	z15 0	z16 0	z17 2	z18 2	z19 2	z20 2	z21 2	z22 2	z23 2	z24 2	z25 2	z26 2	z27 4	z28 2	z29 8	z30 10	z31 7	z32 3	z33 1	z34 4	Together 34 92
19.	..... .....	2012-04-20 09:51	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 1	z5 1	z6 1	z7 1	z8 3	z9 1	z10 1	z11 1	z12 1	z13 1	z14 1	z15 2	z16 1	z17 1	z18 1	z19 1	z20 1	z21 1	z22 1	z23 1	z24 1	z25 1	z26 3	z27 3	z28 2	z29 4	z30 5	z31 3	z32 5	z33 2	z34 2	Together 33 57
20.	..... .....	2012-04-20 08:14	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 1	z5 1	z6 1	z7 1	z8 0	z9 1	z10 1	z11 1	z12 1	z13 1	z14 1	z15 1	z16 1	z17 1	z18 1	z19 1	z20 1	z21 1	z22 1	z23 1	z24 1	z25 1	z26 2	z27 2	z28 2	z29 3	z30 5	z31 3	z32 6	z33 1	z34 2	Together 39 53
21.	..... .....	2012-04-20 09:51	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 0	z5 1	z6 1	z7 1	z8 0	z9 0	z10 1	z11 1	z12 1	z13 0	z14 1	z15 1	z16 0	z17 1	z18 1	z19 1	z20 1	z21 1	z22 0	z23 1	z24 1	z25 1	z26 2	z27 2	z28 4	z29 12	z30 5	z31 3	z32 5	z33 1	z34 5	Together 39 71
22.	..... .....	2012-04-20 08:28	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 1	z5 1	z6 1	z7 1	z8 1	z9 0	z10 1	z11 1	z12 1	z13 1	z14 0	z15 1	z16 0	z17 1	z18 1	z19 1	z20 1	z21 1	z22 1	z23 1	z24 1	z25 1	z26 2	z27 2	z28 2	z29 4	z30 5	z31 3	z32 1	z33 2	z34 1	Together 30 47
23.	..... .....	2012-04-20 09:51	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 0	z5 1	z6 1	z7 1	z8 0	z9 1	z10 1	z11 1	z12 1	z13 0	z14 1	z15 2	z16 0	z17 1	z18 1	z19 1	z20 1	z21 1	z22 0	z23 1	z24 1	z25 1	z26 2	z27 2	z28 2	z29 4	z30 5	z31 3	z32 3	z33 4	z34 2	Together 37 61
24.	..... .....	2012-04-20 08:13	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 0	z5 1	z6 1	z7 1	z8 1	z9 0	z10 1	z11 1	z12 1	z13 0	z14 1	z15 0	z16 0	z17 1	z18 1	z19 1	z20 1	z21 1	z22 1	z23 0	z24 0	z25 1	z26 2	z27 2	z28 2	z29 3	z30 3	z31 3	z32 3	z33 0	z34 2	Together 30 54



25.	..... .....	2012-04-20 09:58	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 0	z5 1	z6 1	z7 1	z8 0	z9 0	z10 1	z11 1	z12 1	z13 0	z14 1	z15 0	z16 0	z17 1	z18 1	z19 1	z20 1	z21 1	z22 0	z23 1	z24 1	z25 1	z26 2	z27 2	z28 0	z29 2	z30 5	z31 3	z32 2	z33 1	z34 0	Together 34 51
26.	..... .....	2012-04-20 08:14	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 2	z5 0	z6 1	z7 1	z8 0	z9 0	z10 1	z11 1	z12 1	z13 1	z14 0	z15 0	z16 0	z17 1	z18 1	z19 1	z20 1	z21 1	z22 0	z23 0	z24 0	z25 1	z26 2	z27 2	z28 0	z29 4	z30 4	z31 2	z32 0	z33 0	z34 1	Together 30 69
27.	..... .....	2012-04-20 08:26	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 1	z5 1	z6 1	z7 1	z8 1	z9 1	z10 1	z11 1	z12 1	z13 0	z14 1	z15 1	z16 1	z17 1	z18 1	z19 0	z20 1	z21 1	z22 1	z23 1	z24 1	z25 1	z26 2	z27 2	z28 0	z29 2	z30 5	z31 3	z32 0	z33 1	z34 2	Together 40 55
28.	..... .....	2012-04-20 09:51	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 1	z5 1	z6 1	z7 1	z8 1	z9 0	z10 1	z11 1	z12 1	z13 1	z14 1	z15 0	z16 1	z17 1	z18 1	z19 1	z20 1	z21 1	z22 1	z23 1	z24 0	z25 1	z26 2	z27 2	z28 2	z29 4	z30 5	z31 3	z32 1	z33 1	z34 1	Together 41 54
29.	..... .....	2012-04-20 08:28	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 1	z5 1	z6 1	z7 1	z8 1	z9 1	z10 1	z11 1	z12 1	z13 0	z14 1	z15 1	z16 2	z17 1	z18 1	z19 1	z20 1	z21 1	z22 1	z23 1	z24 1	z25 1	z26 0	z27 4	z28 0	z29 3	z30 5	z31 3	z32 0	z33 1	z34 0	Together 37 62
30.	..... .....	2012-04-20 08:18	Task/ Scor/ Display	z1 1	z2 1	z3 1	z4 1	z5 1	z6 1	z7 1	z8 1	z9 0	z10 1	z11 0	z12 0	z13 0	z14 1	z15 0	z16 0	z17 1	z18 1	z19 1	z20 1	z21 0	z22 1	z23 0	z24 1	z25 1	z26 2	z27 2	z28 0	z29 3	z30 5	z31 3	z32 1	z33 1	z34 1	Together 34 52

VII. Project "e-mature" – innovative method of reporting and evaluation data

## Summary

The current systems for e-examination allow mainly checking knowledge on the basis of closed questions. Examined to answer questions, the outcome of which is checked with a template, and allocated him points for correct answers. Typically, these systems are targeted to a small group of recipients, often only as modules e-learning platforms.

The e-baccalaureate is innovative, as it serves not only to the examination with open and closed questions, but also to diagnose students' mathematical and precise reporting on the examination of knowledge of impossible during the "paper" exams.

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