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The grammar and language style of papers is not reviewed and corrected.

CONTENTS

DESIGN OF EXPERIMENT IN DEPARTURE STORES

Marek ANDREJKOVIČ – Michal TKÁČ

Abstract
This paper discusses about the design of experiments and its usage for optimization of sales in department store. We use the problem of sales optimization for good when we choose different positions of this good in the store. The conditions are described in the paper. Also the algorithm of DOE is shown and used for this problem as case study.

Keywords: design of experiments, logistics, marketability

Introduction

Planning placement of goods in the stores is an important step towards improving the marketability of goods. It is therefore necessary for correctly and accurately identifying the factors that affect the overall marketability of the selected goods. In case of improper use of the experimental results they are distorted and thus increased deviations from the desired state, which does not seem possible to explain the evaluator.

1. Defining the experiments

Statistical studies could be generally divided into two main groups:
- observational
- experimental

The common feature of observational studies is that the observer (experimenter) does not interfere with the process, which is subject of measurement. Of course, sometimes it's the only way how to get data, respectively realize statistical study. Conclusions could not be interpreted in the same way as it does in the case of planned experiments where the observer deliberately changes the conditions of experiments and observe how these changes affect the response.

Analysis of historical data can help us to understand how the process is evolved over time, and what are its characteristics. Also we can significantly help pre-design of the experiment itself: planning factors, the choice of appropriate levels of factors and so on.

One of the main engines of improvement in the method of Six Sigma is the design of experiments. The planning and execution of experiments is based on

data analysis to seek causal relationships between factors of the experiment - the process and response factors.

During design of the experiments, we meet with the concept of response. It represents a numerical characteristic, which we monitor and try to influence it in any way. This numerical characteristics is strong ties to a specific output of the process. For example, if you want to monitor wear of the grinding wheel, the observed response is the average attrition. In practice, however, often not only average, but the specific needs and characteristics of other figures as the standard deviation, minimum, maximum, and so on.

After defining the response we go to the next term, factor. Factor represents a process parameter which in some way affects the value of the response. They may be controllable and uncontrollable. Noise is also a factor. Noise is a factor beyond control, or factors that we do not want to control their impact on the response we previously identified as no significant.

Planned experiments are carried out through trials. Trial is deliberately driven at a relatively controllable process conditions, which is used for obtaining or verification of experience, knowledge and expertise.

Problem occurs in the question, how with the least possible number of factors to describe all the relevant circumstances of the experiment, when often we have no idea what might affect the planned experiment. In this situation, the historical data can help us, or experiences and knowledge of experts. Using them we can certain factors (which may be expected to have negligible effect on the response) exclude from further consideration, respectively appropriate measures during the implementation of the experiment to eliminate their influence and further ignore them.

The choice of relevant factors is usually the output of the brainstorming of team of improvement, from the method of Ishikawa, benchmarking or process analysis.

We know two main reasons of using experiments. We want to know:
- how strongly these factors influence the response,
- how to set the process parameters to gain the asked level of process output parameters (response)

In the first case we are talking about the screening. The role of screening experiment is how to most effective, so with the least possible number of trials to determine the strength of individual factors to influence response. Under trial we are going to understand a specific level adjustment for all relevant factors, which will take place in the measurement of responses. Imagine a situation where the team of improvement needs to determine which factors have the greatest impact on the variability of the roughness profile of the brake disc. After discussion with the manager of production, operators and manufacturers we have found that a significant influence on variability can be: the choice of grinding wheel, grinding speed, grinding wheel wear, machine type, machine wear, operator of the machine, cut rolls inspection, job change, and so on. We

make a proper screening experiment project which determines how these factors strongly influence the variability.

The second category is called as optimization experiments. Their aim is from the factors which have come from screening experiment as an important, to set up a mathematical model by which the improvement team will be able to optimize the process and achieve the objectives. If you take the variability of the roughness profile of the brake discs, the interest of the producer may be reduced by this variability, but also reduce this variability should not be counterproductive in terms of cost, ie when we reduce variability at any price. It is therefore the creation of such optimization, which takes into account more than one response. This optimization method we use for planning experiments - RSM method.

Design of experiments is established by a strategy that will lead to obtaining such data on which we can reliably detect the causal relations between factors and response (feedback) and to optimize these factors to achieve our objectives. The situation can be illustrated by the following p-diagram.

Figure 1

Process Diagram
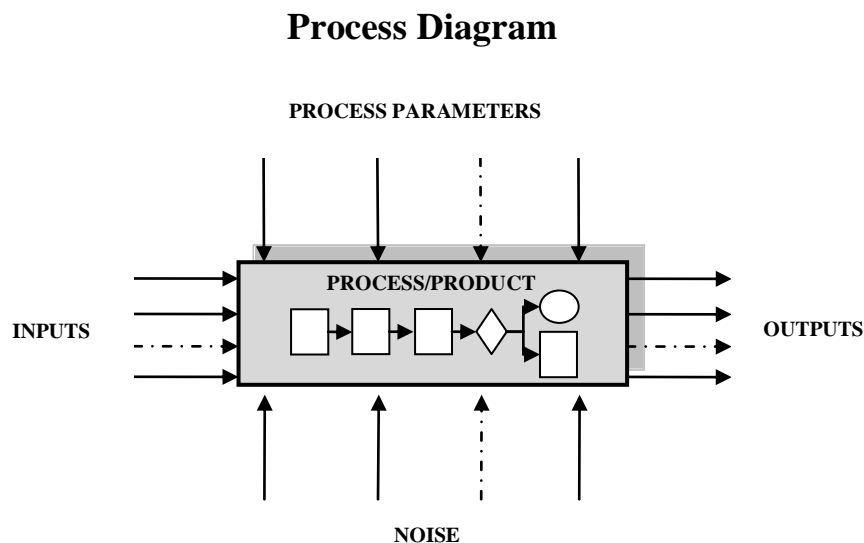
Input and process parameters present controlled factors which optimizing we achieve desired outcomes. Under the noise we mean uncontrolled or uncontrollable factors which distort the causal relationships between inputs, outputs and process factors.

If we have only one variable, whose impact we want to find out - factor - and this variable can take only two states - levels - to assess the situation, we may use paired or two samples t-tests. If there are more levels, we can help you by one factor ANOVA. Similarly, if there are more factors we use the method of Multi-factorial ANOVA.

2. RESPONSE SURFACE METHODOLOGY

Response Surface Methodology is a sequential method, which task is to optimize the set target levels of factors, on which we reach the (optimized) value of the response. Previous sections of this chapter is devoted to the proposal of experiments, the results of the response were recorded only for pre-defined levels of factors. Thus, we can only identify the optimal settings of the selected settings. From contour graph we know that, even if at least one factor is continuous variable, the optimal settings may be located precisely in the same combinations of levels of factors in which we conducted the experiment. Therefore, approach of the experiment is to 2^k with a view to finding the optimal solution is not sufficient.

Whether the RSM is used to identify the set of factors that we do not know, it is clear that we must assume that we know the functional relationships between different levels of combinations of factors. In a simple experiment 2^k we define the optimal settings for that for which the level of response in the node (a combination of factors levels) optimal (maximizing response to the highest standards for types of responses that minimize the lowest level). In this case, we can look to the process as a black box, when we see the functional relationship between individual factors and their precise impact on the level of response.

The points of square are the different levels of a combination of factors. Contour plot (contour graph) indicates the level of response, which is the highest level of response is accompanied by a still darker shaded of contours. If we use only 2^k planned experiment, we came to the conclusion that the optimal adjustment factor is the pressure in the setting of -1 and the temperature factor in the setting 1. However, the picture we can see the real (global) optimum is outside the body examined. And the RSM is a way to identify each set of factors that ensure the achievement of the optimum response.

RSM is realized in next steps:

0. Screening experiment

In RSM it is first necessary to identify insignificant factors. This can be detected by the screening experiment. In most cases it is an incomplete two-level experiment. Its aim is simply to identify important factors, which we will further investigate in detail pay.

After identifying relevant factors, the following should be divided into two groups according to their type, for continuous variables and discrete variables. For discrete variables it can not be set to "between" the levels of factors, we determine the level at the level at which the value of achieving a better response (if the sex factor, a factor is the level of "man", the second factor is the level of "woman". It is not possible to find the optimal level of response

between these two levels).Thus, the procedure will only set of factors to optimize continuous variables.

Transfer functions are mathematical form, which expresses the relationship between the response of output values and setting values of input factors. Then the transfer function describes the relationship, what level of output response will be gained if factors A, B and others will set to particular values of x_1, x_2, ... x_k. For example, a particular transfer function represents the amount of produced chemical substance in reaction, if we set the temperature to a level of 250 ° C and pressure to 150 Pa.

At the end of this step we obtain a smaller number of factors which significantly affect the level of response, while these factors are included under the type of variable into one of two groups, continuous variables or discrete variables.

1. Does the optimal combination of factor levels laid between the experiment boundaries?

In practice, two situations can occur, and that the optimum response level will be located inside the experiment boundaries or not. This can be graphically displayed in the picture below. First figure illustrates a situation where the optimal level of response is outside the experiment boundaries. We can see that 2^k experiment provides a linear transfer function y = f (x).

Figure 2

Different location of optimum
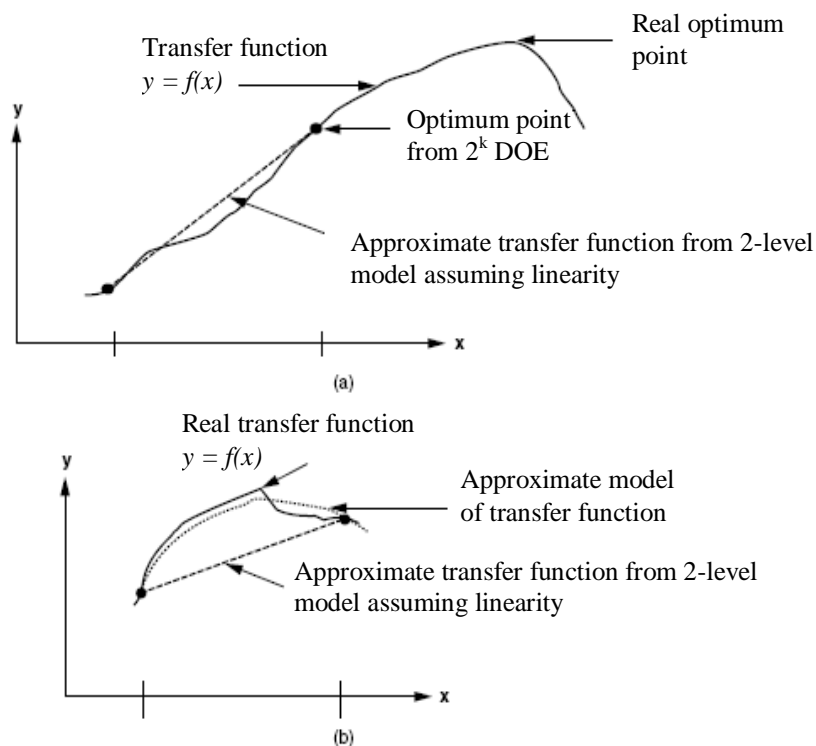
2. Area with optimum point identification

In the previous section, we show graphically the problem of verifying that the optimum lies in the experiment or not. This fact will be found based on the curvature test. The definition of centerpoint is a necessary step towards the realization of this test. Optimum is searched by the curvature. This means that if the optimum found between the experiment boundaries, the curvature of the transfer function is statistically significant. In the case where the optimum lies outside the current field of experiment, the transfer function curve is not statistically significant.

We design experiments using 2k factor designs. Due to the use of curvation test, it is necessary to establish the centerpoints, which can be graphically displayed as on next figure.

Figure 3

Points in experiments
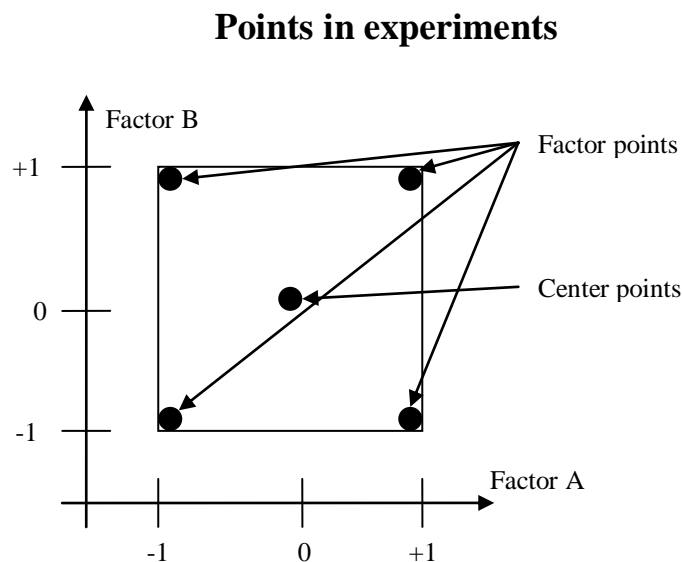
Regression model for 2^k or 2^{k-p} experiment with centerpoints could be recorded as:

$$y = \beta_0 + \sum_{j=1}^{k} \beta_j x_j + \sum_{i<j} \beta_{ij} x_i x_j + \sum_{j=1}^{k} \beta_{jj} x_j^2 + \varepsilon$$

where $\sum_{j=1}^{k} \beta_{jj} x_j^2$ means curvature. So curvature test could be simplify to hypothesis:

$$H_0 \quad \beta_{jj} = 0$$
$$H_1 \quad \beta_{jj} \neq 0$$

Null hypothesis describes a model that is not encumbered by curvature, this means that the optimum is probably outside the scope of the experiment. F-test

procedure is based on this test of hypothesis. In this procedure, the F-test, single degree of freedom sum of squares of curvature is calculated as:

$$SS_{curvature} = \frac{n_F n_C (\bar{y}_F - \bar{y}_C)^2}{n_F + n_C}$$

where $\bar{y}_F$ = mean of response in factor points)

$\bar{y}_C$ = mean of response in center points

n_F = number of factor points

n_C = number of center points

If, $\bar{y}_F$ is not statistically different from $\bar{y}_C$, we can assume linear impact factors to response and rejection of first (alternative) hypothesis. Also with rising difference between $\bar{y}_F$ and $\bar{y}_C$, the value of $SS_{curvature}$ will rise. Null hypothesis we reject in the case, if $F_0 > F_{\alpha,1n_e}$. F_0 we count as ration of $SS_{curvature}$ and MSE, so

$$F_0 = \frac{SS_{curvature}}{MSE}.$$

Our aim is thus to find an area in which the optimum is located. If test curvature indicates that this model for this experiment boundaries do not includes optimum (the curvature is statistically insignificant), it is necessary to proceed in its determination.

3. EXPERIMENT OF PLACING GOODS IN THE STORE

To determine the most suitable location we use the experiment. Goods can be placed at various locations on the shelves. Suppose there are three types of vertical shelf location, and the ground, the middle shelf at eye level and finally at the top shelf. For simplicity, in the experiment we assume only 2 levels, under and above the eye level. The seller may place the goods at any place in the selected shelf. Goods can move to another shelf. Thus, we define two possible positions, for exactly 1 meter from the end of the shelf. Thus, we have therefore defined two factors that affect the marketability of the selected goods. The location of other goods or promotional activity is not changed. Other factors will be considered negligible.

At the beginning we have selected a plan in which each day we change the location of the goods. To eliminate the impact of a specific day of the week to generate sales, we elected to repeat the experiment so that each combination of factors, we carry on each day.

In this case, we have following possible conditions:

- vertical shelf location:
  - -1 – under eye level
  - +1 – above eye level
- horizontal position:
  - -1 – one meter from the end of shelf nearer to the story entry
  - +1 – one meter from the end of shelf farer to the story entry

Based on these factors, we find the number of products sold in duty day. In these days with usage of electronic cash registers, it can be observed not only in sales for one day, but at the same day. Thus we can identify and compile a recommendation and the time during the day. It is possible that the location changed during the day and then we monitor the impact of time during the day. This is difficult for logistics, as the sale does not terminate.

We also recommend that measurements in different combinations of factors were also be iterated.

In next two figures we show the results from the concrete measurements in the selected departure stores in which we realized this algorithm of searching the optimum point.

Figure 4

Main effect plots
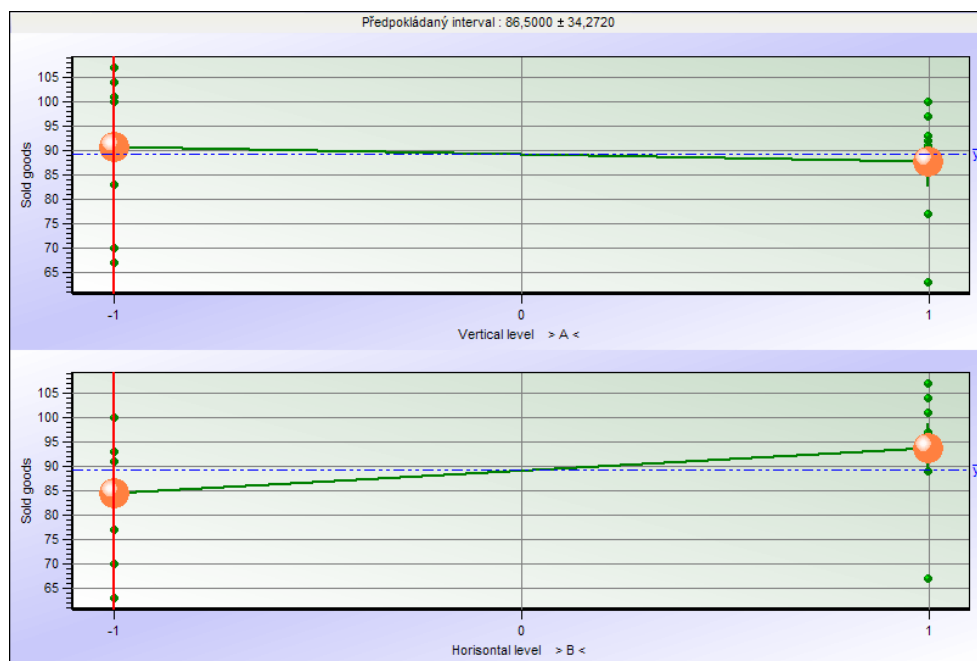
Figure 5

Interaction plots
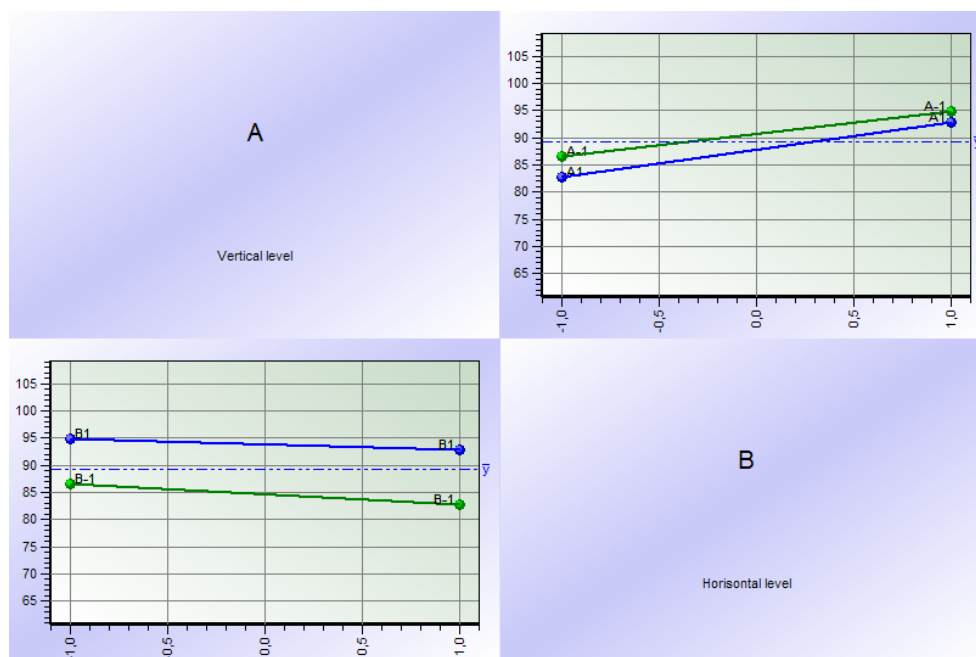
We checked that the best configuration is in the situation, when you place goods on above shelves which are nearer to the story entry.

Then optimization using of RSM adjust factors, and thus finding the optimal placement of goods is given to those realized marketability of goods. The continuation of this experiment, subsequently determine the impact of advertising. Then there will be a change of types of advertisements but we will need to determine which inertia of different types of advertising are in order to affects such advertising, at least partially limit. Then we can identify the most effective advertising and thus increase the efficiency of resources spent on promotion.

Conclusion

Using the design of experiments is necessary to identify the optimal settings of factors in determining the best outcomes (response). In this article we focus on the use of experiments for optimizing the location of the goods in the sales shelf. Location can be varied horizontally and vertically. To the objectivity of the results of the experiment will include other factors to be monitored and further inclusion in the model will be further analyzed later. Then we define the method of making such an experiment, including the usage of RSM.

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IMPLEMENTATION OF THE METHODOLOGY OF INNOVATION IN THE RENEWAL PROCESS OF TECHNOLOGICAL EQUIPMENT IN THE SELECTED COMPANY

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Abstract

This contribution is dedicated to innovation. It deals with the implementation of the methodology of innovation in a existing company. It captures the view on the whole innovation process, from the initial idea to the realization of innovation, including financial analysis and evaluation of its effectiveness.

Keywords: innovation, innovation management, innovation process, evaluation of the innovation effectiveness

Introduction

All of the companies are now under constant competitive pressure. The prerequisite of resisting this pressure as well as of being successful is to improve their own internal processes. The appliance for such improvements is also innovative activity. However, any innovative activity means also another company costs, therefore is necessary to manage every innovation. Comprehensive management tool that effectively manages the innovation activities and innovation process in a business unit is called the innovation management. This contribution deals with that topic and provides rather practical view at this management tool, through a real case study, made in a concrete private company.

1. Case study

Wood-working company decided in the first half of 2010 to upgrade its current heating technology. They decided to proceed this step after careful assessment of their current needs and therefore can be considered as a necessary innovation. The circumstances of these needs will be presented in following text.

Basic characteristics of the innovation

According to the level of changes, respectively degree of novelty, this innovation can be concerned as the novel within the enterprise. On the basis of

changes level scale, this innovation can be classified on the sixth stage - "the creation of new species" - it is a reconstruction at the preservation of the principle.

The purpose and objective of innovation

The primary purpose of innovation in the mentioned company is saving energy costs. To ensure the main objective is necessary to define a secondary objective - which is to effectively replace the current gas heater by a new biomass boiler. However, to meet the primary and secondary target is necessary also to ensure these following targets:

- design of innovation management method
- design of innovation management process
- design of innovation activity organization
- calculation of the innovation efficiency

2. Analysis of current situation

The company is located in an industrial area in the city of Košice. The total area of the site is 5000 m^2. Hereof the built area is 2221 m^2, which includes a production hall and office space, of which the heating surface is 1800 m2. The heating period is from September to April (or as appropriate), thus an average of eight months. These areas are currently heated by two gas boilers type ATTACK 50. It is thus a technology based on non-renewable resources. Given the object of business is necessary to point out that it has a continuous supply of wood waste (from saw and carpentry). At the same time it keeps at its disposal the technology for processing gross wood waste (chippers). Based on this analysis of the current state is possible to make the following reasons and motives of the innovation:

- rising natural gas prices
- energy efficiency improvements
- reduction of operating costs for heating
- modernization of the heating system
- increasing of wood waste using
- reduction of CO_2, SO_2, NO_x (positive externality of innovation)

2.1. Current heating technology

At present are mentioned two buildings heated by gas boilers ATTACK 50. Each of these boilers has power of 50 kW. This means the joint power of 100 kW. From a technological point of view are these the stationary cast-iron boilers with flamboyant ignition and thermo bimetal flame watch. Exhaust of burnt gas

is attached to the chimney. Concerning the fuel consumption, the data are as follows:

- average annual consumption of gas for a boiler is 19 353,6 m^3 (at average power and the heating period)
- average annual gas consumption for two boilers is 38 707,2 m^3 (at average power and the heating period)
- In the matter of operating costs of the mentioned gas boiler, data (on the average consumption) are as follows:
- average price of gas varies in the amount of 0.6 Eur/m^3
- average annual cost for two boilers is 23 224, 32 Eur (699 656, - Eur), a monthly expenses are 1935,36 Eur (58 305, - Sk).

This indicates that the current heating technology (especially the cost) doesn´t meet the needs and ideas of company. The ideal, in terms of opportunities and requirements of the company appears to be the biomass boiler.

2.2. New heating technology

Prerequisites for the selection of the most suitable boiler are as follows: it is necessary to take into account the fuel possibilities as well as to think about the potential fuel changes, which could seriously affect the installation of the device.

In regard of the fact, that the company has an unlimited amount of wood waste (wood waste from saw, and carpentry - i.e. sawdust, shavings, chips, pieces of wood) and from the long term point of view is improbable the change of the company´s object, a natural choice fell on the biomass boiler, namely model Hager - BME EKOBIO (after the price, performance and delivery terms consideration, etc.).

Biomass boiler HAGER – BME EKOBIO

Under this name is hidden stationary hot water boiler, which is designed for a environmentally clean burning of wood waste and biomass. Prescribed fuel is: wood chips, sawdust, pellets, chips, wood waste and other biomass (e.g. straw pellets, etc.). The overall performance of the boiler is 110 kW. Exhaust of burnt gas is also provided. As regards the fuel consumption figures are as follows:

- average annual consumption of wood waste is 750 m3 of fuel (at average power for heating period)
- As regards the costs to operate the biomass boiler, data (on the average consumption) are as follows:
- average price of wood waste varies in the amount of 9.3 Eur/m3
- average annual cost is 6975, - Eur (210 129, - Sk) a monthly cost is 581, - Eur (17 503, - Sk).

It is necessary to note that at present the average annual cost of fuel is almost zero, given that the wood waste generated by daily business operations. The amount is calculated in the event that (for whatever reason) the focus of the company would change and the company would be forced to buy the mentioned fuel.

3. Proposal of project management methods

Innovation is divided into two main stages:

- stage: January 2010 – first half of march 2010

Market research of biomass boilers (including selecting the most appropriate), development of financial analysis, development of written project

- 2. stage: second half of 2010 – august 2010

Purchase of new boiler, implementation of the boiler (before heating season).

Listed steps are illustrated in Table 1. From this schedule may be read not only the time fixed for the implementation of specific activities, but also assignment of responsibility for tasks to specific people.

Table 1

Stages 1 a 2 – The Schedule of tasks and their performance

The Schedule of tasks and their performance 2010		
month / activity	01/10 02/10 03/10 04/10 05/10 06/10 07/10 08/10	Responsible person
Market research	→————→	Head of supply
Development of financial analysis	→————→	Head of econ. department
Development of written project	→————→ →————→	Managing director
Purchase of boiler	→→	Managing director
Implementation of boiler		Supplier
Control	→————————————————→	Managing director

Source: self processing

In the mentioned schedule is possible to learn that the introduction of the boiler is scheduled for August 2010 (starting 02/08/2010). All the necessary activities related to the introduction of a new boiler, together with the time

needed to achieve them shows Gantt chart shown in Figure 1 (for completeness, it is necessary to note that the activities provide, under the agreement, an external supply company). More particularly, the following activities are these:

1. removal of gas boilers – 2 days
2. installation of biomass boiler Hager - BME EKOBIO - 3 hours (0,125 days)
3. connection to electricity - 2 hours (0,083 days)
4. connection to the distribution of heating - 2 days
5. connecting and programming the control unit of the boiler - 12 hours (0,5 days)
6. connection to the chimney – 1 day
7. pressure test - 1 day

Figure 1

Gantt chart – implementation of the boiler
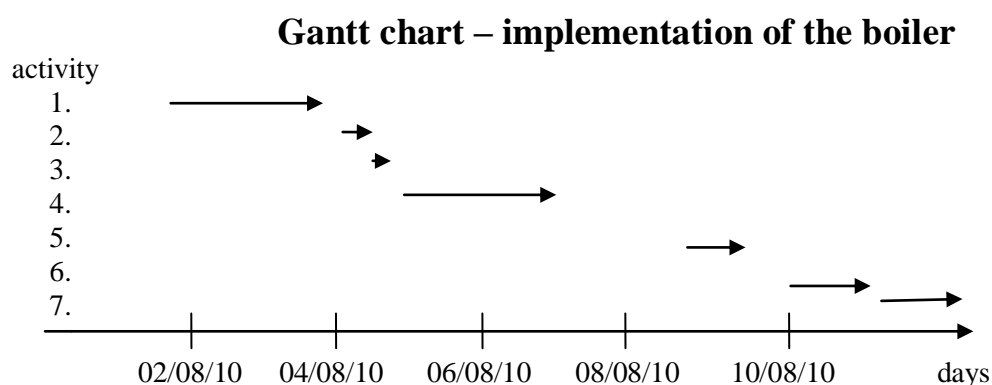
Source: self processing

4. Proposal of innovation process management

Innovation management process consists of three phases, namely: *-preparation and verification of innovation*: in this step is necessary to obtain initial information, to evaluate possible options and to create a written document. The company is for a long time decided to replace the existing heating technology. After careful examination of company´s opportunities choice naturally fell on the technology using biomass. Then followed a market survey of biomass boilers and evaluating of possible options. After negotiations with several potential suppliers, finally managing director decided for a model Hager - BME EKOBIO, according to the price, performance and delivery terms. In this phase was performed also a financial analysis. The part of this phase is also the creation of written document.

- *innovation planning:* the process including the following components: goals and strategies, subject decomposition, responsibility matrix, time scheduling, resource and cost plan, risks plan.

- objectives and strategies –the primary objective of the innovation is saving energy costs. A secondary objective is to effectively replace the current gas heater by a new biomass boiler. One way of achieving these goals is to purchase biomass boiler, removing old gas and to install a new equipment.

- subject decomposition - includes the following activities: market research for biomass boilers, development of financial analysis, preparation of written project, the boiler purchase, implementation, continuous control. The implementation of the boiler includes the following activities: removal of gas boilers, installation of the boiler for wood waste, connection to electricity, connection to the distribution of heating, connection and programming of the boiler control unit, connection to the chimney, pressure test (see Table 1 and Figure 1).

- responsibility matrix – responsibility for particular tasks assigned by the head of supply (market research), the head of the economics department (development of financial analysis), the manager of the company (through a written project, the purchase of the boiler, control), the external supply company (all activities related to the dismantling of the old and installation of new boiler - in agreement with the supplier).

- time scheduling – the time evaluating of the various activities as well as their connections are shown in the time table in Table. Gantt chart in Figure 1 shows the range of activities required for implementing a new heating system (along with the scheduled time of completion).

- resources and costs plan – the company has for this innovation available finances in the term account in a bank (available in April 2010), which means it does not need to use external resources. Cost data are displayed in the part "evaluation of the innovation effectiveness."

- risks plan – economic risks (the risk that funds from its own resources for the financing of this innovation will be unusable for any reason), technological risk (the risk that technology will be insufficient, respectively unsatisfactory in terms of technical parameters), the risk associated with supply (the risk that a supplier fails to deliver equipment on time - before the heating season), risk of changes in business activity (risk that the company would has to start to buy the wood waste, which involves higher costs).

- *realization and innovation control* - as for as the control of the innovation is concerned, we can say that it is quite easy in this case, given its size, company size and simple organizational structure. Inspection is carried out continuously (at all levels) by the manager of the company.

5. Organization of innovation activity

Organizational structure, given the size of the company itself and innovation activities remains unchanged. To the individual company employees were given particular tasks and their implementation is continuously supervised. See the Table 1.

6. Evaluation of the innovation effectiveness

Every innovation present for a business unit primarily an investment. It is necessary to consider whether this investment is effective, through various methods and indicators (e.g. cost comparison, the net present value, payback period, etc.).

6.1. Comparison of costs

It is necessary to have the costs of innovation in relation to the expected return.

The cost of gas boiler:

The average annual consumption of gas for a boiler is 19 353,6 m^3 (an average performance and during the heating period), the average annual consumption of gas for 2 boilers is 38 707,2 m^3 (under the same conditions), the average price of gas varies in amount of 0,6 Eur/m^3. It follows that the average annual cost is:

38 707, 2 m^3 x 0,6 = 23 224, 32 Eur (699 656, - Sk)

The cost of biomass boiler:

The entry price for the biomass boiler is 12 856,- Eur (387 230,- Sk)

- Alternative A – the company has to purchase wood waste

The average annual consumption of wood waste is 750 m^3 (an average performance and during the heating period, the average price of wood waste varies in amount of 9,3 Eur/m^3. It follows that the average annual cost is:

750 m^3 x 9,3 Eur = 6975,- Eur (210 129,- Sk)

- Alternative B – the company has its own wood waste

In this case, although the average annual cost is negligible (almost zero), it is necessary to think also about the alternative costs that result from the opportunities, that company loses, because they don´t sell its own wood waste. If we consider that the average annual volume of wood waste is 800 m^3 and the

sale price would be at 9 Eur/m^3, then: 800 m^3 x 9 Eur = 7200,- Eur (216 129,- Sk)

A comparison of two boilers at various alternatives

- Alternative A – the company has to purchase wood waste

23 224, 32 Eur (699 656,- Sk) - 6975,- Eur (210 129,- Sk) = 16 249,32 Eur

Calculated amount represent an annual saving. If we subtract from this savings the costs associated with the investment (spent on the purchase and installation of biomass boilers) we find that: 16 249,32 Eur – 12 856 Eur = 3 393,- Eur

It follows that there are a significant savings in this innovation and that it is likely to be back in the early years of life-cycle.

- Alternative B – the company has its own wood waste

23 224, 32 Eur (699 656,- Sk) - 7200,- Eur (216 129,- Sk) = 16 024,32 Eur

16 024,32 Eur - 12 856 Eur = 3 168,- Eur

This variant appears to be more realistic for the company. It is visible that savings against alternative A is admittedly lower, but nevertheless significant.

On the basis of cost comparisons, it appears that the investment would be effective, even that it should return in the early years of its life-cycle. To confirm this assertion we do "test accuracy" through indicators: net present value and payback period.

7. Net present value and Payback period

NPV indicator talks about how much money the investment (innovation) generates for a certain period, this money are measured as a "today's money". If NPV is greater than zero, the project is profitable, this means that it generates more money than is the amount to open an investment needed. The formula for calculating NPV is:

$$NPV = \sum_{i=1}^{N} P_n \frac{1}{(1+i)^n} - K \quad , \text{ where} \tag{1}$$

P - cash income from investment in individual years of life n;
n - individual years of life;
i - interest rate (interest in %/100);
K – capital costs

The Payback period indicator represents the time at which the investment is repaid from cash inflows from investment, i.e. after-tax profits and depreciation.

- Alternative A – the company has to purchase wood waste

Table 2 outlines the costs and benefits associated with the implementation of the biomass boiler. With regard to depreciation, we can say the mentioned technology falls into a group of depreciation 1, which means that it will be amortized over four years. We chose linear (uniform) depreciation. We consider as a benefits in this case „saving resources", which arise as a result of heating system exchange.

Table 2

Determination of annual cash income from investments - Alternative A

	Year 0	Year 1	Year 2	Year 3	Year 4
Investment Costs	12 856,00	-	-	-	-
Project Benefits	-	16 249,32	16 249,32	16 249,32	16 249,32
-Fuel Costs	-	6 975,00	6 975,00	6 975,00	6 975,00
-Repairs Costs	-	240,00	240,00	240,00	240,00
-Labor Costs	-	2 400,00	2 400,00	2 400,00	2 400,00
-Depreciation	-	3 214,00	3 214,00	3 214,00	3 214,00
Gross Profit	-	3 420,32	3 420,32	3 420,32	3 420,32
-Tax	-	649,86	649,86	649,86	649,86
Net Profit	-	2 770,46	2 770,46	2 770,46	2 770,46
+Depreciation	-	3 214,00	3 214,00	3 214,00	3 214,00
CF (PP[1] from I)	-	5 984,46	5 984,46	5 984,46	5 984,46

Source: self processing of data provided by the company management

In order to calculate the NPV, we have to discount cash income calculated according to Table 2. We use the calculating of a „Present Value of a future Sum" for discounting. For purposes of this calculation, we decided to determine the life-cycle of the project for four years and the interest rate (concerning the low risk of the project) set at 10%.

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[1] PP = Cash Income

Table 3

NPV calculation – Alternative A

Year of life (n)	Cash Income (PP)	PV[2] of a Future Sum for i = 0,1	Discounted CI (PP)	Cumulated CI (PP)
1.	5 984,46	0,9091	5 440,47	5 440,47
2.	5 984,46	0,8264	4 945,56	10 386,03
3.	5 984,46	0,7510	4 494,33	14 880,36
4.	5 984,46	0,6830	4 087,39	18 967,75
Sum	23 937,84	-	18 967,75	-

Source: self processing

The present value of cash incomes is 18 967,75 Eur. The net present value of the project is the difference 18 967,75 Eur (the sum of discounted cash income for each year of life) and 12 856, - (investment costs), i.e. NPV = 6 111,75 Eur.

In this case, the net present value is of a positive number, a discounted cash incomes are greater than investment costs. It follows that the innovative project has secured sufficient funds to be functional and sustainable in long-term period.

Table 3 shows that the payback period of investment costs 12 856, - Euro is between the second and third year. In the case of uniform profit formation and depreciation during the year, payback period can be quantified more precisely:

$$2 \text{ years} + \frac{12\,856 - 10\,386,03}{4\,945,56} = 2,49 \text{ years.}$$

The calculated payback period is relatively short, and thus investment costs will be returned to the company (in this alternative) after two and a half years, which we evaluate positively.

- Alternative B – the company has its own wood waste

Table 4 shows the annual cash flow revenue stream from investment, taking into account the opportunity cost, which in this case is 7200, - Eur. This is the cost of lost opportunity that arises in the moment when the company decides that its wood waste won´t be sold, but on the contrary it will be used for its own purposes. Amount of 7200, - Eur represents a conjunction of the average annual volume of wood waste resulting from the production (800 m^3) and the price at which they would sell the wood waste (9 - EUR/m^3).

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[2] Present Value of a Future Sum for i = 0,1

Table 4

Determination of annual cash income from investments - Alternative B

	Year 0	Year 1	Year 2	Year 3	Year 4
Investment Costs	12 856,00	-	-	-	-
Project Benefits	-	16 024,32	16 024,32	16 024,32	16 024,32
-Alternative Costs	-	7 200,00	7 200,00	7 200,00	7 200,00
-Repairs Costs	-	240,00	240,00	240,00	240,00
-Labor Costs	-	2 400,00	2 400,00	2 400,00	2 400,00
-Depreciation	-	3 214,00	3 214,00	3 214,00	3 214,00
Gross Profit	-	2 970,32	2 970,32	2 970,32	2 970,32
-Tax	-	564,36	564,36	564,36	564,36
Net Profit	-	2 405,96	2 405,96	2 405,96	2 405,96
+Depreciation	-	3 214,00	3 214,00	3 214,00	3 214,00
CF (PP[1] from I)	-	5 619,96	5 619,96	5 619,96	5 619,96

Source: self processing of data provided by the company management

Table 5

NPV calculation – Alternative B

Year of life (n)	Cash Income (PP)	PV[2] of a Future Sum for i = 0,1	Discounted CI (PP)	Cumulated CI (PP)
1.	5 619,96	0,9091	5 109,11	5 109,11
2.	5 619,96	0,8264	4 644,33	9 753,44
3.	5 619,96	0,7510	4 220,59	13 974,03
4.	5 619,96	0,6830	3 838,43	17 812,46
Sum	22 479,84	-	17 812,46	-

Source: self processing

The present value of cash incomes is in this case 17 812,46 Eur. The NPV is the difference between 17 812,46 Eur and 12 856,-, i.e. NPV = 4 956,46 Eur.

Also in this case is NPV positive number. So the innovation also in this alternative would be effective.

Table 5 also shows, that Payback period of investment cost 12 856,- Eur is between 2. and 3. Year. In the case of uniform profit formation and depreciation during the year, payback period will be:

$$2 \text{ years} + \frac{12\,856 - 9\,753,44}{4\,220,59} = 2{,}74 \text{ years.}$$

Alternative B shows a slightly longer Payback period than variant A. In this case, the investment will be returned approximately after 2 and 3/4 of the year.

Conclusion

In the second half of this year, the company decided to innovate its heating technology. There were several reasons but the most significant was the cost created by the operation of gas boiler. Because of the rising price of gas as well as the threat of stopping gas supply (which is still high), the company decided to invest to the equipment which will not be only economically but also ecologically efficient. In terms of fuel options, the company decided for biomass burning boiler.

The primary objective of this innovative activity was thus saving energy costs. To ensure the main objective it was necessary to define a secondary objective, which was to effectively replace the current gas heater by a new biomass boiler. To the replacement and implementation itself preceded a thorough analysis, which records this document, which is also an written outcome of the mentioned innovation.

In conclusion, it can be stated that the primary objective of innovation will be met. On the basis of financial analysis (evaluation of efficiency), after considering all options, risks, after calculating the net present value and payback period is possible to say that the innovation (in terms of both variants) is not only feasible but also effective.

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AXIOMATIC DESIGN IN SUPPORT OF NEW CONCEPT DESIGN

Denisa ĎURIČEKOVÁ – Michal TKÁČ

Abstract
Axiomatic design provides a method for evaluating the actual quality of design, which contributes to optimal and creative decisions. This paper sets out the methodology of the design process through the concept of axiomatic design, which aims to evaporate the functional requirements of design parameters. The methodology has been applied to a simple example to understand the fundamental principles of axiomatic design. Axiomatic design method helps to improve product quality, reduce design complexity, and increase efficiency products.

Keywords: axiomatic design, QFD, zig-zag method, hierarchical decomposition

Introduction

In practice, it is possible to meet up with two possible ways of identifying and modifying proposals. The first approach is algorithmic, and the second system is axiomatic. In an ideal world, knowledge based on the axioms pass into into algorithms and then to the instruments through which the implementation progress.

Taking into account the purely algorithmic process that seeks to identify the process, namely through the process of finding a solution. The idea of doing so based on the premise that the best way intended goal of improving the process by understanding the best practices. This approach can therefore be used primarily for specific situations, or to the lowest level of detail processes. Then it is appropriate to exploit the opportunities arising from the right experience to be very difficult to generalize to higher levels. However, this algorithmic approach is easily manageable for elementary processes. For processes whose complexity is high, such an approach is very difficult to use.

On the other hand, we have axiomatic approach. This approach assumes that the system studied is based on a system of universal principles - the axioms. These axioms define, in general, while the behavior of the system in certain situations. Proposal of process improvement is based on generalizations of good practices and decisions. So we can say that on the basis of certain general facts can be determined most appropriate solution. Thus, it is possible under the existing solutions to come to a relatively new idea, based on universally applicable principles.

1. Principles of axiomatic design

The aim of axiomatic design is the variety: to make more creative designers, to reduce random search process, to minimize the interactive process of experiment and mistake, to determine the best designs during the design process.

Design and implementation of the concept through production can be defined by a set of processes and activities that transform customer requirements. These processes are realized in various phases from concept phase. In assessing the proposal is necessary that the approved design included the system that has no or minimum vulnerability. This proposal follows the issue of vulnerability for the quality and security of its business activities in the production of selected products, respectively the implementation of a process. It is the existence of these vulnerabilities requires the use of a systematic approach for the chosen business area. In practice, we encounter two types of vulnerabilities:

- Conceptual vulnerability – leads to the proposal have a deficiency of robustness in the concept stage of product / process. This category focuses on the problem of poor identification of the proposed principles, recommendations, which can translate into two basic axioms due to the complexity of the system (Axiom 2) and matching the individual characteristics of the system (Axiom 1).
- Operational vulnerability - This vulnerability is a reduction in robustness of the process at the time of its use during the life cycle of the system when the system at the time of operation is prone to influences noise.

The companies are faced with two approaches to removing vulnerabilities:
- „Prevention" – securing the proposal with little or no conceptual vulnerabilities.
- „Fire" – problem solving, so that the system has the least operational vulnerabilities.

The second type is most common. Use of axiomatic design and robust proposal in conjunction with other methods employed in the design concept helps companies operate in the 'first league' start improving business by reducing waste and resources while growth in customer satisfaction. This process involves the use of statistical techniques and conceptual methods.

Next attention is paid to conceptual vulnerability, where it is necessary to use the axiom as a scientific concept of search in the absence of scientific design principles. For any proposal to acknowledge the following two axioms:
- Axiom 1 – **Axiom of independence** - maintaining the independence of functional requirements,
- Axiom 2 – **Information Axiom** – to minimize the information content of the proposal.

Fulfilling the axioms 1 is proposed to reach simplicity by minimizing the information content through axioms 2nd Information content of the proposal is defined as a measure of complexity and to determine the likelihood of successful creation of optimal design.

2. Process mapping of design

Design process covers three mapping between four domains (Fig. 1). The first mapping involves mapping between customer requirements (time) represented by the CTS (critical-to-critical to satisfaction = satisfaction) and the functional requirements (FRs). Functional requirements while a neutral solution (independent DPs), which reflect what the system does and are usually expressed in words, a pair of words, or triplet. Functional specifications are based upon the set of DPs. Physical mapping is a very critical view of the fact that it is necessary to define the minimum set of FRs eligible for the highest level of customer perspective. This can be achieved for example using QFD.

Figure 1

The four domains of the axiomatic design
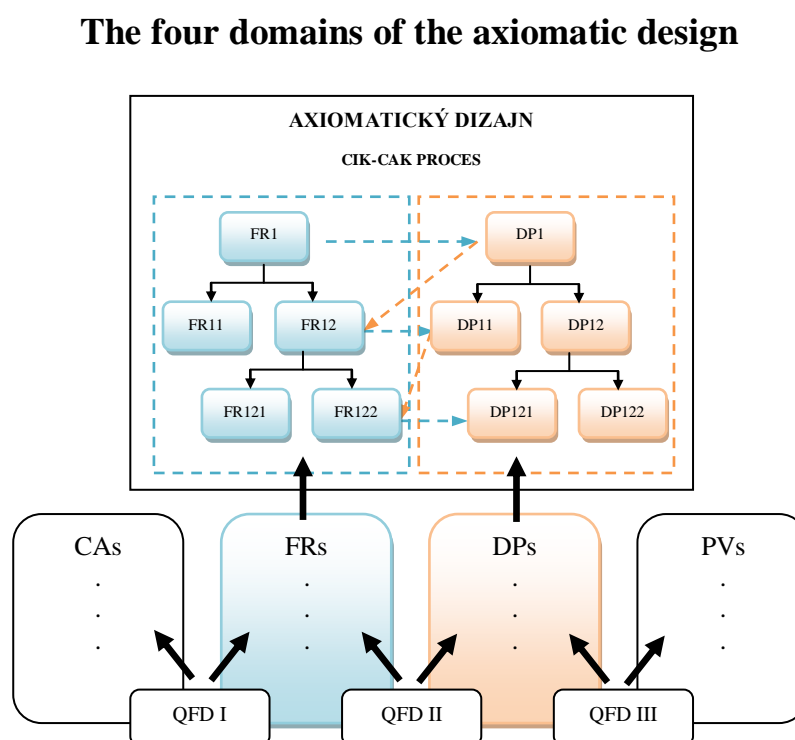
If a defined minimum set of FR or CTS, then we can start the physical mapping. This mapping includes the FR domains and sub domains DP. This represents a preliminary and detailed design phase in the development cycle and can be represented by matrices of the proposal. Set a higher level cascade FRs is decomposed to the lowest level (Figure 2). Draft set of matrices is a natural

conceptual structure that reveals the vulnerability and providing significant pairing effects chains to change the proposal.

Decomposition of physical mapping by zig-zag
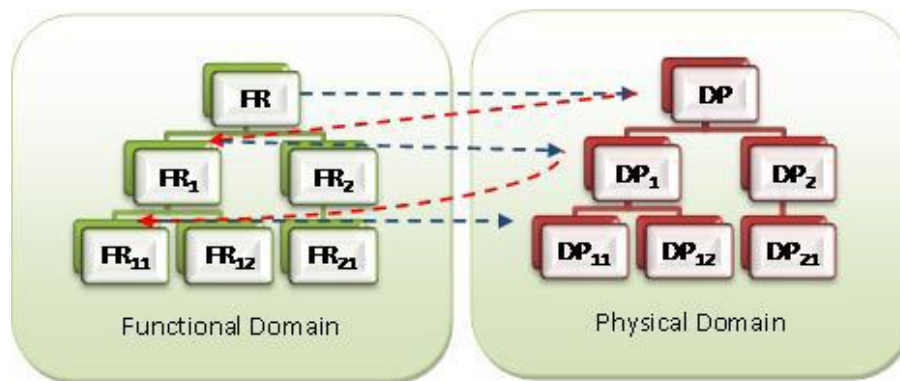
Source: Cebi, S. – Kahrman, C.: Axiomatic Design Principles under Fuzzy Environment. In: *Proceedings of 2008 3rd International Conference on Intelligent System and Knowledge Engineering.* 2008. ISBN 978-1-4244-2197-8

Process mapping is a recent mapping and requires the transfer of DP (design parameters) domain of PV (process variable) sub domain. This mapping can also be well presented in the form of a matrix describes the process and structure necessary for the transcription of DPs in the production of PVS.

Both are mapping a connection with the concept of the transfer function. The project team identifies possible relations between the two domains without the possibility of mathematical record. Later transfer function can be derived from a natural area or identified on the basis of empirical data through regression or DOE. Most of the approximated mathematical transfer functions are needed modeling and simulation.

3. Axiomatic design methodology

The first step is to identify customer requirements. Consequently, the greatest possible number of requirements should be the search by selecting FR1. To do this, it is necessary to analyze the possibility of meeting each requirement. Due to the fact, it is not possible to meet certain requirements in whole or in part, should focus on the most desired requirements that would allow others to serve in whole or in part.

Figure 3

Example for decomposed hierarchical structure of the FRs
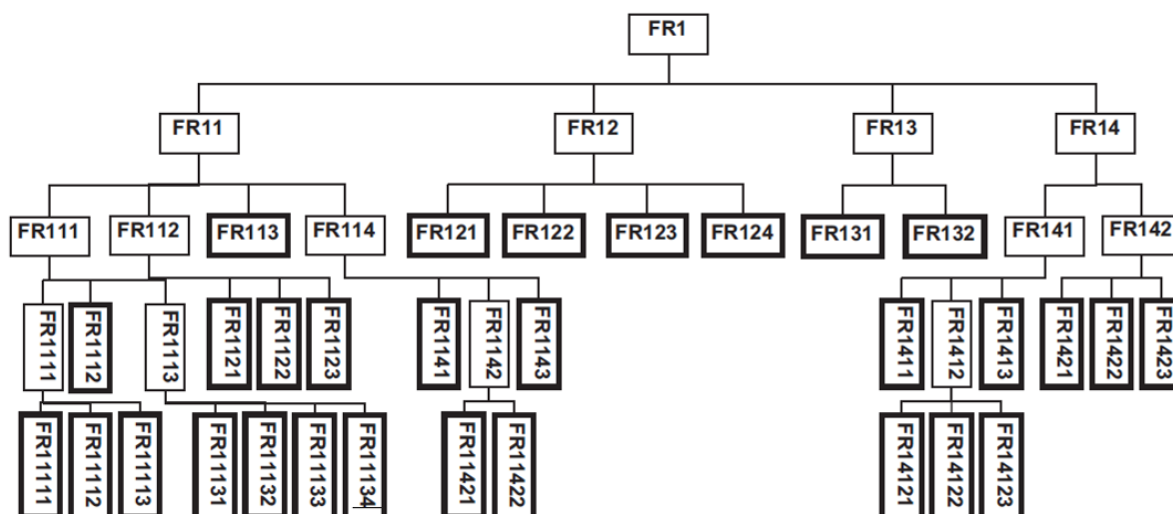
If CAs (customer attributes) are fulfilled, it begin to define the first level FR. The first functional requirement (FR) bay be: minimizing complexity in the use of the proposed product.

Figure 4

Example for decomposed hierarchical structure of the DPs
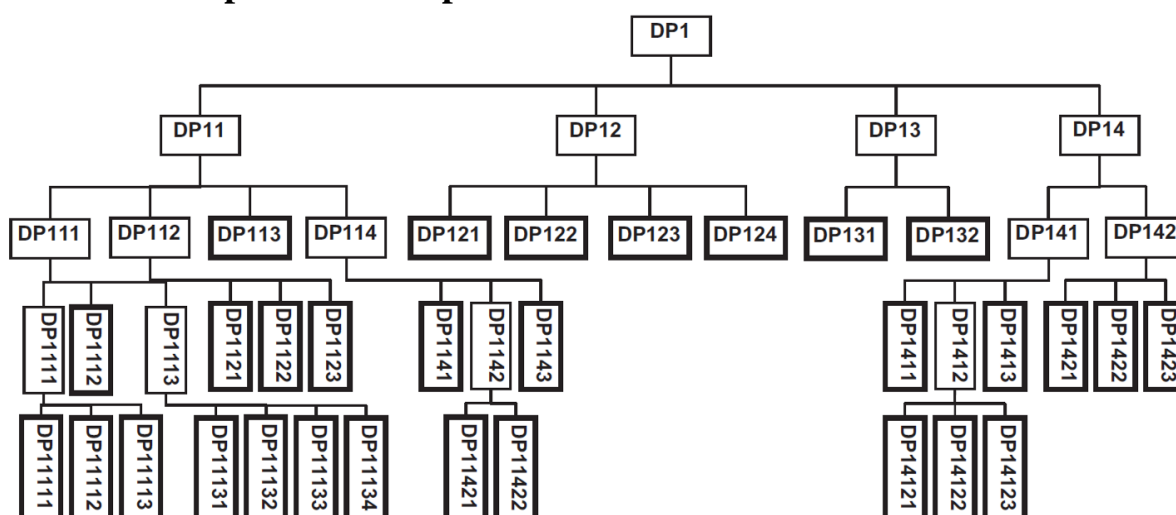
On the basis of functional requirements (FRs) is identified by a structural parameters (DPs). Identification of DPs is essentially a functional association with the requirements of a design argument. To perform it, one must ask the following question: "What are the difficulties in the use of QFD applied must be minimized model? These difficulties have been observed and identified by analysis of the literature on this issue. Difficulties in using QFD are associated with the development phase matrix quality, difficult to work in teams, with the development of a conceptual model and defining the means to evaluate the development of QFD as a result of this method is applied. If teamwork is necessary to consider the reasons which led to the use of axiomatic design in QFD. To do so, you should take into account two aspects. First, QFD was also developed to address the loss of information occurring in the gradual evolution of the product (at Ohfuji. Al., 1997). Second, the pluralist perspective, QFD looking for a different vision of product development and focus on functional business areas related to product development (Cheng, 2003). In this way it seeks to integrate knowledge from these functional areas.

3.1. Define first level of the physical mapping

Due to space limitations and understanding in detail the first and second levels of hierarchical structure, which is listed below.

Identification of customer requirements to be met, beginning with the definition of FR1. The first functional requirement should be FR: "minimize the difficulties of using QFD.

Figure 5

The first level of physical mapping
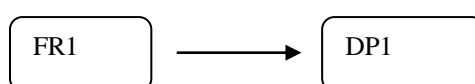
When defining the FR1 it should look for a one DP (design parameter) in the physical domain, which would satisfy the FR. There may be several alternatives for meeting between FR1 and subsequently designed DP1.

3.2. Define the second hierarchical level of physical mapping

After defining the first-level hierarchical structure should be FR1 and DP1 broken down into more detailed levels in the hierarchical order until the DPs are not detailed enough for implementation. Then start defining the DP1 is returned to FR1 detail.

Figure 6

Defining the functional requirements of the other levels
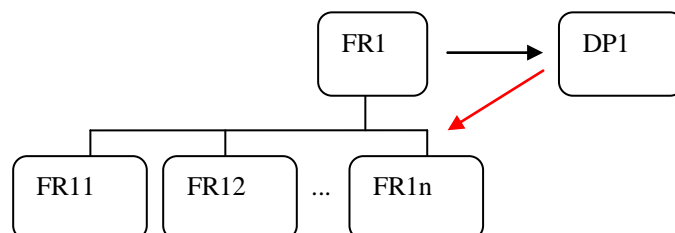
The previous consideration shows that FR1 is the identification of DP1 then broken down into detailed requirements of the other levels, ie FR11, FR12, ..., FR1n. After defining the second level hierarchy FR1 DP1 is structured in more detail by the FRS at the second stage. This means that each FR is associated DP: DP11, DP12, ..., DP1n.

Figure 7

Definovanie konštrukčných parametrov druhej úrovne
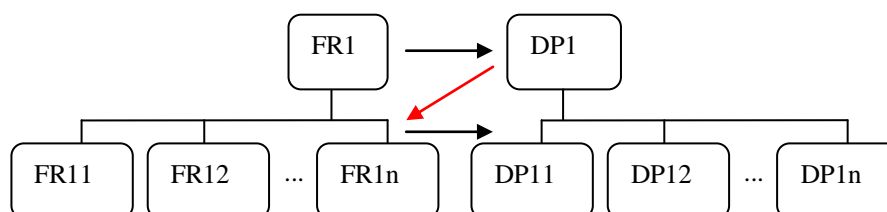
In defining the design parameter DP11, Cheng (2003) recommends the use of literature as an example of the QFD method, rather than the rule for the development of QFD matrices and tables. This makes it possible to identify the best solution for reducing the difficulties in the development of quality nuts and to show the effectiveness of FR11. In this way, continued with the identification of all DPs. Design parameters may also meet several functional requirements. Redefining the FRs and DPs on the second level we will draft a matrix to ensure that the relationship between FRs and does not violate axiom DPs first This matrix equation is represented by the first.

$$\begin{Bmatrix} FR11 \\ FR12 \\ \vdots \\ FR1n \end{Bmatrix} = \begin{vmatrix} X & 0 & \cdots & 0 \\ 0 & X & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & X & X \end{vmatrix} \times \begin{Bmatrix} DP11 \\ DP12 \\ \vdots \\ DP1n \end{Bmatrix} \qquad \textbf{(1)}$$

If there is a relationship between FRS and DPs, denoted by X. There may be three cases. First case is the *Uncoupled Design*. This is a case in which the functional requirement of just one structural parameter. If the matrix is a triangular matrix (upper / lower), we talking about the *Decoupled design*. The last case is called *Coupled design*, which includes the number of requests exceeds the number of factors, or physics cause non diagonal matrix elements are zero. Proposal may be paired or unpaired evaporation by adding the appropriate missing factors in the formulation of the problem.

The process continues in a hierarchical decomposition of functional requirements of assigning design parameters.

4. Application of axiomatic design

To understand the principle of axiomatic design procedure was applied to the teaching device, which is an overhead projector and data projector it developed.

Figure 8

Overhead projector vs. data projector

The basic requirement of the customer was a quick and easy display of written text or other graphical features on the surface of walls or other vertical surface. The customer needs to see this was clear and precise.

At the beginning of the development concept is a survey that defines the customer base, and the projection of the designated text or graphic object to a vertical surface. Overhead then decomposes by zig-zag. The critical function of the customer is marked as a FR1. To achieve this requirement is necessary to determine the structural design parameter DP1: sharp and big enough picture. After identification DP1 Returning to the FR1, which decomposes the second level of the FRS: FR11 - legibility of text; FR12 - sufficient size? The functional

requirements of design parameters match: DP11 - Sharpness control (wheel), DP12 - Focal distance control (zoom).

If we defined a second level, it is necessary to determine whether it is possible to identify further levels of decomposition of functional requirements. We identified the functional requirements for third level, namely:

- FR111 – sharpness,
- FR112 – sufficient aperture,
- FR113 – stable power light source,
- FR121 – the size of your display area,
- FR122 – adjustment of the projection head,
- FR131 – low weight.

Functional requirements identified by the third level are influenced by the following design parameters:

- DP111 – levels of sharpness control settings,
- DP112 – power source,
- DP113 – protection against overheating,
- DP121 – structural distance from the wall,
- DP122 – control the amount of projection head,
- DP131 – choose materials with low weight.

Figure 9

Decomposition of a hierarchical structure of soils
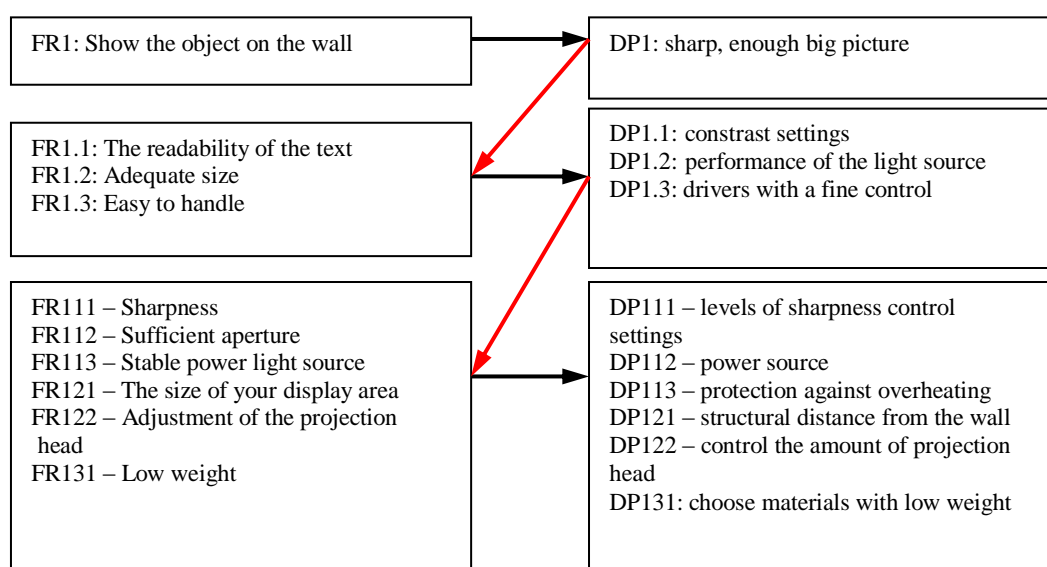
Next is to define the relationship matrix of design between FRs and DPs.

$$
\begin{Bmatrix} FR111 \\ FR112 \\ FR113 \\ FR121 \\ FR122 \\ FR131 \end{Bmatrix} =
\begin{vmatrix} X & 0 & 0 & X & X & 0 \\ 0 & X & 0 & 0 & 0 & 0 \\ 0 & X & X & 0 & 0 & 0 \\ 0 & 0 & 0 & X & X & 0 \\ 0 & 0 & 0 & 0 & X & 0 \\ 0 & 0 & 0 & 0 & 0 & X \end{vmatrix} \times
\begin{Bmatrix} DP111 \\ DP112 \\ DP113 \\ DP121 \\ DP122 \\ DP131 \end{Bmatrix} \quad (2)
$$

The matrix is evident that the partially coupled design. It is necessary to change the design parameters so as to obtain uncoupled design. The first step is to identify design parameters that affect more than one functional requirement. That parameter is the driver wheeled field, which in addition to turning the focus changes the image size on the wall.

Proposal for improvement of soils:

1. *Sharp exchange control (circles) for two separate drivers,*
2. *Remove the head design and its replacement by installing optical lenses directly to the projector,*
3. *Control the outbreak through distance control,*
4. *Reduce the dimensions of soils for better handling and portability.*

These proposals to change the appearance of forehead and back of the projector data projector have been developed with the evaporation of its functions.

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WPŁYW CZYNNIKÓW OSOBOWOŚCIOWYCH NA POSTAWY STUDENTÓW AKADEMII WYCHOWANIA FIZYCZNEGO

Aleksandra KOPEĆ – Jolanta URBAŃSKA

Wstęp

Obecnie najbardziej preferowaną ze względów praktycznych i teoretycznych jest propozycja skoncentrowana na potwierdzaniu wagi podstawowych cech osobowości, które określa się mianem Wielkiej Piątki (z ang. Big Five). Punktem wyjścia do późniejszego rozbudowania w formę teorii Wielkiej Piątki były analizy empiryczne. Teoria ta zakładała, że cechy są podstawą indywidualności i elementami tworzącymi osobowość człowieka. [3] W ciągu życia jednostki jego cechy wpływają na specyficzne sposoby adaptacji jak na przykład: postawy, dążenia osobiste czy przekonania o własnej skuteczności. [4] Autorzy, którzy najbardziej przyczynili się do rozwoju badań w zakresie cech i dalej konstrukcji teorii, to Paul T. Costa oraz Robert R. McCrae. Autorzy nie podają w literaturze teoretycznej definicji osobowości. Próbują natomiast zdefiniować osobowość operacyjnie, rozumiejąc przez to pojęcie: „strukturę najbardziej podstawowych czynników, wpływających na cechy identyfikowane zarówno w naturalnych językach, jak i kwestionariuszach psychologicznych. Czynniki te definiowane są przez grupy skorelowanych cech." [5]

Geneza Modelu Wielkiej Piątki

Model Costy i McCrae pozostaje w opozycji do teorii PEN Eysencka i zwiększa liczbę super czynników osobowości z trzech do pięciu. Jest on również w pewnym stopniu konkurencyjny dla innych pięcioczynnikowych modeli, z którymi łączy go jedynie liczba czynników, a nie ich treść. Na tle analiz, model Costy i McCrae wydaje się być najbardziej rozwiniętym metodologicznie i psychologicznie. [6] Określenie „wymiar różnic indywidualnych" oznacza możliwość uporządkowania ludzi ze względu na natężenie danej cechy. Cecha jest jednak w tym przypadku tylko dyspozycją, a nie determinantą zachowania.

Punktem wyjścia do stworzenia modelu Wielkiej Piątki była lista nazw cech opracowana przez Allporta i Odberta. [7] Auto.rzy ci stworzyli cztery grupy cech i podzielili prawie 18 tysięcy określeń na:

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3   Zimbardo, P.G. (2006). Psychologia i życie. Warszawa: PWN.
4   Oleś, P.K. (2003) Wprowadzenie do psychologii osobowości. Wydawnictwo Naukowe Scholar.
5   Zawadzki, B., Strelau, J., Szczepaniak, P., Śliwińska ,M. (1998). Inwentarz osobowości NEO-FFI Costy i McCrae. Adaptacja polska. Podręcznik Warszawa: PTP.
6   ibidem
7   Gasiul, H. (2006). Psychologia osobowości. Nurty, teorie, koncepcje. Warszawa: Centrum Doradztwa i Informacji Difin.

1. cechy stabilne
2. przejściowe stany
3. ewaluacje społeczne
4. metaforyczne, fizyczne i niejasne określenia

Lista ta stała się podstawą analiz przeprowadzonych przez późniejszych badaczy osobowości, którzy systematycznie ją upraszczali. Ostatecznie Costa i McCrae posługując się stwierdzeniami, do których mieli ustosunkować się badani wyodrębnili pięć wymiarów osobowości, które zostały później powszechnie zaakceptowane. Te wymiary to: ekstrawersja, ugodowość, sumienność, neurotyzm i otwartość. W ujęciu autorów treść poszczególnych wymiarów przedstawia się następująco:

1. Wymiar Neurotyzmu określa właściwości sfery emocjonalnego reagowania jednostki opisując stopień zrównoważenia, jakość przeżywanych emocji, poziom odporności na stres oraz skalę realizmu myślenia. Jest to wymiar odzwierciedlający przystosowanie emocjonalne vs emocjonalne niezrównoważenie. Oznacza podatność na doświadczenie negatywnych emocji takich jak strach, gniew, poczucie winy, zmieszanie czy niezadowolenie. Wysoki wynik na skali Neurotyzmu obejmuje: lęk, agresywną wrogość, depresyjność, impulsywność, nadwrażliwość oraz nadmierny samokrytycyzm.

2. Ekstrawersja jest wymiarem charakteryzującym jakość i ilość interakcji społecznych oraz poziom aktywności, energii i zdolności do odczuwania pozytywnych emocji. Wymiar Ekstrawersji dotyczy społecznego funkcjonowania człowieka, określając zakres i jakość nawiązywanych przez jednostkę kontaktów społecznych. Wysoki wynik na skali Ekstrawersji obejmuje: towarzyskość, serdeczność, asertywność, aktywność, poszukiwanie doznań oraz emocjonalność w zakresie pozytywnych emocji.

3. Otwartość na doświadczenie opisuje tendencje jednostki do poszukiwania i pozytywnego wartościowania doświadczeń życiowych, tolerancję wobec nowości i ciekawość poznawczą. Wymiar ten wiąże się z intelektualną sferą funkcjonowania człowieka, odzwierciedlając jego stosunek do nowych doświadczeń oraz tendencję do ich poszukiwania. Wysoki wynik na skali Otwartości na doświadczenie obejmuje: wyobraźnię, estetykę, uczuciowość oraz intelektualną ciekawość.

4. Ugodowość opisuje pozytywne vs negatywne nastawienie do innych ludzi, orientację interpersonalną przejawiającą się w altruizmie vs antagonizmie, doświadczanych w uczuciach, myślach i działaniu. Wymiar ten związany jest z jakością ustosunkowań wobec innych ludzi opisując rodzaj nastawienia dominującego w istniejących i tworzonych przez jednostkę relacjach interpersonalnych. Wysoki wynik na skali Ugodowości obejmuje:

zaufanie, prostolinijność, altruizm, ustępliwość, skromność oraz skłonność do rozczulania się.

5. Sumienność jest wymiarem, który charakteryzuje stopień zorganizowania, wytrwałości i motywacji jednostki w działaniach zorientowanych na cel – opisuje stosunek człowieka do pracy. Wymiar Sumienności opisuje zadaniową sferę zachowania człowieka, obrazując stosunek jednostki do powierzonej jej pracy. Wysoki wynik na skali Sumienności obejmuje: kompetencję, skłonność do utrzymywania porządku, obowiązkowość, dążenie do osiągnięć, samodyscyplinę, oraz rozwagę.

Model Wielkiej Piątki ma swoich zwolenników jak i przeciwników. Zwolennicy postulują za tym, iż jest to model struktury osobowości, który jest prosty i uniwersalny oraz najlepiej jak dotąd potwierdzony w badaniach empirycznych. Jest to zarazem koncepcja porządkująca teorię cech, która pozwala na orientację, jaki aspekt osobowości jest przedmiotem badań. Stanowi teoretyczną podstawę leksykalnych i psychometrycznych badań nad strukturalną organizacją osobowości i jest propozycją integracji nauk o osobowości, ukazując miejsce i znaczenie teorii cech. Zarzuty stawiane teorii Costy i McCrae wiążą się z teorią, iż model Wielkiej Piątki jest sprowadzeniem poznania osobowości do opisu i gubi unikalność jednostki, posługując się danymi liczbowymi i analizą czynnikową. Krytyce poddano również statystyczne ujęcie cech w tej teorii, które nie nadaje się do wyjaśniania zmian osobowości i wzorców zachowania oraz nie prowadzi do wyjaśniania mechanizmów łączących się z dynamiczną organizacją i integracją osobowości.[8]

Można jednak pokusić się o stwierdzenie, że poprzez wyszczególnienie ponadkulturowych, ponadczasowych, transsytuacyjnych, ponaddemograficznych oraz strukturalnie najbardziej ogólnych wymiarów model ten pozwala na względnie pełną i wszechstronną charakterystykę różnic indywidualnych, która z powodzeniem może znaleźć zastosowanie w różnego rodzaju badaniach empirycznych dla wielu dziedzin nauki.

1. Studenci AWF aktywnie uprawiający sport powinni charakteryzować się wysoką Ekstrawersja, Sumiennością i Otwartością na doświadczenie a niską Neurotycznością i Ugodowością.

2. Płeć i wiek są potencjalnymi czynnikami wpływającymi na motywację celu, motywację zwyciężania i motywację do współzawodniczenia badanych studentów. Kobiety powinny charakteryzować się większą motywacją do współzawodniczenia, mężczyźni natomiast motywacją skierowaną na cel.

3. Zróżnicowanie płciowe i wiek mogą wpływać na różnice w orientacji na współzawodniczenie i orientacji na mistrzostwo. Mężczyźni powinni być bardziej zorientowani na mistrzostwo, a kobiety na współzawodniczenie.

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8   Oleś, P.K. (2002). Rozwój osobowości. W: B. Harwas-Napierała i J. Trempała (red.), Psychologia rozwoju człowieka. Rozwój funkcji psychicznych. T.3.(s.131-171) Warszawa: PWN.

4. Zarówno kobiety jak i mężczyźni aktywnie uprawiający aktywność fizyczną powinni charakteryzować się wysoką nadzieją na sukces sportowy, czyli dużą siłą woli i umiejętnościami znajdywania rozwiązań.
5. Osobowość studentów będzie miała wpływ na ich orientację na współzawodniczenie i orientację na mistrzostwo. Ekstrawertycy powinni być bardziej zorientowani na mistrzostwo, a osoby o wysokiej Ugodowości i Neurotyzmie – na współzawodniczenie.

Osób z motywacją skierowaną na zwyciężanie i cel oraz u osób z motywacją skierowaną na współzawodniczenie wystąpią różnice osobowości. Motywacja Ekstrawertyków będzie skierowana na zwyciężanie, a Neurotyków na współzawodniczenie.

1. Próba badawcza

Badania zostały przeprowadzona na studentach Akademii Wychowania Fizycznego im. Bronisława Czecha w Krakowie.

W badaniach wzięło udział 198 studentów, w tym 111 kobiet i 87 mężczyzn. Osoby badane były studentami wszystkich lat studiów. Wszyscy badani zadeklarowali, iż aktywnie uprawiają co najmniej jedną dyscyplinę sportu. Najmłodszy badany miał 20 lat, najstarszy natomiast 27. Wszystkie osoby, które wzięły udział w badaniach, zadeklarowały dobrowolnie uczestnictwo w wypełnieniu ankiety, a przedmiotowe badania miały formę anonimowego wypełniania rozdanych kwestionariuszy w wersji papierowej.

Biorąc pod uwagę liczebność próby badawczej stanowiącą ok. 20% populacji studentów kierunku Wychowanie Fizyczne dla wszystkich lat w badanej uczelni, możemy uznać ją za liczebnie reprezentatywną. Reprezentatywność ta dotyczy również struktury płci i wieku badanych.

2. Metodyka badań
2.1. Kwestionariusz NEO - Five Factory Inventary Paul T. Costa, Jr. i Robert R. McCrae

Inwentarz osobowości NEO-FFI Paul'a T. Costa, Jr. i Roberta R. McCrae w polskiej adaptacji opracowali: P. Szczepaniak, M. Śliwińska, J. Strelau, B. Zawadzki. Jest to narzędzie umożliwiające diagnozę pięciu podstawowych cech osobowości: neurotyczności, ekstrawersji, otwartości na doświadczenie, ugodowości oraz sumienności. Służy do rzetelnej diagnozy cech osobowości z modelu Wielkiej Piątki, których szczegółową charakterystykę zamieszczono w części teoretycznej tej pracy. Kwestionariusz ten jest powszechnie stosowany w praktyce psychologicznej. Badania nad charakterystyką psychometryczną kwestionariusza NEO-FFI są prowadzone od wielu lat i wskaźniki rzetelności są

bardzo dobre. Dodatkowo narzędzie to jest stosunkowo krótkie i nie posiada żadnych ograniczeń, co do płci i może być stosowany w dość szerokim przedziale wiekowym.

Zanim skonstruowany został kwestionariusz NEO-FFI, Costa i McCrae stworzyli kilka inwentarzy osobowości. Pierwszy z nich nosił nazwę „NEO Inventory", zawierał 144 pozycje i diagnozował trzy wymiary: neurotyczność, ekstrawersję i otwartość na doświadczenie. Kolejny, znany pod nazwą „NEO – Personality Inventory", zawierał już skale diagnozujące wszystkie pięć cech i 180 pozycji oraz jedną pozycję kontrolną. Najnowsza wersja „Revised NEO Personality Inventory" pozwala na pomiar głównych cech osobowości wraz z ich składnikami. Wersja ta obejmuje 240 pozycji. Dla celów diagnozy wyłącznie podstawowych cech osobowości, bez ich składników, autorzy opracowali NEO-FFI. W rezultacie skrócenia NEO-PI. Powstały inwentarz składa się z 60 pozycji, po 20 w każdej z pięciu skal[9] (Zawadzki, Strelau, Szczepaniak, Śliwińska,1998).

2.2. Weryfikacja hipotezy nr1: Analiza statystyczna wyników Kwestionariusza NEO-FFI

Tabela 1

Statystyki opisowe zmiennych kwestionariusza NEO FFI dla całej próby

Cecha	Statystyki opisowe				
	N	Średnia	Wynik minimalny	Wynik maksymalny	Odchylenie Standardowe
Neurotyczność	198	30,73	12	51	7,16
Ekstrawersja	198	43,79	32	56	5,74
Otwartość na doświadczenia	198	37,24	26	52	5,47
Ugodowość	198	42,88	32	53	4,94
Sumienność	198	42,70	30	59	5,58

Źródło: Opracowanie własne

Prezentowane wyniki (tabela 1) wskazują na kilka ważnych – jak się wydaje – kwestii. Badana próba uzyskała najsłabsze wyniki na skali neurotyczności przy jednakowym nasileniu cech ekstrawersji ugodowości i sumienności (średni wynik wynikający z przyjętej skali to 36). Cechą najbardziej różnicującą grupę jest neurotyczność – dyspersja mierzona współczynnikiem zmienności wynosi 23,29%. Pozostałe cechy charakteryzują się kilkunastoprocentową zmiennością. Wartym odnotowania jest również wystąpienie minimalnej oceny w przypadku neurotyczności – 12, przy maksymalnej z pozostałych cech – sumienności na poziomie 59.

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9   op. cit. Zawadzki, B., Strelau, J., Szczepaniak, P., Śliwińska, M. (1998).

Tabela 2

Statystyki opisowe zmiennych kwestionariusza NEO FFI dla kobiet

	Statystyki opisowe				
Cecha	**N**	**Średnia**	**Wynik minimalny**	**Wynik maksymalny**	**Odchylenie Standardowe**
Neurotyczność	111	32,65	20	51	6,15
Ekstrawersja	111	43,73	32	54	5,52
Otwartość na doświadczenia	111	37,41	26	52	5,79
Ugodowość	111	44,27	34	53	4,45
Sumienność	111	42,73	31	53	5,11

Źródło: Opracowanie własne

Tabela 3

Statystyki opisowe zmiennych kwestionariusza NEO FFI dla mężczyzn

	Statystyki opisowe				
Cecha	**N**	**Średnia**	**Wynik minimalny**	**Wynik maksymalny**	**Odchylenie Standardowe**
Neurotyczność	87	28,28	12	46	7,59
Ekstrawersja	87	43,86	34	56	5,99
Otwartość na doświadczenia	87	37,03	29	47	5,03
Ugodowość	87	41,10	32	52	4,96
Sumienność	87	42,66	30	59	6,13

Źródło: Opracowanie własne

Grupa mężczyzn w próbie badawczej (tabela 2 i 3) charakteryzowała się wyraźnie wyższą zmiennością w zakresie neurotyczności i sumienności względem kobiet. Pozostałe zmienne, poza otwartością na doświadczenie, charakteryzowały się również nieco wyższą zmiennością w grupie mężczyzn, przy czym różnice te były nieistotne statystycznie.

Tabela 4

Wartości testowe i poziomy odrzucenia dla testów równości średniej i wariancji w podziale na plec

Cecha	Test równości średniej	p - value	Test równości wariancji	p - value
Neurotyczność	**4,366***	0,000	**1,525***	0,021
Ekstrawersja	-0,160	0,563	1,177	0,216
Otwartość na doświadczenia	0,481	0,315	1,323	0,088
Ugodowość	**4,662***	0,000	1,247	0,143
Sumienność	0,091	0,464	**1,439***	0,040

* - wartość istotna statystycznie na poziomie istotności α = 0,05
Źródło: Opracowanie własne

Co się tyczy średnich ocen badanych cech (tabela 4), wartości wyznaczone dla kobiet w zakresie neurotyczności i ugodowości były istotnie wyższe niż dla mężczyzn.

Korzystając z posiadanych danych wyznaczono współczynniki korelacji pomiędzy poszczególnymi cechami określanymi przez wybrane zagadnienia zawarte w kwestionariuszu NEO FFI (tabela 5).

Tabela 5

Wartości współczynników korelacji pomiędzy wybranymi cechami kwestionariusza NEO FFI dla całej próby

Cecha	Neurotycz-ność	Ekstrawersja	Otwartość na doświadczenia	Ugodowość	Sumienność
Neurotyczność	1				
Ekstrawersja	**-0,46278***	1			
Otwartość na doświadczenia	-0,00141	-0,01622	1		
Ugodowość	-0,07039	**0,138737***	0,145141	1	
Sumienność	**-0,31324***	0,014565	**0,139828***	**0,218698***	1

* - wartość istotna statystycznie na poziomie istotności α = 0,05
Źródło: Opracowanie własne

Możemy mówić o wysoce istotnej statystycznie zależności ujemnej pomiędzy Neurotycznością i Ekstrawersją oraz Sumiennością (tabela 5). Zatem osoby charakteryzujące się wysokim poziomem Neurotyczności powinny jednocześnie charakteryzować się odpowiednio niższym poziomem Ekstrawersji i Sumienności. Zależność ta ma charakter obustronny (symetryczny). Sumienność wykazała związek pozytywny (dodatni) z Otwartością na doświadczenie i Ugodowością. Ugodowość z kolei nikły, aczkolwiek istotny związek dodatni z Ekstrawersją.

Tabela 6

Wartości współczynników korelacji pomiędzy wybranymi cechami kwestionariusza NEO FFI dla kobiet

Cecha	Neurotycz-ność	Ekstrawersja	Otwartość na doświadczenia	Ugodowość	Sumienność
Neurotyczność	1				
Ekstrawersja	**-0,54868***	1			
Otwartość na doświadczenia	-0,04534	-0,01094	1		
Ugodowość	**-0,2032***	0,142724	0,069226	1	
Sumienność	**-0,18463***	-0,09645	0,021064	**0,199601***	1

* - wartość istotna statystycznie na poziomie istotności α = 0,05
Źródło: Opracowanie własne

W grupie kobiet (tabela 6) potwierdzono istnienie istotnych statystycznie zależności pomiędzy Neurotycznością a Ugodowością, oraz Sumiennością i Ekstrawersją. Zależności te mają charakter ujemny i co warto wspomnieć w przypadku relacji Ekstrawersja – Neurotyczność mamy do czynienia z bardzo wyraźną (r = -0,549) zależnością. Podobnie jak w przypadku badań ogólnych potwierdzono istotną, dodatnią, umiarkowaną zależność pomiędzy Ugodowością i Sumiennością.

Tabela 7

Wartości współczynników korelacji pomiędzy wybranymi cechami kwestionariusza NEO FFI dla mężczyzn

Cecha	Neurotycz-ność	Ekstrawersja	Otwartość na doświadczenia	Ugodowość	Sumienność
Neurotyczność	1				
Ekstrawersja	**-0,42053***	1			
Otwartość na doświadczenia	0,02682	-0,02270	1		
Ugodowość	-0,16817	0,15812	**0,23994***	1	
Sumienność	**-0,45681***	0,12362	**0,28883***	**0,25627***	1

* - wartość istotna statystycznie na poziomie istotności α = 0,05
Źródło: Opracowanie własne

W grupie mężczyzn (tabela 7) wskazano na istotne statystycznie zależności pomiędzy Sumiennością a Otwartością na doświadczenie i Ugodowością (dodatnie) oraz Neurotycznością (ujemną). Ponadto potwierdzono umiarkowaną dodatnią zależność Ugodowość – Otwartość na doświadczenia i ujemną relację Neurotyczność – Ekstrawersja. Wspomniane ujemne relacje Neurotyczności są dość silne – powyżej 0,4. Mimo istniejących różnic, wartości otrzymanych współczynników korelacji dla obu płci okazały się nieistotnie różne od siebie co wskazywałoby na jednorodność próby pod względem badanych cech. Ponadto w opracowaniu podjęto próbę weryfikacji trafności stosowania wskazanego testu w ujęciu prezentowanym literaturze. W pierwszej kolejności podjęto próbę grupowania posiadanych wyników z wykorzystaniem metody Warda (rys.1).

Prezentowany rysunek (rys.1) wskazuje wyraźnie na podział na pięć grup/cech, przy czym skład poszczególnych mierników w niektórych przypadkach nawet znacznie różni się od wartości znanych z literatury.

Diagram analizy skupień przeprowadzonej metoda Warda w oparciu o wyniki kwestionariusza NEO FFI
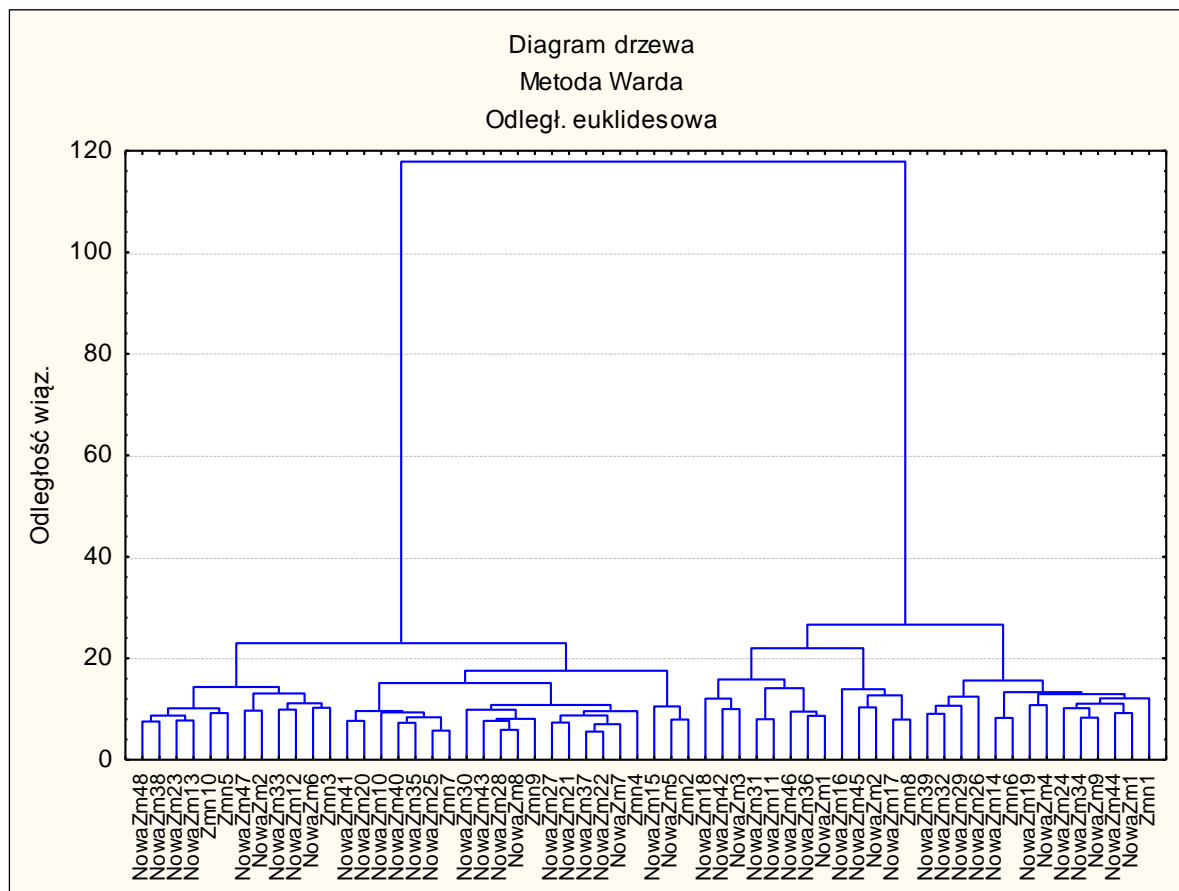
Źródło: Opracowanie własne

W związku z powyższym przeprowadzono analizę rzetelności pozycji dla każdej z pięciu zmiennych (tabela 8) i otrzymano następujące wyniki:

Tabela 8

Wartości współczynników rzetelności pozycji

cecha	Alfa Cronbacha	Alfa standaryzowana	Liczba składowych	Alfa Cronbacha „pierwotna"
Neurotyczność	0,808	0,807	8	0,794
Ekstrawersja	0,765	0,773	11	0,751
Otwartość na doświadczenia	0,761	0,760	5	0,629
Ugodowość	0,706	0,707	8	0,675
Sumienność	0,765	0,770	12	0,765

Źródło: Opracowanie własne

Prezentowane wartości współczynników Alfa Cronbacha (tabela 8) wskazują na właściwą rzetelność konstrukcji wskaźników, przy czym w trzech przypadkach sugerowane są ograniczenia liczby składników poszczególnych

cech. W podejściu pierwotnym – zakładającym 12 składowych – wartości opisywanych współczynników alfa były i tak dość wysokie – wynosiły od 0,629 do 0,794. wartości te jak najbardziej upoważniają nas do wykorzystania wspomnianych wcześniej miar cech nawet w wersjach podstawowych.

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QUALITY IMPROVEMENT OF THE TEACHING PROCESS

Erika LIPTÁKOVÁ

Abstract
Many educational institutions including universities are now working on to introduce or already have implemented the quality management system. These organizations must declare efforts and continuously improve their processes. The main processes in such an institution include also an educational process. In this article we show how to improve a teaching process specifically in an *Introductory to statistics* course which is included in the study programs of many universities. We show a way how to change the teaching of statistics from knowledge of procedures and calculations to a deeper understanding of statistical ideas.

Keywords: quality improvement, teaching process, statistics, statistical reasoning

Introduction

Educational institutions that wish to implement a quality management system must declare their efforts and continuously improve their processes. The main processes of such institutions include also the educational process. The improvement of this process includes, among others, the improvement of teaching process. This process is affected by several aspects, including the motivation of students and teaching style.

Students at the universities with different focus, whether economic, technical, social or natural sciences, have in mandatory completion of an Introduction to statistics course.

From a study of articles about the teaching of statistics at the colleges (Moore, 1997; Gal, 2004; Garfield & Ben-Zvi, 2009), from my own and my colleague´s experiences is known that teachers in classroom encounter various problems:

- The students´ passive approach to the learning process;
- Students' fear of statistics;
- Negative comments to the address of the statistics on its completion;
- Frustration of the teacher in teaching students who have a little motivation, less mathematical ability, or non-presence on the hours or are very weak on verification of knowledge.

To eliminate these problems requires rethinking, how we teach and what methods we use. The central idea of improving quality of statistics education is a waiver from "information exchange" in favour of "constructivistic" view of education.

In this article there is presented one of the ways of teaching statistics which, we believe, will contribute to improve the quality of teaching this subject.

1. Improving the quality of processes

At present many educational institutions including universities try to implement or already have implemented the quality management system. The introduction of quality management system in organization requires, among other things, also monitoring, measuring and analyzing processes and implementing necessary actions to achieve planned results and continuous improvement processes.

The educational process is one of the main processes running in the college. The "college managers" as well as teachers in such institution should satisfy the requirements of the "customers" of training - students and their future employers. This is necessary to ensure continuous improvement of the educational process.

2. Prospective managers and statistics

Many prospective managers of the companies are now studying at business schools. Specific knowledge, skills and abilities are imposed at managers. One of the areas of managerial work is the assessment of results, their treatment and overall assessment (Liptáková & Andrejkovič, 2010). Their analysis and the creation of the conclusions require good knowledge of the basic concepts and tools of statistics.

The amount of information which should be analyzed by a good manager at his work must be processed accurately and properly. Therefore, active use of statistical thinking, the ability to make conclusions, the use of the language of statistics and the statistical arguments used in his work are prerequisite for success.

3. Reform movements in the teaching and learning of statistics

Two reform movements have been affecting the teaching and learning of statistics at all educational level:
1. The reform focused on content and pedagogy, shifting the focus from computation and procedures to an emphasis on statistical reasoning and thinking (Moore, 1997).
2. The reform in the area of student assessment, focusing on better alignment of instruction with important learning goals, and using assessment as a tool to improve student learning (Chance & Garfield, 2002).

Currently, there is preferred shift from the traditional view of teaching statistics as part of mathematics (with an emphasis on calculations, formulas and

procedures) for the view, which considers mathematics and statistics as separate disciplines. According to Moore (1997): "Statistics is a mathematical science but is not a part of mathematics. It is a discipline with its own rules, with the distinctive ways of thinking that are more important than any specific methods or mathematical theory."

4. Constructivist view of learning

The central idea of the new pedagogy is the abandonment of an "information transfer" model in favour of a "constructivist" view of learning: students are not empty vessels to be filled with knowledge poured in by teachers. Its basic principles could be summarized as follows (Cobb, 1994):

1. People learn by constructing knowledge, rather than by receiving knowledge.
2. New knowledge and understanding are based on the existing knowledge and beliefs we already have and are grounded in our experiences.
3. We learn by doing.
4. When we learn, our previous knowledge does not go away; it is integrated with the new knowledge.

The implication of the constructivist theory of learning to practise involves activities that provide students many opportunities to think, reason, and reflect on their learning, as well as discussing and reflecting with their peers. It does not mean that teachers should never tell students anything directly and instead should always allow them to construct knowledge for themselves. Rather it means that learning is enhanced when teachers:

- pay attention to the knowledge and beliefs that learners bring to a learning task;
- use this knowledge as a starting point for new instruction;
- monitor students´ changing conceptions as instruction proceeds.

5. Active learning

Students must necessarily be mobilized, if we want to teach effectively. Than they will increasingly be involved in developing their own knowledge. Educational methods in which the activity of students in the learning process is higher than the activity of the teacher is called active learning.

The use of active learning methods in introductory statistics courses is nothing new. Already Shaugnessy (1977) in their experiment showed that students teaching by active learning methods have been successful in understanding the important statistical concepts and methods, as students in the

traditional form of teaching. Gnanadeskian, Scheaffer, Watkins and Witmer (1996) published an article from which we quote: *"That students acquire a basic understanding of statistical concepts, an initial orientation course statistics must change from the traditional form (the teacher lectures, the students listen) to form to motivate students. .... These activities made statistics available to students like an experimental science rather than a traditional course in mathematics. Activity-based approach improves students' attention to the exercises, increasing their motivation and understanding of concepts. "*

The paper of the American Statistical Association (2005) says: *"The use of active learning methods in teaching is a way for students to make collaborative learning in which students learn from one another. These methods allow students to discover, construct and understand important statistical ideas and contribute to the development of statistical thinking. They have added value in that it engages students in learning and make learning process more fun. "*

The proposed change in the way of teaching is based on the active learning methods. The students in the exercises actively produce themselves statistical samples and discuss the statistical problems.

6. Statistical literacy, reasoning and thinking

The concepts of statistical literacy, reasoning and thinking are closely linked to the statistical learning.

Statistical literacy includes basic skills such as displaying data in graphs and tables, an understanding of statistical concepts, vocabulary and symbols and understanding the likelihood as a measure of uncertainty. We likened it to "*ability to understand and critically evaluate statistical results that permeate daily life*" (Gal, 2004). This means that every educated person in our society should be able to read, organize, interpret and critically evaluate statistical information presented in the media, websites, newspapers and magazines

Statistical reasoning requires the ability to interpret data on graphs, tables and statistical conclusions. It also includes the ability to make connections and explain relationships between different statistical processes. Statistical reasoning implies an understanding and ability to explain statistical processes and the ability to fully interpret statistical results (Ben-Zvi & Garfield, 2004). Statistical reasoning offers local look at how one understands the statistical information in a particular situation.

Statistical thinking is an overview of the process of statistical investigation. It focuses on how and why to make statistical conclusions. This includes knowing when and how technology can be used to adequately analyze the data. Furthermore, here we include the ability to know how and why we can apply the conclusions drawn from the sample for the entire base set. Statistically, thinking

people are able to evaluate and criticize the statistical study (Ben-Zvi & Garfield, 2004).

7. Develop an understanding of statistics

The current trend in teaching statistics is focused on the development of the deeper and more meaningful understanding and help students develop their statistical capacity to think and argue. This approach is effective when uses interactive combination of the text materials, class activities, discussion, technology, teaching approach and assessment. This is based on six principles of instructional design described by Cobb and McClain (2004):

1. Focus on developing central statistical ideas rather than on presenting set of tools and procedure.
2. Use real and motivating data sets to engage students in making and testing conjectures.
3. Use classroom activities to support the development of students´ reasoning.
4. Integrate the use of appropriate technological tools that allow students to test their conjectures, explore and analyze data, and develop their statistical reasoning.
5. Promote classroom discourse that includes statistical arguments and sustained exchanges that focus on significant statistical ideas.
6. Use assessment to learn what students know and to monitor the development of their statistical learning as well as to evaluate instructional plans and progress.

8. Traditional teaching vs. training aimed to develop an understanding

The main reason for the change of approach in which the teacher is in the center, to an approach where the student is in the centre, is that the second approach is more effective in helping students develop and deepen understanding of statistics, the ability to utilize what they have learned in school or in the real world. One problem with the *"teacher says"* is that students rarely have the opportunity to develop a deeper understanding of what they have learned and quickly forgotten knowledge on successful completion of the object (by taking the test).

8.1. "Traditional" education

Students arriving for training without too much expectations, what they learn, ready to write what the teacher says. The teacher presents many formulas and calculation procedures, as supplemented by examples, some data analysis and

demonstrations. Students listen, make notes and maybe even ask a question. They leave home by typing exercises arising from the information currently undergoing training. At home, try to solve problems in search of his prepared remarks or in the textbook examples, but sometimes they are frustrated from being unable to cope with the award. At the heart of the "traditional" teaching is the teacher and when preparing for the teaching he asks himself what to tell to students or what to cover. The teacher is a kind of feeder knowledge in class.

8.2. Teaching aimed at developing a deeper understanding

This approach is more focused on students. The teacher when preparing for class asks himself what to do to encourage students to learn, how to engage students in teaching activities, in development of argumentation, in discussion considerations, team work, etc. The teacher acts as mentor, as the co-learner or broker.

Students know they have to be prepared for classwork - to study the pre-announced topic from various sources (books, lectures, Internet ...). Students come to the exercise with the pre-vision concepts and techniques. Education begins with a brief summary of what students learned in previous exercises, they may ask questions about taken over the curriculum. These questions should reflect the students and /or teacher. The teacher rarely answers the question directly, but often asks students what they think about the problem, what is their opinion. If a student answers, the teacher also invites others to comment on this response.

After this introduction, students are ready to start the first activity. They can get a script or exercise worksheet to accompany their lessons. Students are asked questions like: "What do you think about...?" What would you expect from...? ". What happens if ..? etc. Students form small groups, discuss these issues and then share and compare their account and speculation, hypotheses and arguments with peers.

In another part of the exercise the students use the software displays the data file that they compiled by yourself. Work in pairs, solve the problem by using graphical and numerical methods - create graphs and statistics addressing the issue.

The role of the teacher in such exercises is to present the issue to debate, to anticipate misunderstanding or difficulty with reasoning, to assure that students are engaged in the task and have no problems in its solution.

Teacher should know when to end debate, which fix bugs, and provide a good summary of the activities of students relying on their work, so then they will appreciate what is learned from the activity.

At the end of teaching, after discussion and summary can students be asked to draw up a short review of the test (can be anonymous). The results of this test will provide the teacher and student feedback on teaching.

Contrasts in the roles and responsibilities of teachers and students in both teaching methods and its other aspects are summarized in Table 1.

Table 1

Main differences between „traditional" teaching and teaching aimed at developing a deeper understanding

Aspect of the Course	„Traditional" teaching	Teaching aimed at developing a deeper understanding
Focus of the course	Skills and procedures, covering content	Big ideas, developing statistical reasoning
Role of textbooks	Use for examples or homework problems	Read and take notes to prepare for class
Center	Teacher centered	Student centered
Role of the teacher	Delivers knowledge by telling and explaining	Facilitates developing of knowledge through discussion and activities
Role of the technology	To compute or check answers, construct graphs	To explore data, illustrate concepts, generate simulations, test conjectures and collaborate
Discourse	Teacher answer the questions	Teacher poses questions and guides a discussion. Students present arguments, answer other students´ questions, and are asked if they agree or disagree with answers.
Data	Smaller data sets prepared by teacher to illustrate and practice procedures.	Real data sets to engage students in thinking and reasoning and making conjectures. Many data sets are generated by students from surveys and experiments.
Assessment	Focuses on computations, definitions and formulas; on short answers and multiple choice tests. Often only midterm and final tests are given.	Uses a variety of methods, assesses reasoning and thinking. Formal and informal assessment is an integral part of learning and is aligned with learning methods and goals. Students may be asked to explain their reasoning and justify their conclusions.

Source: (Garfield – Ben-Zvi, 2009)

Conclusion

If the educational institutions want to be competitive they must continuously work on improvement of their educational activities which includes the teaching process. Currently, employers increasingly require from their employees analytical, quantitative and computer skills. These requirements are pushing for changes in education.

In this paper we show one of the ways how to change teaching process from „traditional" teaching to teaching aimed at developing a deeper understanding of the basic ideas in the subject.

We face the challenge of modernizing what we offer to students - what we teach and how we teach. And it always remains on the teachers.

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VOICE OF CUSTOMER AND METHODS USED IN ITS IDENTIFICATION

Lenka PČOLINSKÁ

Abstract

Predmetom článku bolo poukázať na dôležitosť analýzy požiadaviek zákazníka, resp. požiadaviek iných subjektov a predstaviť metódy využiteľné pri týchto analýzach. Jednotlivé metódy slúžiace k analýze „hlasu zákazníka" sú vo všeobecnosti využívané najmä vo výrobných koncernoch zameraných na zlepšovanie a vývoj produktov.

Keywords: voice of customer, customer requirements methods, blue ocean strategy

Introduction

Analysis of customer needs and analysis of customer satisfaction with the product should be an essential and central information before starting the whole process of development and manufacturing products.

Feedback from customers can refer to service quality issues and point to efficiency lapses. They also reflect the sentiments and opinions of the customers and indicate the level of (dis)satisfaction of the customer or his churn propensity.[10]

The article primarily presents the methods that company can use to obtain information about the needs and wishes of the customer.

1. Methods used in the identifying customer needs

The various methods are used in identifying customer's requirements in relation to the use of the product. An important step is to determine who the customer is. Customer is the first one who buys. Selected methods are also accompanied by specific examples.

The basic methods used in collecting information from customers include:
- Questionnaire
- Loud Thinking (Lautes denken)
- Clinical trials (Clinics)
- Group studies (Focus groups)
- Ratings (JD Power)
- Ethnographic research.

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[10] Subramaniam, L.V. et al. 2009. Business intelligence from voice of customer. In: *IEEE International conference on Data Engineering.* IEEE Computer Society. 2009. 1391-1402 p. ISSN 1084-4627

♣ **Questionnaire**

The questioning is considered as a standard method of obtaining quantitative data. The questioning may take place in person, by telephone and self-fullfilment. The questionnaire is still the standard method for recording all types of questioning. One of the goals of questionnaires development is standardization. One type of questionnaire is used for all respondents in the sample and carefully prepared questions should be asked by the way how they were prepared in questionnaire. Standardization is a prerequisite for all other aspects of the quantitative questioning. These include the way of giving questionnaire, selection of respondents by predetermined manner and unified method of recording responses.[11]

In preparing the questionnaire we should follow the rules to ensure clarity of asked questions, integrity and main message of questionnaire or research. The basic rules for making the questionnaire:

- clear main idea of the questionnaire, it means to whom we turn with the questionnaire and an objective of the questionnaire,
- issues need to be explicit, it means prevent ambiguity issues,
- short, clear and concise formulated questions,
- consideration of psychological factors - Respondents will often have a tendency to respond in a manner which they consider to be correct, although it may not be true,
- issues shouldn´t limit the respondent,
- control issues.

Questionnaire may take several forms:

- Open questions - the respondent can give his own words.
- Closed questions - the respondent shall elect one of the options offered.
- Semi-closed questions - offered opportunities + opportunity to respond freely.
- Filters - a special type of question, which divides the respondents to those who the following questions are asked and those who do not respond.

The answers may be offered in the form of scales, namely numerical and word.The best known rating scale is a Likert scale. Respondents are asked to either agree or disagree with a number of arguments. The scale is typically 5 points. Respondent can give immediate response to many claims.

Stages of questionnaire development:
1. Initial Decision
2. The inclusion of specific questions

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[11] Hague, P. 2003. *Průzkum trhu*. Brno: Computer Press, 2003. 85-87 s. ISBN 80-7226-917-8

3. Form and shape of issues
4. Shape of responses
5. Sequence of questions
6. The form of the questionnaire
7. Preliminary testing

Evaluation of questionnaires is also divided into stages. The first activity is the editing and logic control of questionnaires, selection and quotas. The next step is to process the acquired data - encryption. Subsequently, the encrypted data is analyzed and evaluated through statistical methods. If the data is processed in the statistical program, result is the output in the form of tables, graphs.

♣ Loud thinking (Lautes denken) - objectivization of subjective

The method "loud thinking" is a finding of any significant customer views and requirements for new projects. It aims to evaluate concepts identified by customer looking on prototypes and allows examination and trial details, f.e. trial length of the lever to adjust seat height in the urban vehicle.

"Loud thinking" subjected respondent any product or concept without a time limit and expresses his view during an informal interview. The test is performed in a pleasant and harmonious environment. There is always the comparison of two products. Then the customer is asked whether in case of purchase of product he would chose one of them. The respondents are asked to speak freely about their impressions and their evaluation, which came during investigation. This method seeks to objectify the subjective views and attitudes of customers to the analyzed product.

Questioning the customer is in-depth analysis of customer requirements with regard to:

- absolute customer orientation (what respondent says, it's true),
- creating ideas and knowledge, limited to two products,
- informal interview (the person who asks, defines area of interest),
- speaking strengthens the process of observation.

The number of people questioned in this method is optimized for 12 people. When one person questioned it is hardly likely that he mentions all the relevant details in the evaluation of products. For 12 persons there is a high probability that are mentioned enough notes - at least 2,000 and respondents found all the relevant criteria. More than 12 people provide more answers, but will not yield any new findings.

This method can be completed by visual recording. Already during the observation the screen and the final interview, first impressions and ideas of all

stakeholders are recorded. For the record the protocols are used. Only after careful processing of protocols we can obtain a comprehensive picture of customer views on the studied subject.

♣ <u>Clinical trials (Clinics)</u>

The clinical method is about the detection of a customer look at a new product model in order to obtain relevant information from the perspective of design, technical development and marketing in a competitive environment. This information serves as a basis for deciding on further product development in the areas and as a basis for direction of marketing efforts in putting this product on the market. To the product evaluation within the clinical trial it is necessary to concentrate the products in one area (usually in the exhibition hall or a large space like). Given the secrecy of development models, it is necessary to ensure a sufficient level of security.

It is a combination of quantitative questioning, to which is used a standardized questionnaire and group discussions. Respondents are in greater numbers asked according the criteria and allowances for research sponsor. Respondents can come from different countries. They are transported from different countries to the place of performance of clinical studies. Quantitative querying method is face-to-face / interviewer-respondent always exposed next to various products. A smaller group of respondents is participating in group discussions.

Objectives of the Method
- Assessment of product design
- Product characteristics
- Place product in a competitive field
- Profile of potential customer
- CONJOINT: test price - the price for a product, different engines and equipment
- Reasons to buy a product
- Test potential names
- Optimize the potential (design and technical alternatives).

Figure 1

Three-level questioning
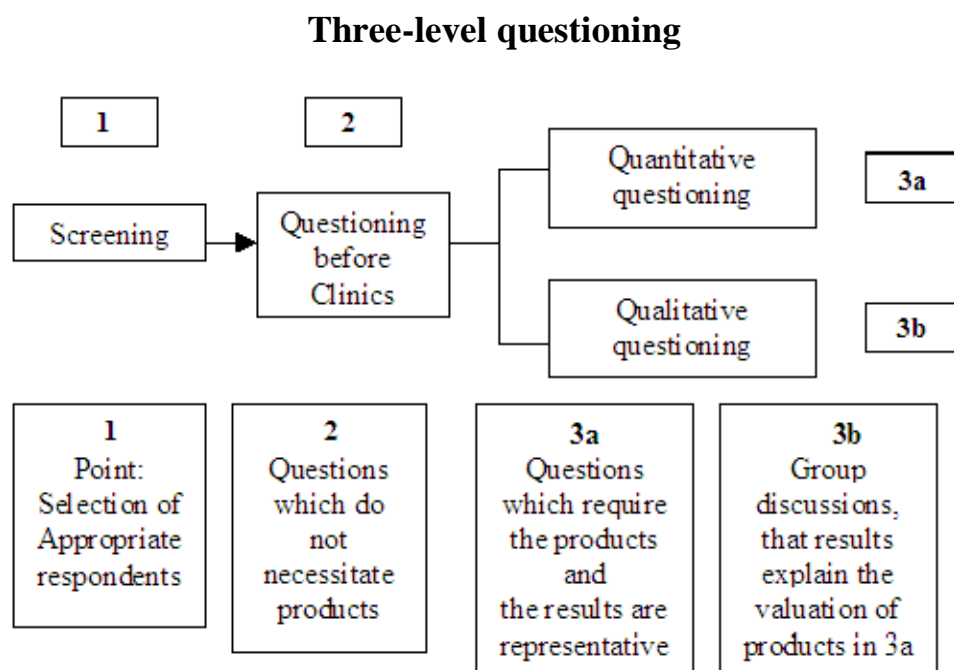
Source: Kolář, K.: Metody ke zjišťování zákaznických požadavků.

The "clinics" and its implementation is derived from the classical approach of the patients investigation in the clinic. This method removes the personality, because the analysis of customer accounts expert who examined the attitudes, perceptions and behavior when using the product. It refers to a situation which is deduced from observations of the customer.

♣ **Group studies (Focus groups)**

A group interview is the most important and most widely used method of qualitative research that allows to identify the main opinion trends of certain populations and explain the background and reasons for those views. By generalization of the results obtained from the views of respondents in the groups recruited on the basis of defined criteria and quota, we get a picture of the main opinion trends in the desired proportion of the population. Qualitative research is not representative research, which would measured the percentage of individual opinions in the population. The testing material may be as a physical object, as photographs, drawings, description of the subject. Depending on the topic of research.

Location of the research

For example, a research agency in the studio, equipped with a lounge in the business center in the hotel. Mostly, in the same research there are used multiple sites. In the case of international research it is the site in different countries.

Timing of research

Group interviews are in one place research in a short time frame: in the number of weeks. Any research usually consists of several group discussions.

Selection criteria

Respondents are selected on the basis of selection criteria for contracting research agency. Selection of respondents is realized with aid of the selection questionnaire. This is a moderated discussion, usually with eight respondents involved in one group. The moderator is a professional staff of research agencies, whose role is to guide the discussion according to the script by selecting themes, additional questions. During group discussions, which usually follow the authority of research, it is possible to ask supplementary questions.

Ratings – JD Power

JD Power Customer Satisfaction Index (CSI) is used mostly in the automotive industry as a ranking of customer satisfaction with cars. It presents the most important criterion for comparing cars of different brands and categories. Evaluated is customer satisfaction with the vehicle after approximately 2 years of operation of the vehicle.

Index is focused mostly on important criteria:
- As it is used in the automotive industry, it looks at what a man feels in his car or everyday use.
- How practical, reliable and economical is the car.

Technics of rating JD Power CSI

Each respondent receives a form with more than 70 questions. Respondent evaluates positives and negatives of activities associated with the vehicle (the problems of quality dealer network, transport costs) . On a scale from 1 to 10 respondents evaluate operations, where 1 - unacceptable, and 10 - extraordinary.

The various areas of investigation were divided for convenience into eight customer categories:
- Mechanical problems
- Interior problems
- Exterior problems
- The behavior of the vehicle
- The interior of the vehicle
- Exterior vehicle
- Sales and service network

- Cost of ownership.

The questions for respondents mainly concern the following four areas:
- Quality and reliability of the vehicle
- Satisfaction with the design, performance and functionality
- Satisfaction with service
- Operating expenses.

For each vehicle total score is generated. Consequently, the scores is expressed in percentage and it is created a final order. The challenge for manufacturers is therefore to understand the customers and try to offer them just what they require, or overcome the expectation that the use of the car brand offers.[12]

♣ **Etnography research**

It is a method adapted to marketing research from cultural anthropology and sociology. This means an in-depth understanding of the behavior, values, symbols and life of group of people, not necessarily ethnic, but in the figurative meaning of the target group of consumers (defined demographically) or subculture (mothers with children, etc.)..

Business ethnography draws on these qualitative research traditions to create research skills and methods that can be applied to create deep understanding of activities and populations of interest for commercial purposes, one of which is product innovation.[13]

It is a method that it hasn´t only innovated approaches to research, but mainly provides to innovate products and communications to be more useful and understandable to the consumer. Unlike the current consumer qualitative research, in ethnography, researcher goes to respondents, to their "territory", to the environment in which they live, buy or spend their leisure time. The research study relies on the fact that respondents not only speak the truth, but that their behavior and attitudes realistically handle in memory. The ethnography provides to observe the situation directly (or on record), when the consumer not only talks about a product, but can also be used. Ethnography can bring real consumer experience with products - when the consumer selects it in the store, expands it at home and uses in the context of domestic relationships and lifestyle. Ethnography helps to obtain comments on the product and experience with them on the spot.

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[12] Kolář, K.: Metody ke zjišťování zákaznických požadavků. In: *Zjišťování přání zákazníků* – prezentácia. [Online]. [Citované 19. 4. 2010]. Dostupné na: http://www.inovace-dmt.fs.cvut.cz/studijni_materialy/2.2_hlasite_mysleni_dotazniky.pdf

[13] Rosenthal, S.R. – Capper, M. 2006. Ethnographies in the front end: designing for enhanced customer experiences. In: *Journal of product innovation management.* Vol 23. p. 215-237. ISSN 0737-6782

The use of ethnography
- Strategical planning and brand positioning
- Marketing Strategy
- Media Strategy
- Ad Relevancy
- Forms of viral and interactive marketing
- Research and Product Development
- Packaging design
- Testing of technologies
- Detection of unused opportunities in the market (niche markets)
- Detection of space for new product categories
- Capture emerging consumer trends
- Strategy works with customers[14]

2. Blue Ocean Strategy

In addition to using the presented methods, the conclusions are to serve the company as a source of inspiration in developing products, it is necessary to find solutions and to ensure sufficient business competitiveness. Effective is to make a bid, that the customer does not wait.

The firm may therefore go by two ways. Either it will be moving towards creating a close relationship with the customer, which includes constant monitoring of customer needs and monitoring and follow-up services, or products that meet these needs, or it can walk through the creation of new needs. This type of strategy is somewhat more difficult and requires a great deal of creativity and innovation. Management concept called these forms of corporate strategies as red and blue ocean strategies.

Red ocean strategy is a classic example of a competitive field, the battlefield on which different companies compete for customers. The "Ocean" are the limits of the sector firmly defined. There are rules of the competitive game, companies are trying to bring more power than its competitors and the market space is shrinking. Red Ocean Strategy promotes competition in existing market space. The aim is to beat competitors and exploit existing demand. An interesting option is the value and costs. The company must choose either the strategy of differentiation or low cost to build success.

Blue Ocean Strategy is the new strategic concept, which aims to create a sovereign market space and ignore competitors. The biggest benefit is the alignment strategy of differentiation and low cost. Blue Ocean Strategy exists in

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[14] Ailová, K. 2006. Etnografia = výlet do divočiny spotrebiteľov. In: *Stratégie*. [Online]. Publikované 26.5. 2006. [Citované dňa: 16. 4. 2010]. Dostupné na: http://www.strategie.sk/sk/sedy/analyzy/etnografia-=-vylet-do-divociny-spotrebitelov.html

a red ocean strategy. The aim is to create new demand and competitors' retirement from the game by giving them a step increase in production value. Value innovation is a cornerstone of Blue Ocean Strategy. It is about creating value and innovation. Value innovation is a new way of thinking about strategy and a new way of its realization. Those who seek to create blue oceans, go through the way of distinct, but low cost. [15]

The main difference between a strategy of red and blue oceans is mainly in the focus on customer needs. Managers of red ocean fight between themselves, it's a tough fight of competitors who are oriented to existing needs and demand. Managers of the blue ocean on the other hand try to get rid of this fight and create a new space, which will not be threatened by competitors. It's an advantage that provides value, it is expensive and significantly different from the existing offers of other enterprises. An example of the implementation of Blue Ocean Strategy is a Cirque du Soleil, the Canadian circus world, who found a niche market and created a world of possibilities beyond the classic circus. The founders of the circus had changed it in a big theater with the plots, people have been largely involved in to the games, which was different compared to other circuses, which were often the biggest attractions of the animals. It was the kind of innovation in this circus world. Cirque du Soleil created a need that was new, created a space that still exist. Bring the story into a theatrical circus performances meant the creation of new demand, the needs that customers may not yet demand. In short, this circus has become world famous and sold out shows are proof of good strategy election.

Conclusion

The subject of the article was the introduction of methods that can be used in the analysis of the voice of the customer, or other stakeholders. The various methods used to analyze the "voice of customer" are generally used in manufacturing conglomerates aimed at improving and developing products (automotive factories, communication technology, etc.).

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IMPLEMENTATION OF THE CAF MODEL TO THE QUALITY SYSTEM OF THE SLOVAK HIGHER EDUCATION INSTITUTIONS (HEI)

Cyril ZÁVADSKÝ – Katarína ZÁVADSKÁ

Abstract

This article concerns about implementation of the CAF Model to the quality system of the Slovak higher education institutions. This quality system is presented by ISO standards and the CAF Model. The aim is to explain and respectively describe individual criteria of CAF Model over a faculty. Within these criteria we graphically show also the interaction between their sub criteria. Finally, we evaluate the role of the CAF Model in the evaluation or ranking, its uniqueness and scope in Slovak higher education institutions.

Keywords: the CAF Model, quality system of HEI, ISO 9000

Introduction

Quality of higher education institutions (HEIs) is gaining ground. The role of HEIs is to provide quality education for specific populations and carry out quality research in their field within the educational system of the country. The question is what determines the quality level of the HEIs? We distinguish establishment of system quality management through ISO standards, rankings and models of excellence EFQM and CAF. Until now HEIs have been good when they have established ISO standards, respectively they achieved prominent place in the ranking evaluation ARRA, but in recent years it is more expected from quality of HEIs. The higher quality requirement is considered to implement an evaluation model of excellence HEIs, the CAF Model. The CAF Model is subjective evaluation of the HEIs, its capabilities and qualifications to achieve outstanding results in relation to customers, citizens, partners, employees, stakeholders and the whole society. The result of implementation of the CAF Model is self-assessment report in which the HEI will assess the reached results. The essence of the CAF Model is nine criteria under which are defined several sub criteria. The main aim of our article is to provide comprehensive picture respectively explanation of individual criteria through the display of the interrelationships among sub criteria of these criteria. By understanding the fundamental methodology of the CAF Model faculty may realize the self-assessment. The CAF Model serves to identify strengths HEIs and to clarify the areas in which should be improved. Self-assessment is performed in the presence of internal actors, but if HEIs want to benchmark together it is required an assessment by external evaluators. This assessment is pursued either in the

National Quality Award of the Slovak Republic or the Slovak Society for Quality.

1. Quality system of the higher education institutions in Slovakia

Particulars relating to HEIs in Slovakia are regulated by Act No. 131/2002 C. l. about higher education institutions. According to the law [1] the mission of universities is to develop a harmonious personality, knowledge, wisdom, goodness and creativity in humans and contribute to the development of education, science, culture and health for welfare of society. Thus, the role of HEIs is to provide higher education and creative scientific and artistic activity.

Crosby [2] defines quality as a compliance with the requirements. In ISO 9000:2000 [3] is quality defined as the degree to which a set of inherent characteristics fulfills requirements. ISO standards 9000 put emphasis on quality control, documentation and involvement of all members of organization to the implementation and quality improvement [4]. For that reason ISO standards are considered as a basis for quality systems. The basis standards for quality management which are frequently used in the Slovak universities are Slovak Technical standards ISO 9000 (Quality management system – foundations, principles and vocabulary), ISO 9001 (Quality management system – requirements) and ISO 9004 (Quality management system – improvement of the performance).

It follows that the quality system of HEIs by introducing ISO standards should lead to the provision of quality higher education and creative scientific and artistic activities. In the presence it is necessary to take into account new trends in higher education in Slovakia that are characterized by:
- increase of the autonomy of HEIs and training needs,
- competitiveness,
- diverse offer of higher education,
- consumer protection,

through quality assurance. Taking into account the current development only ISO standards are not sufficient for HEIs, it is necessary to look for quality of HEIs in their excellence. These opportunities provide us the implementation of the CAF Model.

2. The CAF Model

The common system of quality assessment CAF (The Common Assessment Framework) is a tool of TQM (Total Quality Management) inspired by the model of excellence EFQM and the model of German Academy of Spreyer. The model provides a comprehensive view of the organization and allows analyzing

its performance, either from an internal perspective (through self-assessment) or external perspective (through benchmarking).

The pilot project of the CAF Model was established in 2000 as a result of cooperation the ministers of public administration of European Union, under the protection Group for innovation public services, working group of national experts created by chief executive officer responsible for the governance of public affairs. European information centre of the CAF Model is The European Institute of Public Administration (EIPA) seat in Maastricht. Its task is realization of studies, promotion and provision of necessary information on the CAF Model.

The CAF Model is based on the methodology of the model excellence EFQM, on TQM and also the base of existence is implementation ISO standards in HEIs. Its specifics are adapted to the public sector organizations in order to achieve higher efficiency in the public system (it means to improve the quality of human life and to streamline the relationship between profit and non-profit organizations). It is simple tool to apply quality management techniques which provides self-assessment system. The CAF Model is consistent with the fundamental concepts of excellence which are defined by the model excellence EFQM. The basic concepts of excellence are:

- results orientation,
- customer focus,
- leadership and constancy of objectives,
- management by processes and facts,
- employee involvement processes,
- mutually beneficial partnerships and social responsibility,
- continuous improvement and innovation.

The aim of the CAF Model is to improve the performance of the public sector organizations, while respecting their unique features, which enable and facilitate benchmarking between the public sector organizations and also serves as a link between other models used in quality management.

As the CAF Model is appointed for government organizations of the European Union countries it contributes both to reform and improve performance across the government and dynamic development of the country itself. In Slovakia, this model was applied in 2002 under protection of The Slovak Society for Quality also at the Slovak public institutions. The government through the National Quality Program of the Slovak Republic (SR) recommends to ministers launching the Common system of quality assessment of government by implementation of the CAF Model as well as quality management systems. Within The National Quality Program SR 1998 was established The National Quality Award of the SR which is in compliance with the model of competition of The European Quality Award. The competition is based on the evaluation of organizations producing goods, providing services

and public organizations which applied model excellence EFQM and the CAF Model. Just HEIs belong to the category of the public organizations. This competition is conducted annually under protection of The Slovak Office for Standards, Metrology and Testing. The methodology of the CAF Model is open for the public; it means that organizations and institutions are able to reveal their strengths and areas for improvement through the criteria.

In this article we will engage in application of the CAF Model criteria on HEIs, specifically on a faculty, as well as through graphical representation of relations between the sub criteria to explain targeting of the individual criteria. The CAF Model consists of nine criteria consisting of 28 sub criteria. These criteria are divided into two fundamental areas Enablers and Results parts.

Figure 1

The CAF Model criterion
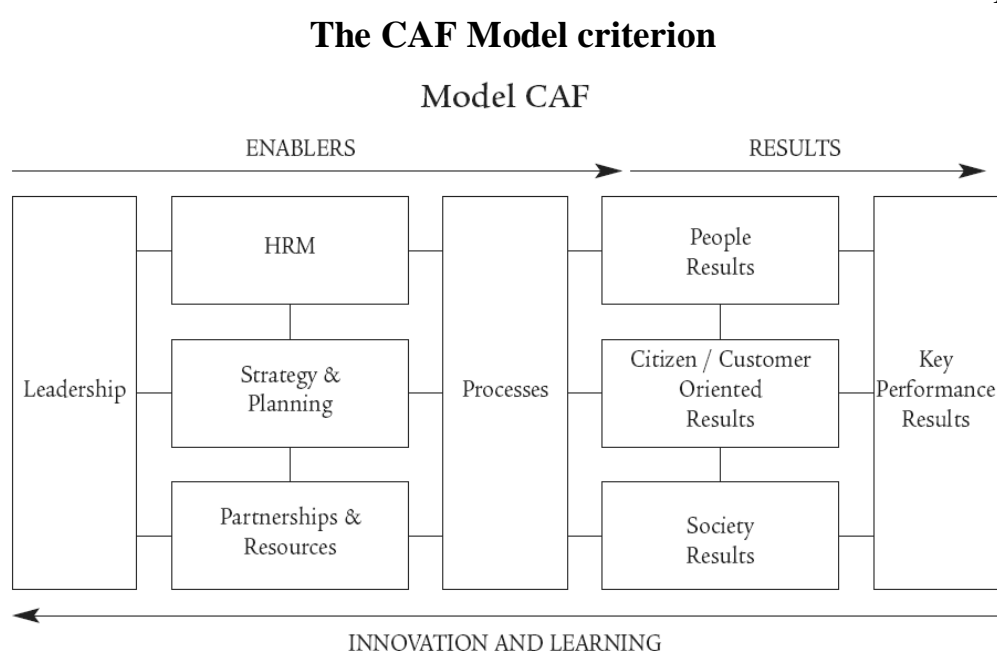
Source: The Common Assessment Framework – CAF 2006 [6]

3. Explanation of the criteria and relations between their sub criteria on HEI

It is necessary to realize that in the CAF Model there are relationships between the Enabler and the Results section, which are in relation cause – effect but only relations between Enablers can have a holistic character. We will demonstrate interrelations between sub criterions within characteristics of individual criterions. The enablers' part consists of five criterion, which reflect the faculty capabilities or assumptions which it achieves its excellence through. These abilities and skills are the basis for the achieved results.

1. ***Leadership*** – within this criterion as fist it is important to identify the leaders of the HEI. It may be one person - rector, respectively dean or group of the selected leaders (dean and sub deans). The criterion defines the exceptional leaders who create and develop the mission and vision of the faculty as well as values and a system needed for ongoing success. These all components they implement through their actions and behaviors. Leaders implement mission, vision and values of the faculty to management system with the participation of their employees (teachers and staff) leading their motivation, support and involvement in developing a culture of faculty excellence. In addition to managing faculty and employees leaders manage the relationships with politicians and other stakeholders who are also involved in formulation and developing the values, mission and vision of the faculty.

Figure 2

Relations between the sub criteria within the criteria Leadership
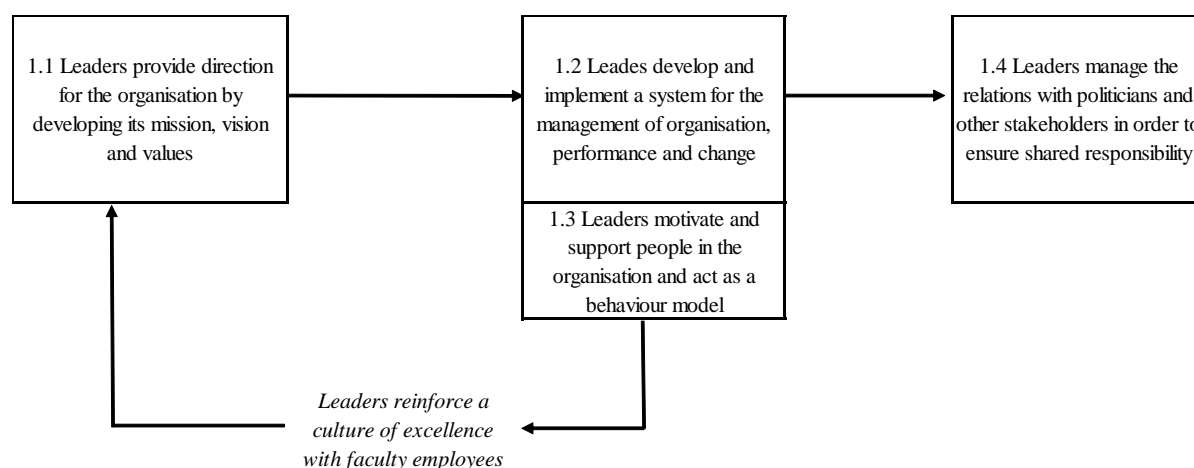
2. ***Strategy and Planning*** – the first step is to re-define the strategic partners, respectively relevant stakeholders (state, politicians, students, researchers, entrepreneurs, research institutions, other universities and other). An important input into the creation of mission and vision are needs and expectations of these stakeholders. Then exceptional faculties implement and develop mission and vision through strategy designed for stakeholders which is also supported by objectives, plans, policies and processes of the faculty. Planning is an inherent activity in establishing and developing faculty strategy. Within the development of faculty it is necessary to plan and implement innovation and modernization processes (education and research), buildings and equipments, monitoring changes as well as lead employees to innovative thinking.

Figure 3

Relations between the sub criteria within the criteria Strategy and Planning

Inputs and strategy development

Start up strategy

Expansion strategy

| 2.1 Gather information relating to the present and future needs of stakeholders | 2.2 Develop, review and update strategy and planning taking into accout the needs of stakeholders and available resources

2.3 Implement strategy and planning in the whole organisation | 2.4 Plan, implement and review modernisation and innovation |

3.   *Human Resources Management (employees)* – employees are the most important asset of the faculty, which ultimately determines the success of the faculty. Outstanding faculty plans, manages, develops and enables the development potential of its employees as an individual, team and entire faculty. It also supports the quality and participation in creation their strategy and planning by the allocation of responsibilities. Respect, dialogue, empowerment and also providing a safe and healthy environment are fundamental to ensure the commitment and participation of the people on the organizational route to excellence.

Figure 4

Relations between the sub criteria within the criteria Human resources management

| Strategy and Planning | 3.1 Plan, manage and improve human resiurces transparently with regard to strategy and planning | 3.2 Identify, develop and use competencies of employees, aligning individual and organisational goals |

Positive environment

3.3 Involve employees by developing open dialogue and empowerment
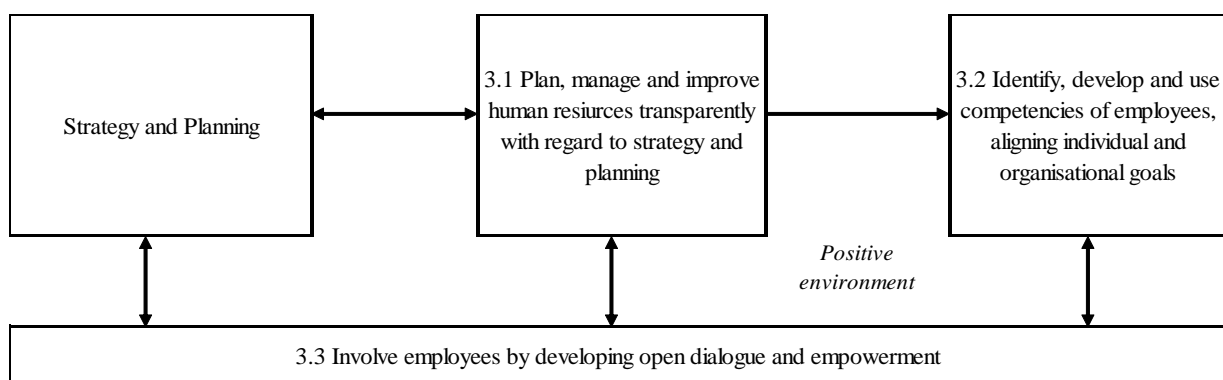
4.   ***Partnerships and Resources*** – the faculty defines their strategic partners in criterion 2 and in this criterion it defines the relationships and responsibilities with them. Outstanding faculty carefully planned and managed external partnerships, suppliers and customers to support its strategy, policies and effective functioning of the process. To ensure effective operation these elements needed faculty finance resources, equipment and technology. Through these resources faculty also supports the training of employees, interaction with stakeholders, access and mutual exchange information, etc. The faculty should plan, monitor, evaluate and implement innovative methods in all these areas.

Figure 5

Relations between the sub criteria within the criteria Partnerships and Resources

4.1 Organisation develop and implement key partnership relations	
4.2 Organisation develop and implement parmerstnership with the citizens/customers	2 Strategy and planning
4.3 Organisation manage finances	
4.4 Organisation manage infromation and knowledge	
4.5 Organisation manage technology	

Consistency and integration
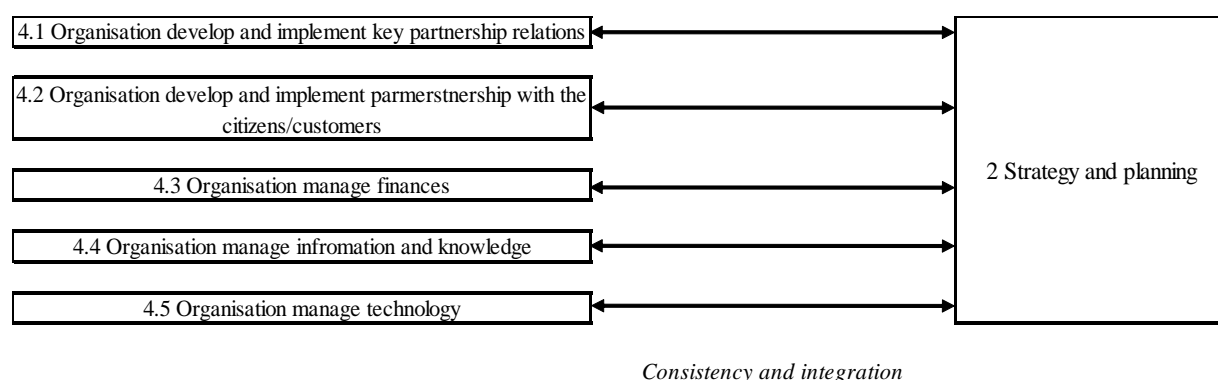
5.   ***Processes*** – the faculty which has well-established quality management system through ISO standards (file 9000) has to define and document the key processes, mainly education, science and research and then others. At the process of design and development of the faculty processes there are involved employees, stakeholders and there are allocated relevant finance resources while pursuing their contribution to the strategic objectives. The faculty is exceptional in how it plans, manages and improves processes to achieve maximum customer satisfaction and also creates for them and other stakeholder added value. Faculty offers its products and services to its customers for maximum satisfaction which are increased by innovation of processes. It is important to note that even the customers themselves are involved in developing and improving products and services.

Figure 6

Relations between the sub criteria within the criteria Processes

Process management (in general) — *Products and services* — *Expansion/ innovation*

| 5.1 Organisation identify, design, manage and improve processes on an ongoing basis | 5.2 Organisation develop and deliver citizen/customer-oriented services and products | 5.3 Organisation innovate processes involving citizens/customers | 6 Citizen/customer oriented results |
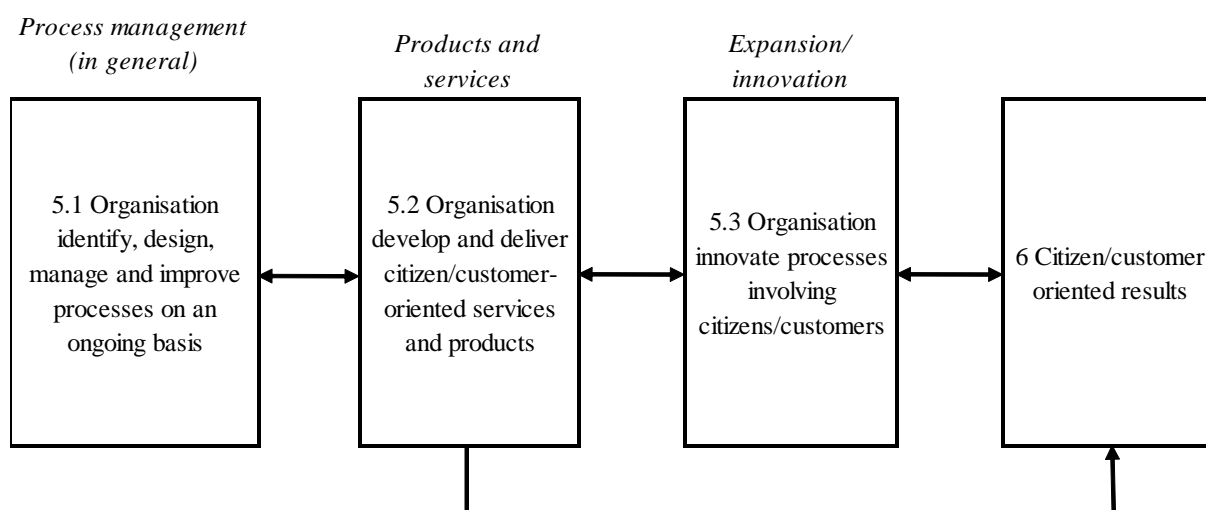
Results section is based on the assumptions of the faculty. They are reflection of how effectively faculty plan, monitor, evaluate and use their abilities. The results are divided into four criteria followed from their focus.

1. ***People Results*** – the faculty defines a set of indicators by which it measures perceptions of employees. This means that exceptional faculty comprehensive measures and evaluates the achieved results concerning about employees satisfaction with the work environment, motivation, mission and objectives of the faculty, professional and personal growth as well as the actual direction. The results are a direct feedback for faculty how it should to preserve respectively improve the activities with employees.

Figure 7

Relations between the sub criteria within the criteria People results

| 7.2 Indicators of people results | 7.1 Results of employees satisfaction and motivation measurements |

Organization indicators — *Employees assessment*

Predictive indicator — *Direct feedback*
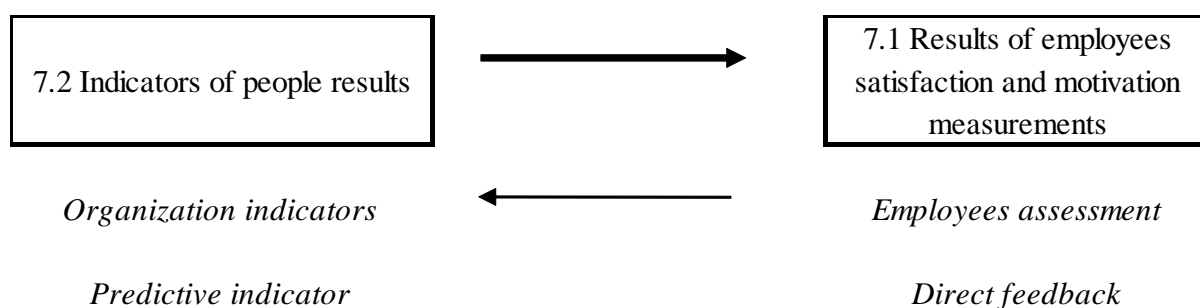
2. ***Citizen/Customers Oriented Results*** – the faculty defines a set of indicators by which it measures perceptions of customers. This means that the exceptional faculty comprehensive measures and evaluates achieved results through customer's satisfaction with its products, services as well as the faculty itself. It would be assessment of customers which provides direct feedback to the faculty on how they perceive its image, products, services and their availability and the possibility of involvement customers in their design.

Figure 8

Relations between the sub criteria within the criteria Citizen/customer-oriented results

| 6.2 Indicators of citizen/customer-oriented measurements | → | 6.1 Results of citizen/customer satisfaction measurements |

Internal assessment   ←   *Citizen/customer assessment*

Predictive indicator   *Direct feedback*

3. ***Society Results*** – the faculty defines a set of indicators by which it measures perceptions of society. This means that the exceptional faculty comprehensive measures and evaluates the results in area of satisfying the needs and expectations of society at local, national and international level. This assessment provides a feedback about perception of the faculty's approach and contribution to the quality of life, the environment and the preservation of global resources and the faculty's own internal measures of its effectiveness in contributing to society.
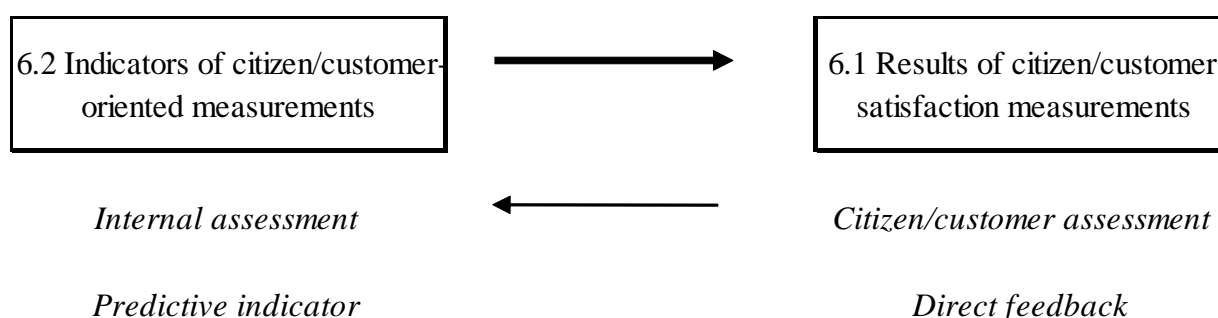
Figure 9

Relations between the sub criteria within the criteria Society results

| 4 Partnerships and resources
5 Processes | → | 8.2 Indicators of societal performance established by the organisation | ⇄ | 8.1 Results of societal measurements perceived by the stakeholders |

Internal indicator   *Society assessment*

Predictive indicator   *Direct feedback*
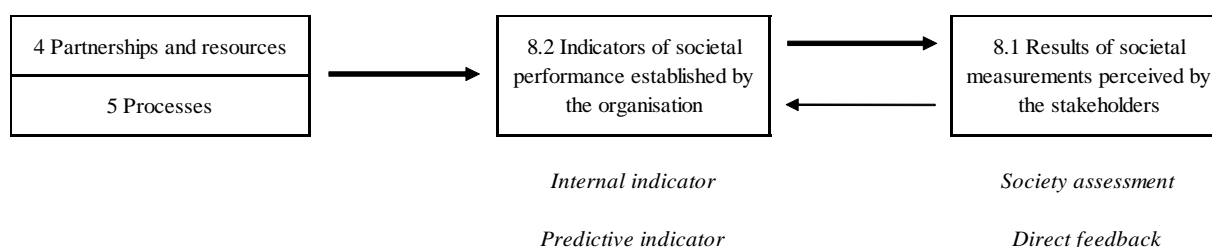
4. ***Key Performance Results*** – the faculty defines a set of key performance indicators. The outstanding faculty comprehensive measures and evaluates internal and external performance results. This means what the faculty achieves with respect to the defined tasks in the strategy and policy, partnerships and

resource management and the processes itself. These results reflect the success of a comprehensive assessment and implementation strategy of the faculty. The key performance results represent section of all results (within criteria 6, 7 and 8) completed by the faculty. Efficiency and effectiveness of the faculty, financial performance, achievement of goals in relation to employees and stakeholders belong there.

Figure 10

Relations between the sub criteria within the criteria Key performance results

2 Strategy and planning		
4 Partnerships and resources	→	9.2 Internal results
5 Processes		

9.1 External results: outputs and outcomes to goals

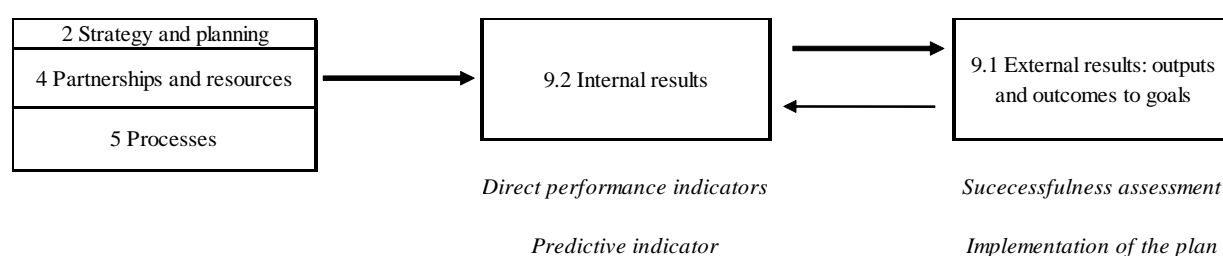*Direct performance indicators*   *Sucecessfulness assessment*

Predictive indicator   *Implementation of the plan*

The functionality of the CAF Model is to link the Enabler (tools and resources) with the Result section thus from the assumption that the faculty achieved excellent results in selected areas (performance, relationship to the citizens/customers, employees and society). The organization can achieve excellent results only if it is able to use their skills. The faculty gets the desired results through well defined processes. The results with the highest evaluation scores confirm the excellence of the organization or organization in the field.

Understanding of the individual criteria and their sub criteria is an essential step towards achieving self-assessment and implementation of the CAF Model in the organization. The CAF Model manual defines ten steps to improve public sector organizations by implementation of the model. The first step is the decision of the organization how to organize and plan the self-assessment. Therefore it is necessary follow-up communication about its course. Implementation of self-assessment requires from the organization to create the CAF team (one or several). The CAF team performs the self-assessment process on the basis of knowledge of the CAF Model acquired in courses and lectures. The fundamental of self-assessment is to draw up self-assessment report and then to draft an improvement Action Plan based on the accepted self-assessment report. The discussion phase continues with the improvement action plan and its implementation. The Action Plan consists of objectives, goals and activities of the organization which lead on elimination of weaknesses and preservation or development areas of organization's excellence. After its implementation the organization may schedule additional self-assessment to verify compliance with the defined objectives and tasks.

Conclusion

We got an overview of the capabilities, activities and results across the HEIs through characteristics of individual criteria and viewing the relations of their sub criteria. Relations between the sub criteria and the criteria facilitate the understanding of the relationship between the Enabler and the Results part. Individual sub criterion defined performance indicators not clearly, the choice left to the HEIs. This allows HEIs to put forward its excellent abilities and also clarify areas where improvement is necessary. ISO standards are a prerequisite ("springboard") for the implementation of the CAF Model because they accurately define and determine the key processes and performance indicators. The CAF Model compared with the ranking is different. The ranking shows the "ex post" results that the organization achieved, but the CAF Model looks to the future, what assumptions should the organization create to achieve the objectives. Its aim is to highlight excellent HEI even though the rankings become an end in themselves. The best HEI by ranking is the one that achieves the maximum in defined indicators of observed areas. This may lead HEI to set the target to achieve maximum in these performance indicators (mostly education, science and research) and not to achieve maximum of customer satisfaction, society, partners, etc. to satisfy their partial requirements. The CAF Model against the ranking also supports innovative activities of HEI. Therefore, if we want to assess the organization as a whole and achieve the synergy improvement we should implement the CAF Model.

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ELIMINATION OF SUBJECTIVE ASSESSMENT OF THE RELATIONS IMPORTANCE IN THE HOUSE OF QUALITY

Matej HUDÁK

Introduction

Almost every major company declares their interest in promoting a society in which we live, the environment, employees etc. Simply we can say that corporate social responsibility means achieving business goals in a way, which the society can benefit from. However, question which of the areas of social responsibility it pays to join and how remains fundamental for companies. QFD may also help them in this decision. In this article we will focus on House of Quality adjustment, which is the main tool of QFD (Quality Function Deployment). We will suggest a method to eliminate subjective assessment of the relations importance among customer requirements and product characteristics.

1. Corporate Social Responsibility and Quality Function Deployment

The question to which corporate responsibility area to invest and how becomes important in times of crisis. During the boom market, established organizations usually have no problem with investing even larger funds in the social responsibility. In many cases it is only about their prestige and investments in social responsibility are understood in the meaning of public relations or advertising.

Situation in corporate social responsibility establishing is more complex in organizations during the crisis. Many businesses struggle for their survival in the first place and all available funds are primarily invested in its market positions maintaining or development. In the idea of social responsibility, effectiveness of the funds invested is much stronger taken into account.

QFD is a subjective method, instrument for transforming customer requirements into technical parameters of new or redesigned product. Emphasis is taken on cognition of customers (also unexpressed) needs and to anticipate failures and prevent serious errors of the product. QFD is a method that deals more with generating opportunities rather than solving problems. The role of QFD is to identify what customers want and then offerimg them exactly that. The main tool in QFD is called the House of Quality, or the matrix or customer requirements.

2. The procedure for the elimination of subjective assessment of the importance

It is possible to prioritize the steps or possibilities of social responsibility implementation in the organization using the QFD method and the house of quality. In the classic method of determining the importance of the relations between customer requirements and product features we assign the value 9 to the strong dependence, value 3 to medium dependence and value 1 to weak one. We assess the value 0, or we omit the field in the case of no dependency.

The primary problem with this evaluation is subjectivity. Values are determined according to the house of quality constructor. Subjektivity in determining the importance of the relationship between customer requirements and product characteristics can be removed by the following model. Consider the situations where the dependence of the parameters and requirements can be expressed by the functional relationships. This relationship (model) can be written as follows:

$$y = \alpha_0 + \alpha_1 \cdot x_1 + \alpha_2 \cdot x_2 + \ldots + \alpha_n \cdot x_n \qquad (1)$$

Consider that the chosen linear regression model including all its regression coefficients is statistically significant. We consider only the linear regression model, because most of the existing relations can be described by this model by chosen parameters transformation (substitution by a functional relationship). The importance of the parameters $\{x_1, \ldots, x_n\}$ is evaluated by the absolute value of corresponding regression coefficient $\{a_1, \ldots, a_n\}$.

The problem of this evaluation is the case, when chosen parameters vary in various units. For example, suppose we evaluate the quality of combustion in the manufacture of the product. Several parameters affect this requirement, such as:
- combustion temperature,
- concentration of oxygen,
- incinerated material,
- exhaust fumes.

From the parameters results that their values vary in different limits. To standardize the various coefficients we use the following procedure:

$$b_i = |\alpha_i \cdot \bar{x}_i| \qquad (2)$$

These adjusted regression coefficients b_i have to be translated into different levels of dependencies of CT matrix z_i. Since we assume only statistically significant regression coefficients, the value 0 (or nothing) is indicating the characteristics of the product that came out in the regression model as statistically insignificant.

Subsequently, the house of quality constructor must subjectively intervene by assigning a value depending on the maximum value of b_i.

$$z_{max} \rightarrow max\, b_i\,; z_{max} \in \{1,3,9\} \qquad (3)$$

This arbitrary action is necessary due to the fact that some marginal customer requirements, automatically assigned by value 9, would artificially inflate the assessment of individual product characteristics that are assigned to customer requests.

Consequently, it is necessary to determine the value of dependence for remaining b_i. These values are obtained according to the variation classification. We obtain the length of the interval class h:

$$h = \frac{b_{max} - b_{min}}{z_{max}} \qquad (4)$$

If I_j is a *j-th* interval with lower limit *d* and maximum *u*, while $j \in \{1,...,z_{max}\}$, then we determine the intervals:

$$I_j = \begin{cases} <b_{min}\,;b_{min}+h) & pre & j=1 \\ <h_{j-1}\,;h_{j-1}+h) & pre & j=\{1,2,...,z_{max}-1\} \\ <h_{j-1}\,;b_{max}> & pre & j=z_{max} \end{cases} \qquad (5)$$

After classification of each b_i into classes, we assign each of them a value z_i depending on *j*, i.e. serial number of interval. So we assign values of dependence from 1 to z_{max} to all statistically significant parameters.

If we want to maintain a dependency evaluation 1, 3, 9, we set up intervals, taking into account the differences between these numbers. Interval, which we assign a dependency value 1 will include the first interval and the first half of the values of the second interval $<b_{min}\,;b_{min}+1{,}5 \cdot h)$, the interval which we assign values of dependency 3 will continue until the end of the sixth interval established by the formula (5), i.e. $<b_{min}+1{,}5 \cdot h\,;b_{min}+6 \cdot h)$. Values falling within intervals of 7-9 according to the formula (5) we assign dependency values 9, i.e. the interval will be $<b_{min}+6 \cdot h\,;b_{max})$.

3. Application procedure

Consider the previous example we briefly described. On the one hand we have a requirement for combustion quality in the manufacture of the product. This requirement translates into a number of parameters, for instance - the temperature of combustion, oxygen concentration, and extraction of material and combusted gases, incinerated material and exhaust fumes. So the parameters affecting the quality of combustion are:

- combustion temperature (x_1),
- concentration of oxygen (x_2),
- incinerated material (x_3),
- exhaust fumes (x_4).

Based on measurements, we found that the derived regression model is statistically significant, with following parameters:

$$y = 50 - 2 \cdot x_1 - 0,8 \cdot x_2 + 1,6 \cdot x_3 - 0,23 \cdot x_4 \qquad (6)$$

We identify the importance of the parameters according to formula (2):

$$b_1 = |\alpha_1 \cdot \bar{x}_1| = 0,8 \cdot 112,2731 = 89,81848 \qquad (7)$$

$$b_2 = |\alpha_2 \cdot \bar{x}_2| = 2 \cdot 1,542 = 3,084 \qquad (8)$$

$$b_3 = |\alpha_3 \cdot \bar{x}_3| = 1,6 \cdot 2,821 = 4,5136 \qquad (9)$$

$$b_4 = |\alpha_4 \cdot \bar{x}_4| = 0,23 \cdot 1,6452 = 0,378396 \qquad (10)$$

Consequently, we group the parameters of importance from the results. Thus, we find that the maximum impact parameter is the temperature of combustion. We would assess this affect on the CT matrix with the value of 9 because it is significantly higher than all others, i.e. $z_{max} = 9$ (3).

Then we determine values of remaining dependencies b_i. These values are obtained according to the variation classification of b_i into intervals. We obtain the following length of interval h:

$$h = \frac{b_{max} - b_{min}}{z_{max}} = \frac{89,81848 - 0,378396}{9} = 9,937787 \qquad (11)$$

Then we determine the intervals to assign dependency values according to:

$$I_1 = < 0,378396; 10,31618)$$
$$I_2 = < 10,31618; 20,25397)$$
$$I_3 = < 20,25397; 30,19176)$$
$$I_4 = < 30,19176; 40,12954)$$
$$I_5 = < 40,12954; 50,06733) \qquad (12)$$
$$I_6 = < 50,06733; 60,00512)$$
$$I_7 = < 60,00512; 69,94291)$$
$$I_8 = < 69,94291; 79,88069)$$
$$I_9 = < 79,88069; 89,81848)$$

We assign a dependency value according to its belonging into the interval for each b_i, i.e. the combustion temperature parameter acquires dependency value 9 and to other parameters, concentration of oxygen, incinerated material and exhaust fumes, value 1 is assigned.

While maintaining the use of dependency values 1, 3 and 9 (instead of the previous 1-9) assigned dependency values would be the same, while intervals for values assigning would be:

$$I_1 = < 0,378396; 15,28508)$$
$$I_3 = < 15,28508; 60,00512) \qquad (13)$$
$$I_9 = < 60,00512; 89,81848)$$

This procedure reduces the subjective interventions of house of quality constructors to only one decision, which is decision about the dependency value of parameter with the greatest value. Remaining dependencies of other parameters are derived by adjusted statistically significant regression coefficients.

Conclusion

In this article we discussed the issue of house of quality construction, namely the determination of the coefficients in the CT matrix. If the company finds accurate stakeholder requirements in the area of social responsibility, they can be transformed into concrete actions through the house of quality and their priority can be determined. In theory, commonly used dependencies evaluation system among requirements and parameters is subjective approach with the 0,1,3,9 scale. Our proposed system uses regression analysis and within it individual regression coefficients are evaluated. To eliminate the problem of

different levels of values of variables, we used the formula (2). We sorted these adjusted variables into intervals. On the basis of these intervals, dependencies values in the CT matrix can be assigned to each parameter.

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Keywords: QFD, House of Quality, CT Matrix, coefficient determining

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THE UTILIZATION OF MATHEMATICAL SOFTWARE AT THE DETERMINATION OF THE DEPENDENCE

Gabriela IŽARÍKOVÁ – Denisa OLEKŠÁKOVÁ

Abstract

Statistical methods allow us to measure dependence between qualitative and quantitative variables. It is very important to find out the dependence between these variables and how they are dependent. The contingention coefficients measure dependence of two variables.

Keywords: dependence of variables, CHI TEST, the contingention coefficients

Introduction

In the recently years came to increasing of the number of students in the universities. For example in the year 2000 was enroled 24648 students, in the year 2005 it was 36196 students and in the year 2008 the number of students was 42037. This number includes 14 940 students concered with engineering schools and 3789 students with science, which is one third of schools, where they continue studying mathematics.

The last years signified a large decrease in mathematical knowledge and skills to the students of advanced study. It is necessary to support the form of education by the new educated methods, for example by the expansion of mathematical software utilization. It is very important for students to have sufficient mathematical knowledge which enables them to become software users having ability to understand and check results.

Students should learn how to use the mathematical software and to do the exercises using computers, but not only using commands from the software package. In the previous years we noted rapid modifications in the information technologies, an increase of computer performance and complexity of the accessible mathematical software (Maple, Mathematica, MATLAB, MuPad, Derive, EXCEL Octave and others). The graduates use maybe only a part of the knowledge from university, but they use excellently a reasoning obtained from the mathematical education.

1. The utilization of Excel at the determination of dependence of χ^2 - test about independence of qualitative character

In every statistical analysis, a great number of variables, numerical and verbal data are traced in a set of specific units. It is very important because of

theoretical and practical reasons to find out if some of these variables are dependent and how are they dependent.

If we pursue only two variables, so first information about their dependence we find out to arrange of determined data into two-dimensional table. The two-dimensionl table with verbal variables is called the contigention table and the table with numerical variables is called the correlation table.

The dependence between the qualitative characters we can investigate using by χ^2-test about independence of qualitative characters (CHI TEST). This test is based on comparison of empirical and theoretical multiplicity for every category of monitored attribute. The nought hypothesis H_0 supposes the independence of the qualitative variables, the alternative hypothesis H_1 supposes the dependence of the qualitative variables. Test criteria for the verification of the nought hypothesis H_0 about the independence between qualitative variables is calculated by the next form:

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{s} \frac{\left(Q_{ij} - E_{ij}\right)^2}{E_{ij}} \; ,$$

where Q_{ij} are empirical multiplicities, $E_{ij} = \dfrac{n_{i.} n_{.j}}{n}$ are theoretical multiplicities,

r is number of rows and s is number of columns.

The value of test criterium χ^2 is compared with table value $\chi^2_{1-\alpha}$, for $(r-1).(s-1)$ degree of freedom, where α is significance level, where test is realised. If $\chi^2 > \chi^2_{1-\alpha}(r-1).(s-1)$, than we reject H_0 - nought hypothesis about independent.

We can use function of Excel: CHINV, CHITEST by the determination of the dependence.

Task: We want to determine if result of the examination is depend on the type of secondary school, i. e. to test if exist the statistical dependence on the type of completed secondary education. We will test if exist the statistical dependence between qualitative statistical attributes, the results of the exam and the type of completed secondary school on the significance level 5% (the results of this determination would be used by the secondary school for the admissions, for example to define coefficients for the individual type of the secondary schools).

Table 2

Number of the respondents according to completed secondary education and success at examination

Type of secondary school	Success at examination					
	A	B	C	D	E	F
High school	5	10	12	7	2	1
Industrial school	8	12	28	35	52	7
Others	3	8	56	50	68	12

The task is to prove if exist some dependence between monitored qualitative attributes. If exist that it is necessary to determine how is intensity of this dependence.

We can formule some hypotheses:

H_0 : There is not the statistical dependence between the type of completed secondary education and success at examination.

H_1 : There is the statistical dependence between the type of completed secondary education and success at examination.

Table 2

Auxiliary table for the calculation of theoretical multiplicities (horizontal and vertical sums)

Type of secondary school	Success at examination						Sums of the multiplicities $n_{i.}$
	A	B	C	D	E	F	
High school	5	10	12	7	2	1	37
Industriil school	8	12	28	35	52	7	142
Others	3	8	56	50	68	12	197
Sums of the multiplicities $n_{.j}$	16	30	96	92	122	20	376

Table 3

Theoretical multiplicities

Type of secondary school	Success at examination					
	A	B	C	D	E	F
High school	$\frac{37.16}{376} = 1{,}57$	$\frac{37.30}{376} = 2{,}95$	9,45	9,05	12,01	1,97
Industrial school	6,04	11,33	36,26	34,74	46,07	7,55
Others	8,38	15,72	50,30	48,20	63,92	10,48

The value of test criterium in substitution in an equation is:

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{s} \frac{\left(Q_{ij} - E_{ij}\right)^2}{E_{ij}} = 46,05$$

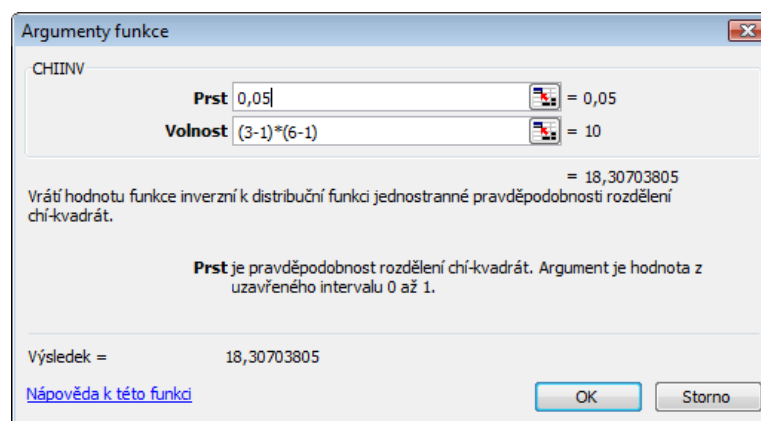We can simply and faster calculate the value of test criterium by Excel:

CHITEST (B3:G5;B11:G13)

Actual - B3:G5 – to mark the empirical multiplicies

Expected – B11:G13 – to mark the theoretical multiplicies
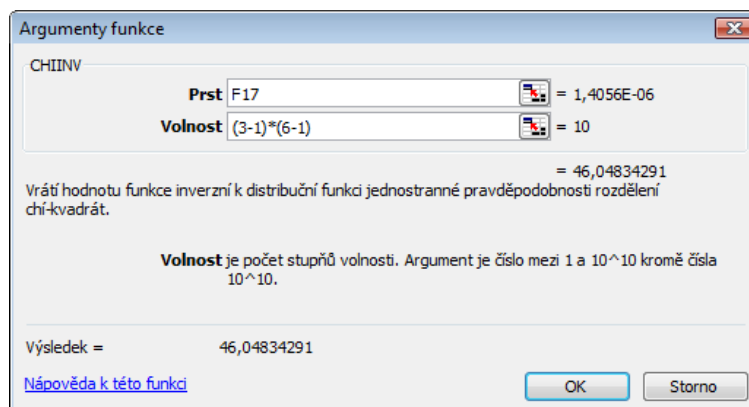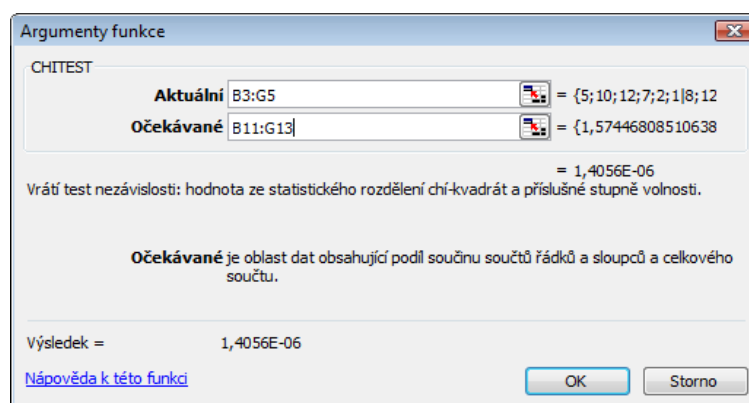
We compare the result $\chi^2 = 46,05$ with the table value $\chi^2_{1-\alpha}(r-1).(s-1) = \chi^2_{0,95}(10) = 18,3$.

The value of test criterium is bigger than critical value on the significance level, i. e. nought hypothesis about the independence is rejectable, i. e. exist the dependece between the type of completed secondary education and succes at examination.

2. Measuring the tightness of dependence

The contingention coefficients measure dependence of two verbal variables. Cramer contigention coefficient C_{cr} and Pearson contigention coefficient C_p belong to the most used.

$C_{cr} = \sqrt{\dfrac{\chi^2}{n.h}}$, $\quad C_{cr} \in \langle 0,1 \rangle$, (the dependence is stronger when the value of the coefficient is near to 1)

$C_p = \sqrt{\dfrac{\chi^2}{\chi^2+n}}$, $C_p \in \langle 0,1 \rangle$, (its upper limit is dependent on the number of rows and columns, for example for $r = 3, s \geq 3$ is 0,816),

where h is minimum $(r-1).(s-1)$, n is total suma - data-set extent.

In the previous part we found out that there is statistical dependance between completed secondary education and succes at examination. Another task will be an analysis of the intensity of this dependence. We find out how strong dependence is by using the contigention coeffiecients. After filling up the form we have:

$$C_{cr} = \sqrt{\frac{\chi^2}{n.h}} = \sqrt{\frac{46,05}{376.2}} = 0,25 \qquad\qquad C_p = \sqrt{\frac{\chi^2}{\chi^2+n}} = \sqrt{\frac{46,05}{46,05+376}} = 0,33$$

The values of these coefficients display that there is a medium-strong dependence between analysed statistical attributes, so success at examination dependents on type of a secondary school.

3. Conclusion

Different statistical processes and methods are used at the analysis of the dependence of variables. Some of them are for reviewing, whether variables are dependent or independent. Others we use for concrete specification of the dependence, which is an assumption of their applied utilization. It is advantageous to use mathematical software in the analysis of the dependence of variables because of a simplification and mainly an acceleration of calculation for example mentioned Excel, but also Maple, Mathematica, MATLAB, Octavu and others.

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NEW APPROACHES TO THE PROJECTS CATEGORIZATION

Radomíra REJDOVÁ

Introduction

In the current economy with a rapidly changing market conditions, firms strive to adapt to new and emerging conditions. The aim is the achievement of the highest competitiveness in domestic and foreign markets. In this regard, companies continuously invest in different innovation activities, which are mostly implemented through projects. Various projects are focused not only to build new premises, but also to expand into new markets, acquiring customers, innovation, manufacturing and services.

Interested of companies about new knowledge in this field continues to grow. This article focuses on the definition of projects and project management. In the article we highlight the different approaches to project management and projects categorization abroad and in Slovak Republic.

1. Project

The project can be understood as expansion of the company into a new market, introducing a new product or service, as well as construction of premises etc. Therefore we cannot meet with the standardized definition of the project in the literature. Definitions are different depending on the area on which it is addressed (studied). Therefore, we present various definitions of projects from various authors:

- The project is plan developed for solving a problem, timed effort to create a unique product or service to achieve exceptional results [1].
- The project is the process of introducing innovation limited by time, resources, costs and required quality [2].
- The project is an effort, in which human, material and financial resources are organized in a specific way to make a series of concrete actions within specified cost and time, which will lead to the intended target [3].
- The project is at the time final set of technological and organizational follow-up activities and resources required to develop product, service or other changes, useful for a customer [4].
- The project is a way of work organization, resulting in a new product [5].

2. Project categorization

In the literature and in practice we encounter with different types and approaches to the projects categorization. Projects are classified by size, complexity, relationship, industry, etc. Although we meet with different categorization of projects in the literature, these subdivisions are not very developed. They are mostly of a formal nature but are not followed, connected by further theory. Instead of developing the specific guidelines for specific types of classified projects, theory is trying to create a comprehensive knowledge base on project summary manner.

We meet mostly with the general projects classification in Czech and Slovak literature, e.g. by content, by purpose and focus [2,3]. By their content, projects are divided into simple, specific and complex. Simple project is a small project, is short in terms of time involved and has a simple goal. A specific project is medium-timed and requires the involvement of more employees. A complex project is long-termed and requires a special organizational structure and also high costs.

In foreign literature, many authors encountered criticism of this general approach and also projects categorization and came with new approaches and different views on the typology of projects.

According to Andersen [6] Shnenhar paved the way for a new approach by describing projects depending on the technological uncertainty and complexity and showed that such projects have a different life cycle and require a more flexible style of management and a higher tolerance for change. Shnenhar thus showed that "not all projects are the same."

Figure 1

Project categorization by project methods and goals

Methods well defined	NO	Type 2 Product development	Type 4 Research / organisational change
	YES	Type 1 buildings	Type 3 software development
		YES	**NO**

Goals well defined

Source: TURNER, J. R. – COCHRANE, R. A.: Goals and methods matrix: Coping with projects with ill defined goals and/or methods of achieving them. In: International Journal of Project Management, 1993 ISSN: 0263-7863, Vol. 11, No. 2, s. 93-102.

Turner and Cochrane [7] developed approach of projects categorization in accordance with project goals and methods. Depending on whether these goals and methods are defined well or poorly, they distinguish four types of projects. Each of these four types requires an individual approach, for example Type I projects, in which the goals and methods are well-defined, are relatively simple from organizational perspective, e.g. construction of buildings. Conversely Type IV projects are difficult on creativity and innovation, as they regards as the entry into something unknown, since neither the project goals nor methods are known. An overview of these four types of projects is shown in the previous figure 1.

Shenhar and Wideman [8] introduced a 2x2 matrix in their work, which categorized projects by type of work to be done on the project and the type of product from the project. They distinguish between intellectual and craft work done on the project. Craft work is defined as activity that requires repetitive efforts, respectively it is an activity which can be improved by repeating and is the result of manual skills. Examples of such work are the shaping and assembling seats, car repairs etc.

By contrast, as intellectual works they consider work that requires creative effort and is the result of creativity and education. Thus, intellectual work, unlike the craft work, determines the project's success, as these activities are the intellectual element that separates our project from other projects. For this reason is important to focus on this activity in the project design. Overview of the projects categorization by this matrix is presented in Figure 2.

Figure 2

Basic 2x2 project classification

Type of work in the project		Tangible	Intangible
	Intellect	Development of an all-new electric car	Development of a new theory
	Craft	Construction of a building	Updating a procedures manual

Type of product from the project

Source: SHENHAR, A.J. – WIDEMAN, R.M.: Toward a Fundamental Differentiation between project types, In: Innovation in Technology Management – The Key to Global Leadership.

3. Project management

Project management as we know it today began to apply 60. in the last century. Companies saw the benefit of the organization of work through projects

and understood the importance of communication, and integration of 'project work' to other departments within the company.

Kerzner [9] understood project management as a set of activities that include planning and system management (monitoring).

Project management is then "set of activities: planning, organizing, leading and control of enterprise resources in a relatively short period, whose objective is to achieve specific plans and objectives. In addition, the project management uses systematic approach to organization management trough the responsible person (according to vertical hierarchy of the organization) and its allocation for specific project (horizontal hierarchy).

Conclusion

Projects are an integral part of the corporate business environment. Slovak business environment was significantly affected by the entry of Slovak Republic into the European Union and the opening of capital borders with other member states. To maintain our position in the market, it is important to invest in activities that help firms to be "over" the competition and maintain its competitive advantage. Almost all such activities are implemented through projects in newly formed and existing markets. Project management and management of project is therefore an essential part of today's business environment. In this article we highlighted the different approaches to the projects categorization in foreign literature, which from this perspective also requires a different approach in the management and administration. In terms of theory and practice is therefore important to research and acquire new knowledge in this area.

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Keywords: project, project categorization, project management

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EVALUATION OF BENEFITS FROM THEIR RELATIONSHIP WITH CUSTOMER

Renáta TURISOVÁ

Abstract
In order to achieve a functioning long-term relationship with customers is the need for excellent communication, supported by a good CRM strategy is built on the basis of information gathered from the analysis of internal and external business environment. Does her own business as well as to meet customer goals. The strategy should be determined in full awareness of the impact on customer behavior. It may be consistent with the behavior of customers in a way that can maximize the potential synergies.

Keywords: CRM strategy, evaluation of benefits, customer

Introduction

In the foreground gets philosophy of continuous improving satisfaction of the customers whose were obtained and served. This philosophy requires continual improvement of communication channels to transmit information and requests from customers. A new trend has become acquisition "mining" of information about customer needs and the apparently non-essential information.

In order to achieve a functioning long-term relationship with customers is the need for excellent communication, supported by a good CRM strategy, which is built on the basis of information gathered from the analysis of internal and external environment company. Company so the customer leads strategy to meet their targets. The strategy should be determined in full awareness of the impact on customer behavior. It may be consistent with the behavior of customers in a way that can maximize the potential synergies.

Customer Value is a core concept of market economy. Generally perceived customer value as "the relationship between needs satisfaction and source used in achieving this satisfaction. Within the organization, customer value is a key element for the following groups:

- They are either shareholders or business owners,
- Another group consists of customers (there are also included brokers)
- And a third group is the management.

Each organization measures a value of its enterprise customers in any way. Based on these measurements it decides whether it is aware that the process is ongoing.

1. Management of customer value

One of the new CRM strategies is investigative competitive strategy. For the preparation and implementation of this new competitive strategy are used different methods, which include CVM – "Customer Value Management".

CVM is a practical concept of a differentiated approach to individual customers according to their value to the supplier. CVM is managed through the development of customer value for suppliers and optimizing costs associated with this process including the development and offer new products and services that are directed to the optimal target group.

The main benefit of CRM applications is to provide data resp. information, which is based for the active management and a possible change of its own business firms. Other benefits include:

– Knowledge about customers and determining which ones are best supplier in terms of
– To encourage customers to buy even if they are unsure what to buy and where they want to buy,
– Knowledge of the period when and what they are buying;
– Knowledge of customer preferences and thus gain their loyalty
– Definition of internal factors and criteria that constitute good customer - Identification of channels that best meet the needs of particular groups of clients,
– Forecasts of future customer orientation,
– Keeping the best customers for as long as possible.

CVM is a specific and unique approach, which can affect business processes, infrastructure and business skills based on knowledge of the customer. The introduction must have the ability as the analysis of business processes, profitability indicators and methods for measuring costs, whether in building data warehousing, analytic applications development, data mining and operational components of CRM implementation.

In terms of management controlled by the customer's system of education, which makes customer-focused strategy is improved by the pre-assessment prior to customer-oriented strategy.

In recent years there has been extensive research in the field of customer value. This research is based on a conceptual framework for customer according to Bolton, RN - Lemon, CN - Verhoef, PC (2004).

As shown in figure (Fig. 1), customer oriented strategy is based on an analysis of the customer, i.e. impact on customer acquisition strategies, customer care, his behavior, but also includes costs.

Within this framework, to a six research topics:
1. Research on the analysis of the customer - the method and technical problems
2. Research on methods of obtaining customer
3. Research on the determinants of customer retention and increase in number
4. Research on the lifetime value of customer and ties and business
5. Research on the value of customer management channels
6. Research on the implementation of customer value

Figure 1

Customer Value Management Process [6]
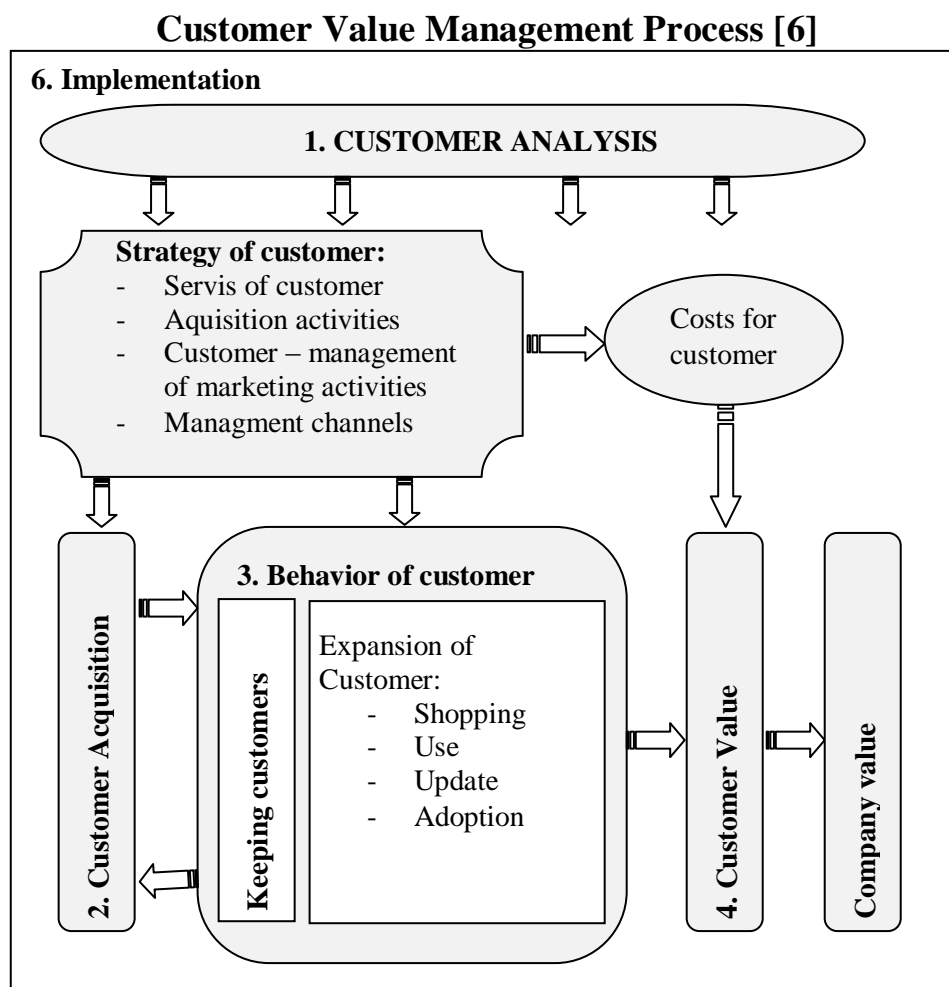
Not every customer is equally beneficial for the company. Some customers use such a large number of profitable products without causing high costs and bring significant benefits to the enterprise. Others on the contrary, very few buyers, requiring frequent support and information and for the loss.

Good quality and / or well service company in comparison with other providers can offer:

- specific individual treatment and supply,
- loyalty bonus, the recognition that the company has remained faithful,
- possible emergence of adverse effects of changes in society.

Figure 2

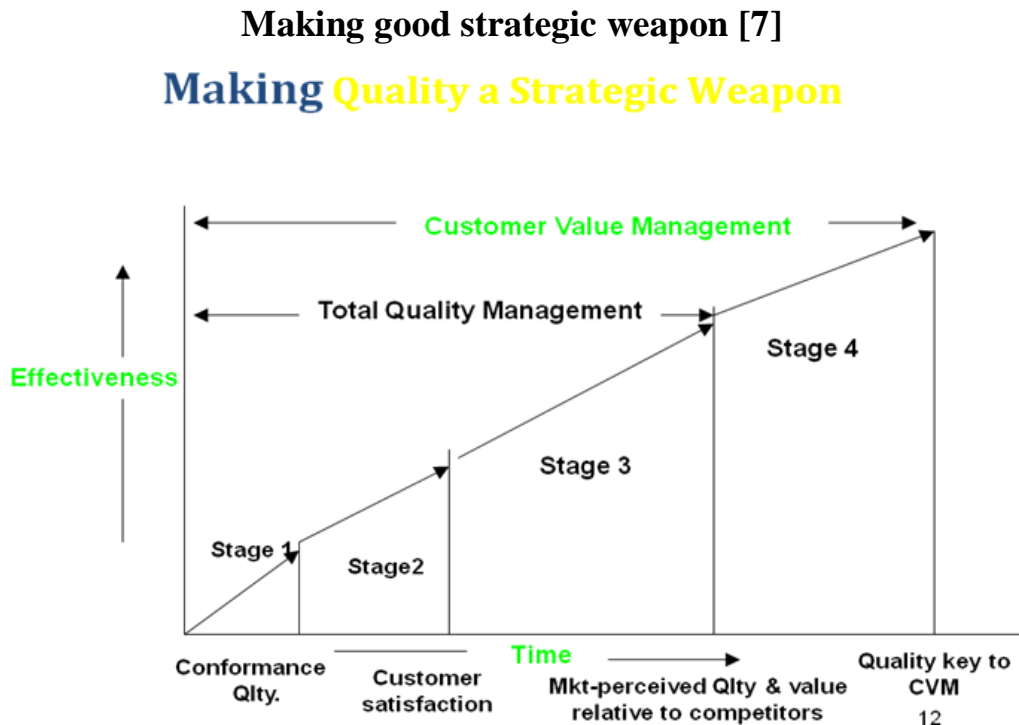**Making good strategic weapon [7]**

Making Quality a Strategic Weapon

CVM creates a better understanding of customers and the targeted activities to keep them. Consider the customer research is a key factor in the successful implementation of the strategy CVM. Other important conditions are:
- introduction of a standardized method for calculating the CVM - KPIs and measure customer loyalty,
- speed optimization Chur quota through customer value approach,
- a comprehensive view of the customer both inside and outside the data mining in all channels and customer interface,
- implementation tools - based on logical decisions and signs the best offer.

Conclusion

Customer-oriented organization is characterized by continuously given to the needs of current and potential customers and all their internal processes and structures geared to meet these needs. It is not to obtain a product and then placed on the market and try to get customers to it, but the fact that an organization first determine what they can stand and its potential customers need, then develop and then produces the product or offer it to market. Customer

orientation is only one part of the site relations, which involves management of the customer.

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