Petr Šnapka[1], Andrea Čopiková[2], Stanislav Konkolski[3]

QUANTIFICATION OF COMPANY'S MANAGEMENT CONTROL IMPACT AND ITS MODELLING

The main aim of this contribution is to present a possible approach to quantification of company's management control impact towards the executive sections of company's organizational structure. This impact is modeled by determining the amount of the so-called invariable proportional manager's control impact. It is dealing with modelling possible amount of change in the achieved level of fulfilling the determined target function — target in the company. Its basic modelling characteristics for modelling control impact level are considered, the so-called flexibility and incremental effectiveness (element of compensation) of the analyzed organization's target function.

Keywords: modelling, management by objectives, function's elasticity, marginal effectivity.

Петро Шнапка, Андреа Чопікова, Станіслав Конкольскі

КІЛЬКІСНЕ ОЦІНЮВАННЯ ПОКАЗНИКІВ УПРАВЛІННЯ КОМПАНІЄЮ ТА ЇХ МОДЕЛЮВАННЯ

У статті розроблено підхід до кількісного оцінювання показників управління компанією на різних рівнях її організаційної структури. Рівень впливу моделюється шляхом визначення міри впливу кожного менеджера. Змодельовано можливу кількість змін у досягнутому рівні виконання певної цільової функції в компанії. Основні характеристики моделювання — так звані гнучкість і наростаюча ефективність (елемент компенсації) цільової функції організації.

Ключові слова: *моделювання, цільове управління, еластичність функції, гранична ефективність.*

Рис. 1. Фор. 12. Літ. 12.

Петр Шнапка, Андреа Чопикова, Станислав Конкольски

КОЛИЧЕСТВЕННАЯ ОЦЕНКА ПОКАЗАТЕЛЕЙ УПРАВЛЕНИЯ КОМПАНИЕЙ И ИХ МОДЕЛИРОВАНИЕ

В статье разработан подход к количественной оценке показателей управления компанией на различных уровнях ее организационной структуры. Уровень влияния моделируется путем определения степени влияния каждого менеджера. Смоделировано возможное количество изменений в достигнутом уровне выполнения определенной целевой функции в компании. Основные характеристики моделирования — так называемые гибкость и нарастающая эффективность (элемент компенсации) целевой функции организации.

Ключевые слова: *моделирование, целевое управление, эластичность функции, предельная эффективность.*

1. Introduction. Main aim of this contribution is to present a possible approach to modelling of the control's level through the intensity of controlling influence of company's managers on productive units in a company. This controlling influence is most often implemented through the competent managers' decisions. But before we introduce the example procedure of possible modelling of the intensity of controlling

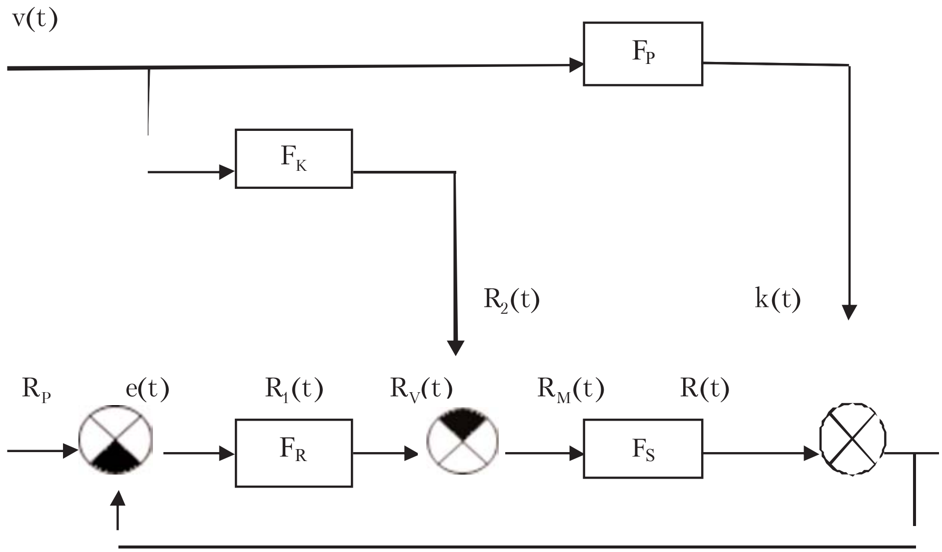
[1] Faculty of Economics, VSB-Technical University of Ostrava, Czech Republic.
[2] Faculty of Economics, VSB-Technical University of Ostrava, Czech Republic.
[3] General Manager, ArcelorMittal Tubular Products Karvina a.s, Czech Republic.

influence (controlling level) in the system management by objectives (subsequently system management by exceptions-variation) we will introduce primary input consideration for this modelling (Dorf, Bishop, 2001; Snapka, 2002; Snapka, 2004; Snapka, Konkolski, 2007). The example of modelling process we will show in the defined objective, which is the level (amount, size) of cost profitability, e.g. of a given company's production process. Modelling will be implemented on the basis of specific model's characteristics marked as elasticity and marginal effectivity of the analysed company's target function. Target function (criterion, relation) enables the modelling quantification in the company of the formed objective (output of this function) to certain amount (level, value) of input factors (variables), whose application makes possible the fulfilment of a given objective. In our case, the target function (relations) will be further mentioned relations for cost profitability. In the future, the ability to optimize cost upon knowledge of business processes will be crucial for companies to stay competitive (Voznakova, Janovska, Vilamova, 2011).

Level (amount) of the control intensity will be modelled through the characteristics of elasticity of the target function. This elasticity quantifies relative change of the fulfilment level of given company's objective with relatively little change of size (value, level) of individual input factor of this function (it takes into consideration that values' changes of these factors are small enough, e.g. by 1%). In the final form for the modelling of the level of the intensity of controlling impact, is this characteristics adjusted to the form of characteristics marked as invariable (Kp), that is invariable of proportional influence's controlling. Invariable models the intensity level of controlling impact of managers in the sense of ensuring the process of fulfilling the established company's objective. Second, already mentioned model characteristics are bound to defined objective is characteristics, the so-called marginal effectivity of this function. It is also possible to talk about a compensation effect. This characteristic makes it possible to model the intensity of necessary change of one of the input factors (variables) of the mentioned established function (in our case cost profitability) in the way that projected level (amount) of the defined objective is kept. Change of one of the input factors (variables) of target function, as above mentioned, is necessary due to influence of failure within the framework of other input factor. It is also possible to take into account the compensation effect.

Production process is for further consideration structurally thought of as a system compounded of two subsystems namely: controlled (efficient) subsystem, where implementation takes place, e.g. material and economic-financial output from this process and controlling (managerial) subsystem, which formulates objectives and shows controlling impact on efficient subsystem in the interest of fulfilling the defined objectives. Within the framework of the modelled example the fulfilment of objectives will be in the economic-financial area in the form of the required level (amount) of cost profitability of the production process' implementation.

The modelled structuralization of the considered system (with regard to modelling aim) and information description we can feature in Fig. 1.



v(t) — disturbance influence (failures) incoming to the analysed system of the company, which jeopardizes the fulfilment of the defined objectives of this system (in our case the production process);
F_p — transfer of the failure's influence (failures') to the system;
k(t) — level of failure's influence on the targeted behaviour of the system;
F_k — transfer of the compensation of failure's influence to controlling subsystem's output;
R_2(t) — level of impact of the compensation influence on system's behaviour;
Rp — level of the objective of controlled subsystem in the requiered amount of cost profitability in implementation of production process;
R(t) — level of reached cost profitability in time (t) in system (production process), i.e. R)t) = RM(t) + k(t);
e(t) — rate of variation in fulfilment of system's objectives, i.e. e(t) = Rp(t) - R(t), it means that undesirable variation is occurring in the case when R(t) is lower than Rp;
F_R — transfer of the controlling subsystem's reaction on the incurred undesirable variation;
R_1(t) — controlling impact formed by the controlling subsystem in the interest of fulfilment of the defined objectives in the area of cost profitability of production process' implementation;
R_v(t) — controlling impact of the controlling subsystem in the area of cost profitability after the absorption of compensation, i.e. Rv(t) = R1(t) - R2(t);
F_S — transfer of the reaction of controlled (efficient) subsystem on controlling impact R(t);
R_M(t) — level of possible reaction of the controlled subsystem on controlling impact in the area of cost profitability;
t — time factor (time interval).

Figure 1. **The modelled structuralization of system**

In time the process can be changed by the controlling impact of the regulated cost profitability (R_1(t)) of the determined system (production process). Change can proceed firstly based on how can (in relation to limitation of change implementation) controlling subsystem suggests change (give orders). Further how can be the suggested changes of amount (level) of the input factor determining amount of cost profitability implemented by the efficient subsystem. Relation (target function), which is quantifying the amount of the cost profitability example can be presented as (1):

$$r_N(t)=\frac{Z(t)}{N(t)}\cdot 100=\frac{c(t).Q(t)-F(t)-v(t).Q(t)}{F(t)+v(t).Q(t)}\cdot 100 \qquad (1)$$

rN(t) — the level of cost profitability in operations of a given system (further only system), in %;

c(t) — input factor — price for production's unit (output) from the system in CZK/unit;

Q(t) — input factor — production's amount from the system in units;

F(t) — input factor — the amount of operational systems' fixed costs in CZK for given time (time interval);

v(t) — input factor — the amount of operational systems' variable costs in CZK /unit;

Z(t) — profit in CZK from process operations in a given time (within the framework of time interval);

N)t) — costs incurred from system operation in a given time (within the framework of time interval) in CZK;

t — given time, i.e. time interval in which or for which we are evaluating the amount of cost profitability (Baye, 2010; Samuelson, 2008; Truett, Truett, 2004).

The abovementioned relation (1) can be modified to relation (2) in the form:

$$R(t)=\frac{r_N(t)}{100}=\frac{c(t).Q(t)-F(t)-v(t).Q(t)}{F(t)+v(t).Q(t)} \qquad (2)$$

The relevance of individual variables (2) was already mentioned. It is evident that during the operation of exemplatory production system, the efficiency can change and by that so can the accomplished amount of target argument in the form of cost profitability R(t). The amount can change in time depending on change (failure influence) in the accomplished level (amount) of already mentioned input factors which are influencing (determining) the level of accomplished cost profitability R(t).

In compliance with the systems' relation quantity of controlling (regulation) system's feedback indicated in Figure 1 (with the exception of linear transformation of the sub element's input changes of this system to its output in time), it is possible to describe dynamics of change (dynamics of controlling impact) as the following relation (3):

$$R(t+1)=Kp\,e(t)+R(t) \qquad (3)$$

The meaning of individual variables in relation (3) was already mentioned in the text, except for quantity R(t+1). Invariable labelled (K_p) was previously only partly characterized. R(t+1) indicates the level of cost profitability of a given production system in future after time (t), i.e. in the time of controlling impact of controlling subsystem on subsystem controlled. This means, that decisions are communicated by controlling subsystem and there is a change of implementation in efficient subsystem with the objective of elimination of the undesired variation in the attained level of operation's cost profitability of determined production system.

As we already mentioned, invariable (Kp) will be indicated as invariable of proportional controlling impact (intensity's level of this controlling impact). Which way we will further analyse how this invariable gains different amount in dependence on that, with which input factor (its change) influencing quantity R(t) is taken into consideration. It means that it will not be systematically dealing with one level (amount) of this invariable, but different levels (it will deal with different invariables base on its amount) in dependence on already mentioned relations.

Invariables model transfer (transformation) of reaction, i.e. the level of controlling impact on incurred impact failure, which leads to occurrence of undesirable variation (e(t)) in fulfilling the defined objective in the area of cost profitability.

As it was already mentioned, for example of the control's intensity impact level modelling including consideration, which is pertaining to the problematics of compensation, we will use established function (relation) determining the level of the reached cost profitability R(t) and its 2 characteristics: function's elasticity (S_i) and marginal, the so-called substitution influence (S_u). Characteristics of the elasticity will be used for determination of the level (intensity) of controlling impact. Characteristics of substitution influence is then applied for overall check of possible compensation influence of the amount of level's change of chosen input factor as a substitution, capable to solve negative change of other input factor's level, which was evoked by the occurrence and failure impact. By this, compensation is able, in our case, to ensure fulfilment of defined objective in the area of cost profitability of given production system.

Further information which pertains to input consideration in the framework of these characteristics is possible to find in the literature (Snapka, 2004).

2. Utilization of The Characteristics Of Established Function's Elasticity For Modelling The Intensity Controlling Impact Level (Invariable K_P). With regard to the already mentioned literature (Snapka, 2004) it is possible to model the intensity controlling impact level on the basis of invariable (Kp) to use characteristics of established function's elasticity (relation), which enables us to quantify (model) determination of the cost profitability amount. It is dealing with already mentioned relation (2). In this relation subsequently c(t), F(t), v(t) and Q(t) are, as it was mentioned, input factors (variables), which influence the achieved level (value, amount) of cost profitability of a given company's system.

Symbolically we can record this function as R = f(c,Q,F,v). Even though we will not further mention the symbol of time (t) in the relations, we will always keep in mind, that the level (amount) of these factors and cost profitability are variable in time.

Subsequently we will mention the determination of elasticity level of the defined objective in the form of cost profitability (further just function) for individual input factors, which influence (determine) the achieved level of this profitability with the utilization of relation (2) without symbolic representation of time factor (t). This elasticity (Si) for individual input factors will be labeled as: S_c, S_Q, S_F and S_v.

Relations for individual elasticity quantification:

a) elasticity (S_c) function in case the input factor is price (c):

$$S_c = \frac{\frac{\partial R}{R_0}}{\frac{\partial c}{c_0}} = \frac{\partial R}{\partial c} . \frac{c_0}{R_0} = \frac{Q}{F + v.Q} . \frac{c_0}{R_0} \quad (4)$$

b) elasticity (S_Q) function in case the input factor is quantity (Q):

$$S_Q = \frac{\frac{\partial R}{R_0}}{\frac{\partial Q}{Q_0}} = \frac{\partial R}{\partial Q}.\frac{Q_0}{R_0} = \frac{c.F}{(F+v.Q)^2}.\frac{Q_0}{R_0} \quad (5)$$

c) elasticity (S_F) function in case the input factor is fixed cost (F) in a given production system:

$$S_F = \frac{\frac{\partial R}{R_0}}{\frac{\partial F}{F_0}} = \frac{\partial R}{\partial F}.\frac{F_0}{R_0} = -\frac{c.Q}{(F+v.Q)^2}.\frac{F_0}{R_0} \quad (6)$$

d) elasticity (S_v) function in case the input factor is variable operational cost of a given production system:

$$S_v = \frac{\frac{\partial R}{R_0}}{\frac{\partial v}{v_0}} = \frac{\partial R}{\partial v}.\frac{v_0}{R_0} = -\frac{c.Q^2}{(F+v.Q)^2}.\frac{v_0}{R_0} \quad (7)$$

In relations (4) to (7) labelling of quantities with index (0) means we are dealing with input factors with the cost profitability with the level (amount), which they are achieving before failure impact, which lead to occurrence of undesired variation in the fulfilment of defined objective in the area of cost profitability in a given system.

With the utilization of information from the literature (Snapka, 2004) it is then possible to establish the amount of invariable (K_p). Accuring from this is possibility to model intensity of controlling impact controlling subsystem in the area of cost profitability R(t) in the relation to individual input factors: c, v, Q and F, whose amounts influence the level of this profitability. The amount of the modelled invariables is possible to formulate as the relation (8):

$$K_{pi} = \frac{S_i}{100}, \quad (8)$$

where index (i) marks the individual input factors of the established function, i.e. i = c, v, Q, F (in case of applying the changes and its amount).

Then there is a question about the range of possibility (limitation) and also competence of managers, who formulate decisions on changes by the form of controlling impact, and executor (performer in the efficiency subsystem) of these decisions, by which from the input factors they will be able to decide on the necessary amount of change and make it happen (Mikusova, Horvathova, 2012; Miklosik, 2010). This assessment in the model example will be executed with regard to the amount of influence's intensity to the achieved level of cost profitability.

3. Marginal Effectivity Characteristics For Compensation Modelling. Marginal effectivity (S_u) of individual input factors (variables) of the example established function describing possible level of cost profitability (R) enables to determine value (amount) of necessary change of one from the input factors of the function, so that the projected level of cost profitability of a given system is retained. Change of the level (amount) of this input factor is de facto evoked in a given system by effectivity limiting failure. This situation leads to occurrence of undesired variation in the level of fulfilling the required objective in the area of cost profitability. This situation is possible to solve with the application of compensation system in the form of levelling up the negative influence of undesired change of level of one of the input factor by affecting failure (failures). Compensation is implemented by the required level's change of other input factor, whereas compensation's influence shows in preservation (sustainment) of the required target level of cost profitability, i.e. ΔR(t) = 0.

Marginal effectivity (marginal rate of substitution) of individual input factors (variables) function of cost profitability can be formulated by partial derivation:

$$\frac{\partial R}{\partial c}, \frac{\partial R}{\partial Q}, \frac{\partial R}{\partial F} a \frac{\partial R}{\partial v}.$$

The relation between increase, that is increase and decrease (changes of the amount) of individual factors R(t) = Rp we will determine basing on following relation (9):

$$\frac{\partial R}{\partial c}.\Delta c + \frac{\partial R}{\partial Q}.\Delta Q + \frac{\partial R}{\partial F}.\Delta F + \frac{\partial R}{\partial v}.\Delta v = 0 \quad (9)$$

Left side of the relation (9) is the total differential of the function (2).

Consequently, we will introduce the determination of marginal effectivity (S_u) for solution of the failure's influence compensation on the example of substitution input factor's relation (c) and (Q). Here at input factor (Q) will show substitution effect (it will compensate the influence, which is limiting failure in the framework of price as the input factor (c) with the aim to sustain the status fulfilling the level of cost profitability of a given system.

With (9) we can determine the marginal effectivity between (c) and (Q) as follows:

$$\frac{\partial R}{\partial c}.\Delta c + \frac{\partial R}{\partial Q}.\Delta Q = 0 \quad (10)$$

From the formula (10) derives:

$$\frac{\Delta Q}{\Delta c} = S_{uQ,c} = -\frac{\frac{\partial R}{\partial c}}{\frac{\partial R}{\partial Q}} = -\frac{(F + v.Q).Q}{c.F} \quad (11)$$

From the relation it derives, that when the effect of limiting failure in the framework of the price as an input facto (its reduction by the amount of ΔQ) it is necessary, in the interest of sustaining required amount of cost profitability to change (increase) the level of the achieved production (Q) by amount of ΔQ.

The amount of ΔQ we will determine by relation (12):

$$\Delta Q = S_{uQc}\,\Delta c \quad (12)$$

This means that in the framework of controlling effect the responsible management must be able to put decisions together and assure the following implementation with relation (12) given change of the input factor's Q in the amount of DQ. The amount of possible change determines a border (limit) of a solution for undesired variation occurred by failure's influence (failures) within the framework of unit's price (c) of a given system. In case when it is impossible to use the compensation element, i.e. to apply necessary changes of the input factor's level (Q) or other factor, the existing undesired variation in fulfilling target objectives of the required cost profitability level would be permanent.

4. Conclusion. From the content of this contribution it is obvious that it is possible to use 2 presented characteristics, i.e. elasticity of the analysed target function and marginal rate of substitution between input quantities (factors) of this function to the solution of assignments connected to company's management.

The first place assignments (analytical and decision-making) are connected to application of system management by objectives, or consequential management system by variation including possible feedback up to the application of BSC.

It is exemplatory dealing with the possibility:

— to model levels' evaluation (intensity) of controlling effectivity in a given area of controlling, and by that ex-ante evaluate the level and impact of controlling decisions in the company aiming to ensuring fulfilment of its objectives, possibly solving undesirable variations in the fulfilment;

— to evaluate the risk's levels of the defined objectives' achievement in a company in given entrepreneurial areas which are connected to expectations of interest groups, which are influencing company's behaviour;

— to assess the compensation actions when deciding on the possibilities to level the undesirable variations;

— to create the company's outcome (output) database of controlling effectivity and compensation process with the possibility of its utilization for management of real situations connected with the system management by objectives.

It is evident that in this example is presented the application of target function in the area of cost profitability, that is one of wide variety of applications to evaluate target function in the sense of diverse structure of company's objectives. It possibly deals with evaluative application of the mentioned consideration to other functions, which makes it possible to quantify company's objectives not only in the area of economical-financial interests but also in other areas.

Acknowledgement: *This article was created with support from the Student Grant Competition Faculty of Economics,VSB-Technical University of Ostrava, in the project SP2011/81 "Measurement and performance management using Balanced Scorecard method".*

References:

1. *Baye, M.* (2010). Managerial Economics and Business Strategy. McGraw-Hill.

2. *Dorf, R. C., Bishop, R.* (2001). Modern control systems. New Jersey: Prentice Hall.

3. *Franklin, G. F., Powell, J. D. and A. Emanmi-Naeni.* (2002). Feedback control of dynamic systems. New Jersey: Prentice-Hall.

4. *Miklosik, A.* (2010). Faktory urovne procesov a procesna optimalizacia. Aktualne vyzvy teorie a praxe pre obchod, marketing, sluzby, cestovny ruch a medzinarodne podnikanie. Ekonom, Bratislava, pp 443-447.

5. *Mikusova, M., Horvathova, P.* (2012) Are you prepared for a crisis? Survey in Czech Small Enterprises. Actual Problems of Economics. no. 11,pp. 303-412.

6. *Samuelson, W. F., Marks, S. G.* (2008) Managerial Economics. Wiley.

7. *Snapka, P.* (2002). Crisis Management and Management by Exceptions, in Econ'02, EkF VSB-TU Ostrava, pp. 213-219.

8. *Snapka, P.* (2004). Krisenmanagement und Leitung nach Abweichungen, in Wissenschaftliche Beitrage aus Wirtschaftswissenschaft Geisteswissenschaften Bau- und Immobilienwirtschaft, Nr. 34, EIPOS, TU Dresden, pp. 96-101.

9. *Snapka, P.* (2004). Production Function and Modelling of Quantitative Level of Managing Acting, in Econ'04, vol. 11, EkF VSB-TUO, pp. 375-383.

10. *Snapka, P., Konkolski, S.* (2007). Modelling of Management System Production Process Issue. Academic International "Conference Increasing Competiveness of Regional, National and International Markets Development", p. 45.

11. *Truett, L. J., Truett, D. B.* (2004). Managerial Economics, Analysis, Problems, Cases. Wiley

12. *Voznakova, I., Janovska, K., Vilamova, S.* (2011). Cost Controlling In Terms Of Metallurgical Production, In: Proceedings of the 20th International Metallurgical & Materials Conference METAL 2011. Tanger, s. r. o, pp. 1272-1278.

Стаття надійшла до редакції 04.10.2012.