BUILDING HIGH PERFORMANCE STRATEGY OF MILITARY EXPENDITURES: THE UTILITY FUNCTION IN THE MIDDLE OF DEFENCE BUDGETING

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ABSTRACT: *The present paper proposes tasks and methods which can be used in process of discovering the most expedient variants of the perspective and effective strategy development process of the defence spending in the Republic of Estonia.The author offers a part of strategy model named "Financial Perspective" as one of the improvement tools for the system of planning military expenditures and effective utilization of budgetary funds. The Balanced Scorecard application by using the "utility function" will allow the Estonian Defence Forces to overcome important barriers to strategy implementation by interrelation of military planning and budgeting processes. The Balanced Scorecard might be used as a very strong practical application. It will improve the calculations of long-term perspective plans and the development of the military budgetary policy by taking into account the features of national defence expenses.*

KEY WORDS: *balanced scorecard; budgeting; defence forces; the utility function; performance measurement; IT technology; Estonia.*

JEL CLASSIFICATION: *C61*

1. INTRODUCTION

The efficiency of the financial assets allocated for military purposes should be determined by national security requirements and should be provided by a certain level of military expenditures.

Althought budgeting is an important control system for most organizations (Simons, 1995), many managers are dissatisfied with their current systems and are actively considering changes (Comshare, 2001; Neely et al., 1997, Hansen, 2011).

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In our case on the top of the problem lies a military expenditure planning method, which is used inefficiently in the Estonian Defence Forces. The application of the state budget may have incorrect targets and this may also have negative impact on the military task performance. The conceptual analysis approach and practical experience of budgetary funds planning prove that the topic is important and vital for the Defence Forces.

The Balanced Scorecard should encourage business units to link their financial objectives serve as the focus for the objectives and measures in all other scorecard perspectives. Every measure selected should be part of a link of cause/and/effect relationships that culminate in improving financial performance. The scorecard should tell the story of strategy, starting with the long-run financial objectives, and then linking them to the sequence of actions that must be taken with financial processes, customers, internal process, and finally employees and systems to deliver the desired long/run economic performance (Kaplan and Norton, 1996).

The research is based on *The Balanced Scorecard* (Kaplan and Norton, 1996) model, which is recognised as a strategic planning and management system that is used extensively in business and industry, government, and non-profit organizations worldwide to align business activities to the vision and strategy of the organization, improve internal and external communications, and monitor organization performance against strategic goals.

In spite of our increasing understanding of performance measurements within the public sector, little is known about the adoption patterns of performance metrics in the military sector, in particular. First of all this study is addressed to the Estonian Defence Forces and it will allow to expand an extant knowledge about the majority of settings that enforce measurement systems performance; it will also establish a deeper immersing into the framework design in the governmental organizations.

This paper examines the Financial Perspective as a new alternative method of budgeting that focuses on the conceptual analysis change concerning military long-term goals and tasks.

Empirical evidence supporting this study was gathered from results, which are based on real financial figures received from the mathematical modeling. The author is inclined to believe that the ***„utility function"*** or usefulness can be used in the process of selecting an optimal annual financial plan of military expenditure and focused on strategic goals and tasks. For our analysis we will use of one of the powerful tools to solve multicriteria choice problems is the Edgeworth-Pareto principle, which is successfully applied since 19th century.

By taking into account all obtained results, the author is convinced that *The Balanced Scorecard* model will help to improve the system of budgeting and will optimize the state spendings on the whole. Management control systems appear important in building the targets of a new strategy to various constituents. As a rule, one of the main and most challenging tasks of building a balanced system of management and controlling of military resources is to choose right indicators from the vast number of options that reflect the key factors performance for each of the strategic areas of the development.

All proposed methods will be established as one consolidated system of strategic budgeting (Or Strategy Map) by reflecting the special features of the strategic management of military resources.

The analysis of reference material has revealed that in most cases we find mainly general concepts of budgeting and, furthermore, the topic of military budgeting is covered superficially.

The multicriteria problem of the final selection serves as a comparative assessment of options based on quantitative and qualitative indicators used in the calculation of production and economic activity. The utility function includes several factors (performances measures):

- Sum of Budget (total planning sum)
- Quality of planning processes (possibility of strategic goals and tasks execution)
- Cost and quality ratio
- Time spent on strategic goals and tasks execution

The proposed budgeting method through the use of utility assessment will help guide the concept of efficient budget spending on defense as well as take into account the usefulness of the strategic planning from a position of economic and financial evaluation.

2. LITERATURE REVIEW

Our study examines the deployment of the balanced scorecard, a performance measurement system that enables managerial decision making by aligning performance indicators with the goals and strategies of the organizations (Lipe and Salterio, 2000, pp. 284). The balanced scorecard has attracted considerable interest in the realms of practice and research for example, Silk (1998) reports that 60 percent of Fortune 1000 firms have experimented with the balanced scorecard. Further, Kald and Nilsson (2000) show that 27 percent of major Scandinavian companies have implemented this performance measurement framework. In a similar vein, Atkinson and Epstein (2000b, p. 2) echo the conclusions of a study by Walker Information which reports that 59 percent of Canadian executives claim familiarity with the terms “balanced scorecard” or “balanced measurement system” (Walker Information, 1998, pp. 4). Lastly, research interest in the balanced scorecard is reflected in the contention by Atkinson et al. (1997a, pp. 94) that investigation of such performance measurement frameworks constitutes one of the most significant developments in management control and, thus, deserves intense research attention (Carmona and Grönland, 2003).

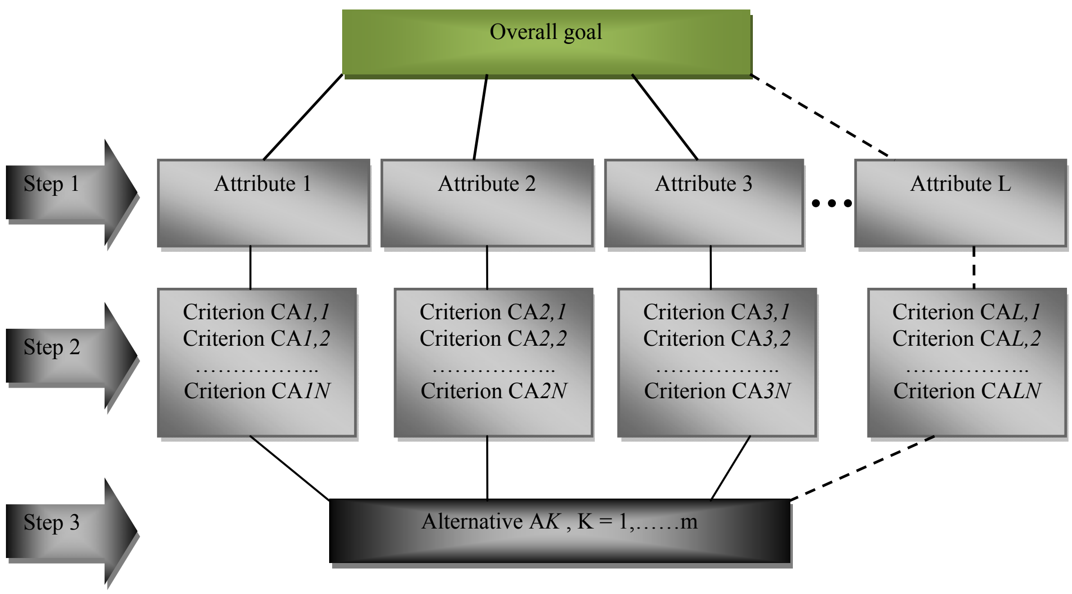
Allowing direct or indirect measurement of the utility allows us to assign *cardinal utility* where one can express numerical values of fulfilment instead of relative better/less-than comparisons. This assignment is not without controversy – since opponents have denied the possibility of measurement of any benefit. Vilfredo Pareto, in a letter to Benedetto Croce, wrote "*I was worried about the pleasure and that pain which had to be measured, because in reality, nobody is capable of measuring pleasure. Who can say what pleasure is double another pleasure*?" However, no one doubted the ability of people to compare the satisfaction, in other words - the ability of people to rank these sets in a single „***scale of preference***" (Schoemaker, 1982).

Various choice problems are studied within a framework of decision making analysis where using utility assessment allows one to realize choice efficiency and avoid inappropriate or self-refencing solutions (Noghin, 2005).

The multicriteria choice problem attempts to find a set of selected alternatives and elements such as an Edgeworth-Pareto principle and can be formulated as a statement that any set of selected alternatives is a subset of the Pareto set. In other words every chosen alternative must be Pareto-optimal. To prove this principle, it is necessary to restrict the class of multicriteria choice problems under consideration by imposing special requirements on the variables mentioned above (Noghin, 2005).

3. THEORETICAL BACKGROUND AND METHODS OF UTILITY FUNCTION

Choice is impossible without a concept of person who makes this choice in order to achieve his/her personal goals. This person (or team) who makes a choice and is responsible for all its consequences is said to be a decision maker (*further*, DM). The DM strives to reach a definite goal that can be expressed numerically in terms of maximization (or minimization) of a real-valued criterion function defined on space *X*. (Noghin, 2005). In simplistic terms, an objective goal is set with certain criteria and input variables that can be measured.



Source: by Haarstrick and Lazarevska, 2009

Figure 1. General scheme of the Analytic Hierarchy Process

Often multiple functions must be considered and weighted accordingly. This can occur, e.g., when the phenomenon, object, or a process is considered from different points of view with competing interests; and in order to formalize each criteria it is necessary to introduce unique functions. Studying different stages of a dynamic process, we form a special criterion for each stage; to estimate the whole multistage process we also need to take into account several criteria simultaneously (Noghin, 2005).

The analytic hierarchy process provides a comprehensive and rational framework for structuring a problem, for representing and quantifying its elements, for relating those elements to overall goals, and for evaluating alternative solutions (see Figure 1). Once the hierarchy is built, the DM systematically evaluate its various elements, comparing them to one another in pairs. In making the comparisons, the DM can use concrete data about elements relative meaning and importance. The analytic hierarchy process concerts these evaluations to numerical values that can be processed and compared over entire problem (Haarstrick and Lazarevska, 2009).

In fact, the mathematical formulation of the problem could be presented in next way. Further details are elaborated in several sources: Noghin (2005), Belton and Stewart (2002), Intriligator (1975), Gorbunov and Kozin (2007).

Thus, we assume that there are M real-valued functions:

f1 , f2 ,..., fm, M ≥ 2 defined on the set of alternatives ***X***. These functions are said to be optimality criteria or goal functions (Noghin, 2005) which are real-valued functions *that* compose a *vector criterion*:

$$f = (f1, f2, \dots\dots fm) \qquad (1)$$

For every alternative $x \in X$, the *m*-dimensional vector (*outcome*)

$y = f(x) = (f_1(x), f_2(x), \dots, f_m(x)) \in \Re^m$ is an image of *x*, where *Rm* is the *m*- dimensional real vector space. This space is called a *criterion space* or a *space of outcomes (Noghin, 2005).* An image of the vector function *f* (i.e. a range) is denoted by $Y = \{y \in \Re^m \mid y = f(x)$ for some $x \in X\}$

This set is called a *set of vectors* (or *outcomes*)

Side by side with a set of selected alternatives, a *set of selected vectors* (*selected outcomes*) can be introduced as follows

$$\mathrm{Sel}\,Y = f(\mathrm{Sel}\,X) = \{y \in Y \mid y = f(x) \text{ for some } x \in \mathrm{Sel}\,X\}$$

This set is a subset of the criterion space *Rm*. Assuming that there exists a one to- one correspondence between the sets Sel *X* and Sel*Y* , we can always find one of them if we know the other.

Consider *f* = (*f*1, *f*2 ,..., *fm*) defined on *X*. Let us introduce the following set

Y = *Y* ×*Y* ×...×*Ym,* where

$Yi = fi\ (X),\ i = 1,2,...,m$. Obviously, $Y \subset Y' \subset Rm$.

Recall that $\succ Y$ is a preference relation defined on *Y*.

Dealing with the *quantitative* information on the relative importance of criteria, we mean that all criteria $f1, f2, ..., fm$ have numerical values. Thus $yi = fi\ (x) \in R$ for every $x \in X$ and all $i = 1,2,...,m$. This is sufficient to consider a multicriteria choice problem within a *mathematical* framework. However, for any *applied* multicriteria problem the numerical value of criterion is a result of measuring on a scale. For instance, if the criterion expresses cost of a project, profit, or expenses then its values are measured in euros, millions of euros, dollars, euro or other currency units.

By the Edgeworth-Pareto principle, the Pareto set includes all selected vectors or, equivalently, only Pareto-optimal vectors should be selected. If it is known that one criterion is more important than another then the Pareto set may be reduced without the loss of selected vectors. In other words we may remove some Pareto-optimal vectors from further consideration, since they should not be selected a fortiori. The reduction of the Pareto set may essentially facilitate the decision process.

The advantage of using quantitative performance criteria is to provide a relative measure of sourcing effectiveness that directly measures the financial effectiveness of a solution. It can be used for estimating and "what if" scenario planning – a very useful criteria in national defense planning.

The first stage of the research is devoted to constructing economic and mathematical models that encapsulate the essence of utility. In general, the goal function *(function 2)* has the form (Gorbunov and Kozin, 2007):

$$F = f\ (P;\ K;\ N;\ T.......) = w\ (P) + w\ (K) + w\ (N) + w\ (T) \qquad (2)$$

Where, f (P; K; N; T;........) is the set of the identified feasible indicators:

- F = the total assessment of the utility of element of decision making
- w - the coefficient of total value
- P - Total amount of budget (total planning sum)
- K - Quality of planning processes (possibility of strategic goals and tasks execution)
- N – Cost (total amount of budget) and quality ratio
- T - Time spent on strategic goals and tasks execution

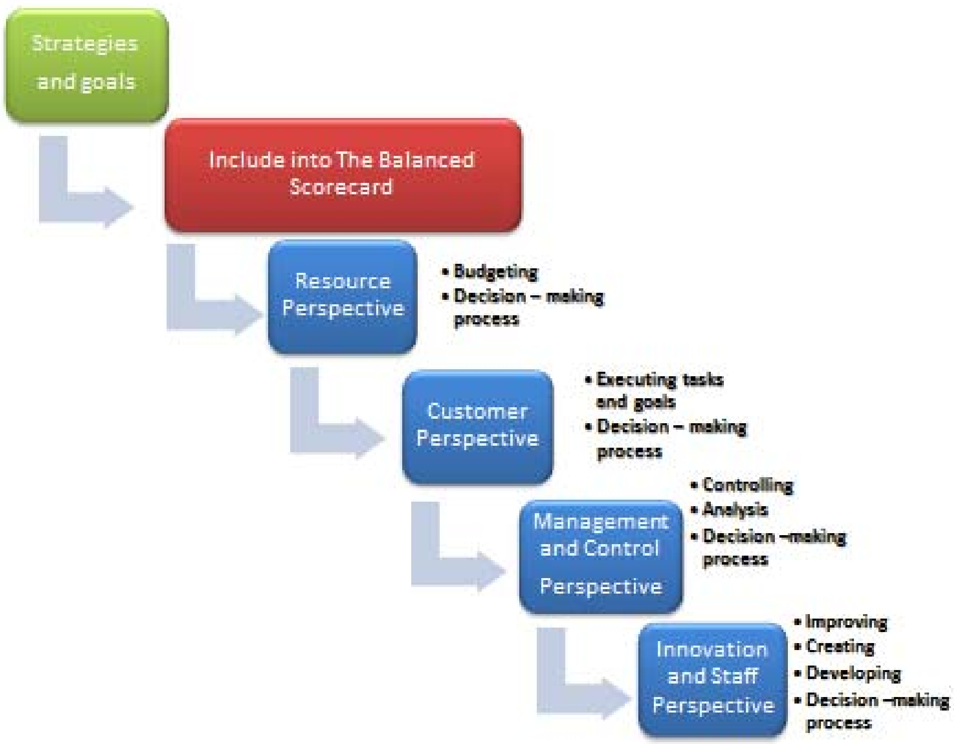
The second stage is presented as an information gathering process and applied analysis.

The third stage is dedicated to the criteria transformation mode into partial utility parameters such as decision making process (Intriligator, 2002).

4. THE BALANCED SCORECARD AS A MANAGEMENT SYSTEM OF MILITARY RESOURCES

It takes almost a year to plan the military budget of Estonia. This process covers the formation of various problems and carries out different analyses, and also builds up the uniform financial plan. Legislative and legal certificates and also various documents are used as a basis (the strategy of national safety, the plan for development, and the military instruction).

Further it is necessary to point that The Balanced Scorecard in the Estonian Defence Forces comprises four perspectives: Resources (Budgeting), Management and Control, Innovation and Staff, and Customer (Estonian Defence Forces) (Take in Figure 2).



Source: by author

Figure 2. The Balanced Scorecard for the Estonian Defence Forces

The Financial Perspective will be used as an example and in our case - ***Resources (Budgeting)***, which will allow us to consider statements and strategic tasks application. In other words, ***Resource (Budgeting) Perspective***, which is posed on the top of the system and lying inside the budget planning process will be realised by using a mathematical model (utility function) in order to make a process itself more transparent and effective. This approach is particularly useful for forecasting prognoses.

For this reason, the analysis and proposed methods might develop a system of strategic controlling (Or Strategy Map) by taking into account the specifics of the strategic management of military resources (Take in Fugure 3). Figure 3 shows a step-down procedure, which represents the transition from high-level strategy to budgeting for local operations.

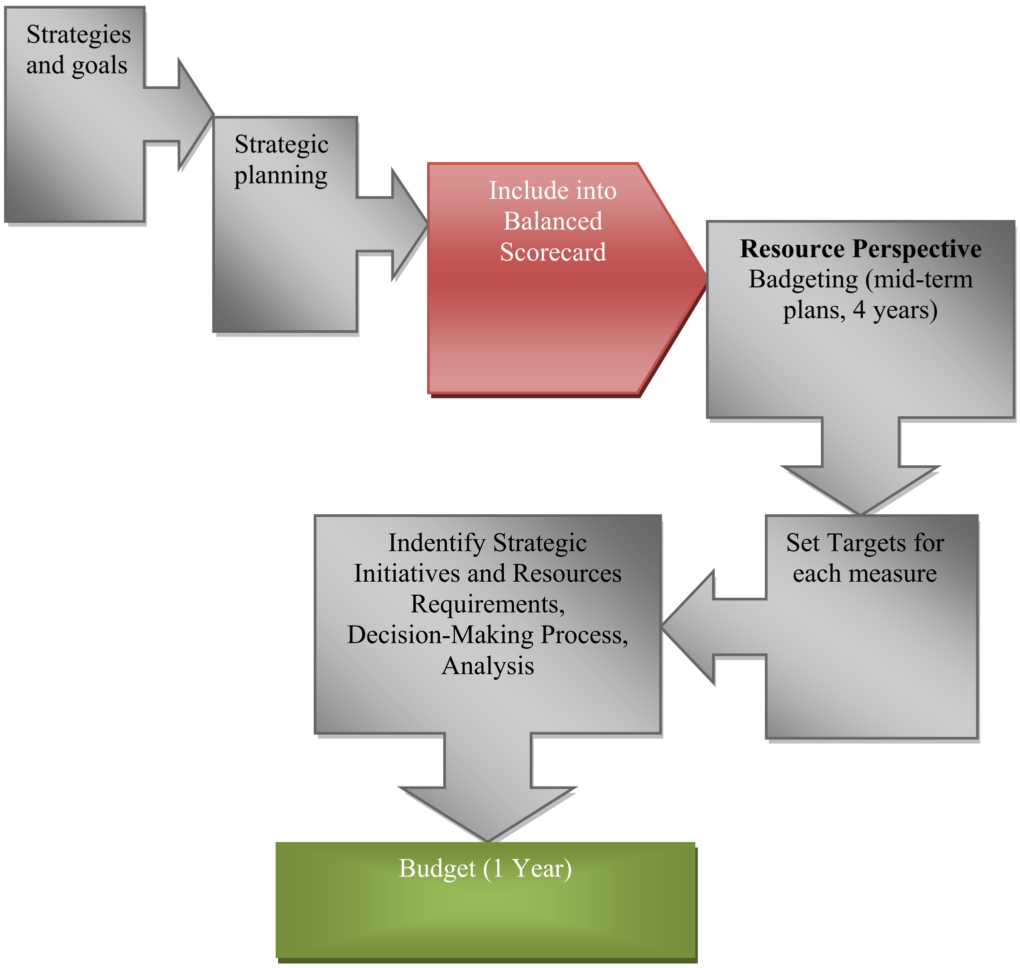


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Figure 3. The Strategic Map of Step-Down Procedure

Management control systems appear important in building the targets of a new strategy to various constituents. As a rule, one of the main and most challenging tasks of building a balanced system of management and controlling of military resources is to choose right indicators from the vast number of options that reflect key factors performance for each of the strategic areas of the development.

5. THE „UTILITY FUNCTION" AS OPTIMIZATION TOOL OF THE MILITARY BUDGETING

The selection process of budgetary strategic elements will be examined on the basis of a second function (***function nr 2***) and by using several indicators. In accordance with our task the research will include different components that contain a specific set of attributes and elements. The utility-based performance measures towards to the strategic budgeting will present the maximum value of every component and the total sum of the utility assessment.

In order to understand how to use the proposed model, the author defines some required information:

- The target period – 4 years;
- The budget planning process begins from an analysis and review of all needed aspects and strategic tasks – 1 year;
- Strategic Goals and Tasks formation – initial stage, which determines the direction of the whole process;
- The purpose-oriented strategic programs will include a few different financial plans (Budgets);
- Finally, it is necessary to choose an optimal financial plan in accordance with received estimations and results (see Table 1 and 2).

In accordance with non-disclosure agreements: assume that we have three budgets (*Budget1, Budget 2, Budget 3*), where the sum of each budget (total amount of budget) is:

- Stratrgic financial plan (Budget 1) **- XXX €**
- Strategic financial plan (Budget 2) - **XXX €**
- Strategic financial plan (Budget 3) - **XXX €**

5.1 Cost Estimation (total planning sum)

Calculation of the partial utility parameters concerning military expenditures is a two-step process. The first stage involves the calculation of coefficients - the best value of budget´s sum ΔP is defined by the ***function nr 3*** (Gorbunov and Kozin, 2007):

$$\boldsymbol{\Delta P} = (\mathrm{P} - \mathrm{P\ min}) / (\mathrm{P\ max} - \mathrm{P\ min}), \text{ where} \qquad (3)$$

$\boldsymbol{\Delta P}$ – the coefficient of optimal cost

P – the current value of total amount of budget
P min – the minimal value of all proposed total planning sums
P max – the maximum value of all proposed total planning sums

At the second stage, the values of ***ΔP*** should be compared with estimated coefficients of partial utility of other factors. In order to make this calculation the author offers to use the transformation function (3) for the factor "Cost" through the values of ΔP, which will compute the coefficient of partial utility ***Qp (function nr 4,*** Gorbunov and Kozin, 2007).

$$Qp = (1-\Delta P) / (1+\Delta P)^2, \text{ where} \qquad (4)$$

Qp – the coefficient of partial utility of optimal cost
ΔP – the coefficient of optimal cost
The maximum value of the partial utility of optimal total budgeting sum belongs to „Budget 1" – ***1,000.***

5.2 Quality Assessment of Planning Processes

Quality can be defined clearly in comunication only when the parameters constituting quality are indentified and measured objectively. Most subjective measurements of quality are relative and the base used for measurement differs among people and changes unknowingly within an individual. These differences and changes cause uncertainty in the description of quality (Watada, 1973).

In our case the quality might be assessed by using subjective numerical values, which are presented in absolute or relative terms. Moreover, the coefficients of partial utility concerning the quality of planning process addressed to the military expenditure is assigned by every department and military personnel.

The quality of budgeting will be estimated by each component using the scale or so-called „The satisfaction scale":
1 – Unsatisfactory;
2 – Partly satisfactory;
3 – Satisfactory;
4 – Average;
5 - Above average;
6 – Good;
7 – Excellent.

The coefficient of optimal quality (***ΔK***) is carried out using the ***function nr 5*** *(Source: made by the author):*

$$\Delta K = \sum_{i=1}^{Z} R / \sum_{i=1}^{N} \sum R_{in} \text{ , where} \qquad (5)$$

ΔK – the coefficient of optimal quality
Ri – the current value

Z – the total sum of current value

N – the total value of participants

The parameters of quality (***Qk***) is carried out using the conversion formula directed to the factor ***"Quality"*** and transformed into the partial utility (***function nr 6***, Gorbunov and Kozin, 2007):

$$Qk = (1 - \Delta K) / (1 + \Delta K)^2, \text{ where} \quad (6)$$

Qk – the coefficient of partial utility of optimal quality

ΔK – the coefficient of optimal quality

Table 1 shows that the most appreciated quality represents ***Budget nr 2*** – ***6,2534***

5.3 Cost Estimation (total planning sum) and quality ratio

The calculation of the partial utility concerning the correlation between "**Cost / Quality"** will be conducted using the results of **"Cost"** and **"Quality".** In accordance with it, indicators of **„Cost"** or its coefficients will be shared with indicators of **"Quality"** (coefficients). Optimization of the choice is based on coefficient of optimality Δ**Z** determined by the ***function nr*** *7* (Gorbunov and Kozin, 2007):

$$\Delta Z = (Z - Zmin) / (Zmax - Zmin), \text{ where} \quad (7)$$

ΔZ - the coefficient of optimal cost/quality ratio

Z – the current value of cost/quality

Z min – the minimal value of all proposed values

Z max – the maximal value of all proposed values

The obtained values were comparable to estimated coefficients of partial utility concerning other factors, which are necessary to calculate the coefficient of partial utility ***Q***z. For this manipulation the transformation ***function nr 8*** (Gorbunov and Kozin, 2007) (price / quality through the values of ***ΔZ***) will be used.

$$Qz = (1-\Delta Z) / (1+\Delta Z)^2, \text{ where} \quad (8)$$

Qz – the coefficient of partial optimal evaluation of cost/quality

ΔZ – the coefficient of optimal evaluation of cost/quality

In order to compose the initial data table, it is necessary to use the coefficients of partial utility and actual values of the budget´s sum. The given analysis has revealed that despite the high quality estimates and the most appreciated evaluation of cost/ quality, which was established by ***Budget nr 2,*** the general indicators of the partial utility (coefficients) were owned by the ***Budget nr 1.***

In this respect, such assessment might have a certain amount of influence on effective financial plan choice but only at the time when other factors are not a priority.

5.4 Time spent on strategic goals and tasks execution

The calculation of the partial utility concerning the time spent on strategic goals and tasks should be based on statistics reports. In our case we use next segment of time spent for these purposes, particularly – (*Budget execution: annual statistics for the last year*).

Further indicators (based on statistical data analysis) will give a full picture of the budgeting process.

Calculations will be conducted in accordance with ***function nr 9*** (Gorbunov and Kozin, 2007).

$$\Delta T = (T - T\ min) / (T\ max - T\ min),\ \text{where} \tag{9}$$

ΔT – the coefficient of optimal spending time
T – the current value of spending time
$T\ min$ – the minimal value of total spending time
$T\ max$ – the maximum value of total spending time

The partial utility values concerning the time spent on strategic goals and tasks will be established using the ***function nr 10*** (Gorbunov and Kozin, 2007).

$$Qt = (1-\Delta T) / (1+\Delta T)^2,\ \text{where} \tag{10}$$

Qt – the coefficient of partial optimal evaluation of spending time
ΔT– the coefficient of optimal evaluation of spending time
The made calculations have shown that the highest optimal value belongs to a ***Budget nr 1.***

Table 1. The partial utility coefficient matrix*

Coefficient of Utility	***Strategy nr 1***	***Strategy nr 2***	***Strategy nr 3***
	Budget 1	Budget 2	Budget 3
Total Planning Sum, ***€***	XXX	XXX	XXX
The coefficient of optimal cost, ΔP	0,0000	1,0000	0,4234
The coefficient of partial utility of optimal cost, Qp	1,0000	0,0000	0,2846
coefficient of partial utility of optimal quality, Qk	6,2404	6,2534	6,2454
evaluation of cost/quality	11620869,5066	13996327,0572	12628821,4664
coefficient of optimal evaluation of price/quality, ΔZ	0,0000	1,0000	0,4243
coefficient of partial optimal evaluation of cost/quality, Qz	1,0000	0,0000	0,2838
The coefficient of spending time, ΔT	0,0000	1,0000	0,8929
The coefficient of partial utility of spending, Qt	1,0000	0,0000	0,0299

**Source: made by the author*

In order to obtain an objective total estimation of utility concerning the selection of optimal financial plan, it is necessary to find average values of separate parameters. And all coefficients of the partial utility will lead to the one general denominator (***function nr 11***, Gorbunov and Kozin, 2007):

$$WQi = Qi / \sum_{i=1}^{N} Qi, \text{ where} \tag{11}$$

WQi – the coefficient of total value
Qi – the coefficient of partial utility for each indicator
N - Number of strategies (budgets)
$\sum_{i=1}^{N}Qi$ - total current value

After reduction of all studied criteria for a single equivalent of mathematical model, it is appropriate to express one integral form (***function nr 12***, Gorbunov and Kozin, 2007):

$$Ftotal= WQp+WQk +WQz+WQt, \text{ where} \tag{12}$$

Ftotal – the total assessment of the utility (set of elements which have influence to the decision making)

WQp – the total coefficient of partial utility of optimal total amount of budget (total planning sum)

WQk – the total coefficient of partial utility of optimal quality

WQz – the total coefficient of partial utility of optimal of cost/quality

WQt – the total coefficient of the time spent on strategic goals and tasks execution.

Table 2. The consolidation matrix of utility coefficients*

Coefficient of Utility	***Strategy nr 1***	***Strategy nr 2***	***Strategy nr 3***
	Budget 1	**Budget 2**	**Budget 3**
WQp	0,7784	0,0000	0,2216
WQk	0,3330	0,3337	0,3333
WQz	0,7789	0,0000	0,2211
WQt	0,9710	0,0000	0,0290
Ftotal	**2,8614**	**0,3337**	**0,8049**

**Source: made by the author*

In accord with **Table 2** (see Table 2), the ***Budget nr 1*** has the maximum value of an indicator of utility.

6. CONCLUSION

In the process of the given investigation the author has pointed several important moments of the budget planning process, in particular, forecasting improvement through the decision-making process and its pathways; the The Financial Perspective integration into military strategic budgeting system, and has discovered that all these components have one common and unique element on the basis. This key element is the „utility function“, which might be used for the strategy development and for the whole budgeting system improvement.

One of the most obvious conclusions is that the present system of Estonian Defence Forces budget planning should be improved. The best solutions are offered by *The Balanced scorecard* model and its component *Financial Perspective,* which makes military expenditure planning more effective.

Moreover, the coefficient method as a component of financial perspective model has proved that budgetary funds can be planned and distributed according to goals and objectives. This technique can be very productive at the redistribution of means if military tasks undergo any changes.

By summarizing all the results, we have discovered that the balanced scorecard implementation into the Defence Forces managerial process is providing many insights into the overall process of deploying performance metrics in public sector organizations.

Further, the framework itself proved helpful for the Estonian Defence Forces in questions of budgeting, analysis and decision-making process. Accordingly, we deem that future research addressing performance measurement systems in centralized organizations may enhance understanding about the role of the balanced scorecard in rendering effective, efficient and “modern” public sector organizations (Carmona and Grönland, 2003).

The new technique will raise quality of resource management, and also will create an effective basis for the detailed analysis that is necessary condition of strategic resources planning. It's no surprise, that the application of these procedures is «built into» strategical system, and it is necessary to concern them more than tools of information support directed to decision-making.

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