Strategic Management and Optimization System of Military Resources (Based on the Example of the Estonian Defence Forces)

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STRATEGIC MANAGEMENT AND OPTIMIZATION SYSTEM OF MILITARY RESOURCES (BASED ON THE EXAMPLE OF THE ESTONIAN DEFENCE FORCES)

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LIST OF PUBLICATIONS

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Sedysheva, M. 2012. The Utility Function: New Strategic Approach to Optimal Budgeting in the Estonian Defence Forces. *19th Annual Conference of the Multinational Finance Society*, June 24-27, Krakow, Poland, [Accepted].

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LIST OF ABBREVIATIONS

BSC	Balanced Scorecard
CU	Cardinal Utility
DM	Decision Maker
EU	Expected Utility
IT	Information Technology
Studies	Articles/ Publications nr I, II, III, IV
UF	Utility Function
U.S. Army	The United States Army
Rm	Linear space of real vectors
$0m = (0,0,...,0) \in Rm$	Origin of *Rm*
Rm+	Nonnegative orthant of *Rm*, i.e. the set of all nonzero vectors whose components are nonnegative
m	Number of criteria
$I = \{1,2,...,m\}$	Set of indices of criteria
X	Set of alternatives
$f = (f1, f2,..., fm)$	Vector criterion
$Y = f(X)$	Set of all vectors [outcomes]
$\prec_x$	Preference relation defined on *X*
$\prec_y$	Preference relation defined on *Y*

ABSTRACT

The allocation of military resources is a complicated and diversified process with many stakeholders and which encompasses a complex network of practical measures and techniques. This requires a well-built management system to both identify and balance the logistical, political, and managerial requirements of multiple stakeholders.

The primary aim of this study was to investigate the role of military expenditure, which plays a vital role in the national defence of a country. Another purpose was to determine objectives and measures that describe the management strategy of the military resources via four Balanced Scorecard perspectives. Finally, implementation in the IT area concerning new methods and techniques (e-Budget platform) was examined in the study.

The background for the dissertation was an inductive study and review of existing management systems. On the basis of the literature review and "real life" data collection, a new strategic management system (model) was established. The originality of the proposed innovation lies in its scientific approach, based upon a mathematical model built using the Utility Function principles.

The results showed that this model can be used as a process for identifying the most appropriate variables required for effective monetary allocations with an emphasis on perspective development for planning defence spending.

In addition, several new contributions to management theory were highlighted:
(1) A template that describes the basic components of value, which are formed by mathematical models integrated into the Balanced Scorecard.
(2) A model based upon strategy creation processes that articulate the dynamics of new management systems.

The principal conclusion is that this thesis synthesizes the divergent strands of the research which have the potential to transform the proposed model into a powerful strategy planning tool.

Keywords: Balanced Scorecard, Utility Function, Strategy Maps, e-Budget application, optimization tools, Estonian Defence Forces.

INTRODUCTION

The research process utilized in this text is guided by the following Studies, which will be referenced via Roman numerals (I – IV):

I   Sedysheva, M. (2011); Building High Performance Strategy of Military Expenditures: the Utility Function in the middle of Defence Budgeting. *The Annals of the University of Petrosani, Economics,* Volume XI, 2011 [Accepted].

II Sedysheva, M. (2011); The Utility Function as One of Optimization Tools of the Military Procurement. *EURAM 2011 workshop: Management Culture in the 21st Century, June 1-4, 2011, Tallinn, Estonia.* http://euram2011.mindworks. ee/public/papers/paper/443 (18.12.2011).

III Sedysheva, M. (2012); Strategic Management System and Methods of Controlling as Key Elements of Military Expenditure Policy-Making Process. *Journal of Strategy and Management,* Emerald Group Publishing Limited Volume , Issue , [Accepted].

IV Sedysheva, M. (2011); The Balanced Scorecard and the New IT Approach to the Defence Budgeting Process. *EBS Review,* Volume 2011, Issue 28, 67-82.

The theory highlighted in this text is of practical and theoretical importance from a management point of view for various institutions and organizations. The hope is to eventually provide a novel approach to the fundamental question of allocating military resources in a measured and reviewed manner.

The Research Tasks

Jay Barney (1991) defined resources as including "*all assets, capabilities, organizational processes, firm attributes, information, knowledge, etc. controlled by a firm.*" He defines resources as valuable "*when they enable a firm to conceive of or implement strategies that improve its efficiency and effectiveness*" (Daft, 1983). In the language of traditional strategic analysis (Learned et al., 1969; Porter, 1981), firm resources are capital that organizations can use to conceive of and implement their strategies (Barney, 1991).

All statements are based upon current problems connected with military expenditure planning and budget application techniques. Moreover, all state organizations in Estonia are provided with useful software that offers financial representations but they lack specific budgetary programs that, in turn, create an array of possibilities connected with planning, execution, and control of public funds.

In accordance with the texts highlighted in the literature review, the author proposes the following main research tasks:

The first research task: To create a methodology and preconditions of the implementation of the Balanced Scorecard model for the military expenditure planning process by comparing prerequisites with existing models.

The second research task: To analyze an instance of the Utility Function modifications and to provide streamlined calculations of strategic perspectives, plans, and contributions to the development of a budgetary policy.

The third research task: To create the e-Budget platform and Strategy Maps by developing the appropriate conditions for effective solutions of strategic objectives and military tasks, in order to optimize the military spending process as a whole.

The fourth research task: To investigate the role of the decision-making process, as a component of the Process Perspective, in accordance with the goals and visions of an organization.

To summarize, the thesis consists of six parts:

(1) The fundamental aspects and construction paradigms of the BSC model. The research evaluates the value of BSC to organizations and its contribution to organizational performance. It is important to note that the sources of performance derived from the BSC consist of three types: (1) better translation of strategy into operational terms, (2) the fact that strategizing becomes a continuous process, and (3) greater alignment of various processes, services, competencies, and units of a public organization (De Geuser et al., 2009). The research examines example perspectives in order to create an improved management system.

(2) The concept of Expected Utility (EU) is introduced, which focuses upon theoretical and empirical research including various interpretations and descriptive modifications which lead to a mathematical form. Special attention is paid to the cardinal utility as well as the manner in which probabilities are incorporated. Moreover, the focus on individual decision-making processes identifies how most of the empirical evidence can be reconciled at the individual level with the principle of EU maximization (Schoemaker, 1982). Finally, a unique mathematical model is presented based on the Edgeworth-Pareto principle which synthesizes the divergent strands of research by indicating their future roles inside the EU model.

(3) Different stages of strategic planning are presented via a circumstance-based theory approach (Clarton and Raynor, 2003). The aim of this investigation is to choose the methods managerial staff should rely on in relation to resource

management (for the Estonian Defence Forces). One of the most challenging tasks in creating a balanced management and controlling system for military resources is to select the 'right' indicators from a vast number of options. All proposed methods are established as one consolidated system of strategic planning (or Strategy Maps) by reflecting the special features of the strategic management of military resources.

(4) A new model is presented with an improved concept of the unique e-Budget software platform based on the BSC model. The author provides an overview of existing research studies concerning the essence of the BSC development. In addition, a new application named 'e-Budget portfolio' will be established where an important factor is the evaluation of what effect a proposed e-Budget portfolio might have upon the practical allocation of resources.

(5) Four manuscripts are presented (Studies I-IV) in order to provide a full description of the process. This section focuses on an adaptation of the BSC and the utility function to the organizational process identifying their particular features. All four manuscripts meet the institutional practices formed when using new methods and rules of the performance management. Secondly, the author addresses different implementation standpoints of the proposed model by highlighting its strengths. Moreover, the research process of the model allows one to deepen both descriptive and normative insights concerning decisions under different evaluation strategies. For example, we have observed that people perceive and solve problems differently, and our research demonstrates how different standpoints might be transformed into a single logical framework in order to discover, address, and eliminate these differences.

(6) The conclusion presents results of the research and its practical achievements. In summary we describe empirical evidence supporting the usefulness of an analysis and valuation based on the BSC model by including concepts of a multiple-criteria analysis and on the basis of the Edgeworth-Pareto principle. The confirmation and/or rejection of the denoted research tasks is also established.

Methodology and Methods of the Research

The author conducted an empirical study of a basic concept: the BSC and methods of its application. In addition the author discovered several management principles that became a scientific platform in creating future budget programs. Also the author has identified how to choose a measurement, which relies on the mathematical modelling (the Utility Function) in order to verify the research.

In a given case, the BSC model is taken as a starting basis. It is recognized as a strategic planning and management system used extensively in business, industry, government, and non-profit organizations to align organizational activities, vision, and strategy. A cohesive policy improves internal and external communications and monitors organizational performance against strategic goals and benchmarks.

The most obvious reasons for choosing the BSC as a performance measurement system are that it empowers managerial decision-making by aligning performance indicators with the goals and strategies of the organization (Lipe and Salterio, 2000) and addresses the design and implementation of such a system in a public sector organization (Carmona and Grönlund, 2003).

The popularity of BSC derives from different aspects and shows how successful adopters follow five management principles to become "strategy-focused" (Kaplan and Norton, 2004):
  (1) translate the strategy into operational terms;
  (2) align the organization to the strategy;
  (3) make strategy everyone's everyday job;
  (4) make strategy a continual process;
  (5) mobilize change through executive leadership.

The theoretical approach and practical experience of budgetary financial planning indicates that the topic is important and vital for managing the defence forces. Performance based budgeting is useful in diagnosing practical problems that government organizations encounter in designing performance management systems.

This research contributes to the understanding of the Utility Function concept and provides empirical evidence in the following literature findings:
  •   Utility Function − the key element for identifying allocation options *(Schoemaker, 1982; Noghin, 2005; Intriligator, 2002; Gorbunov and Kozin, 2007);*

  •   Performance-based management system utilization via a performance-based budgeting processes *(Comshare, 2001; Serven, 2002; Hansen, 2011; Ekholm and Wallin, 2000; Hope and Fraser, 2003);*

- Multiple-Criteria and Pareto principle analysis and examination *(Schoemaker, 1982; Noghin, 2005; Gal, Stewart, and Hanne, 1999; Belton and Stewart, 2002; Intriligator, 2002; Gorbunov and Kozin, 2007).*

Empirical evidence supporting this study was also gathered from results based upon financial figures derived from the mathematical modelling. The author believes that the utility function (usefulness) can be beneficial in the process of planning and selecting optimal financial plans for military expenditure based upon focused strategic goals and operational tasks. In conducting the analysis, the Edgeworth-Pareto principle will be used; this approach has been successfully- applied since the 19th century.

The results of the study are established as follows:
- Studies are based on financial figures derived from the mathematical modeling (the Utility Function);
- The e-Budget platform is based on the author's idea (designed by Cadreos: www.cadreos.com) and the Strategy Map created for the Estonian Defence Forces. The e-Budget platform is the functional part of the e-Budget software that uses a utility function as a key element for identifying allocation possibilities.

The organization-wide effects of three distinct budgeting alternatives (rolling budgets, activity-based budgeting, and beyond budgeting) were investigated using a model that incorporates three important budgeting functions: forecasting, operational planning, and performance evaluations. All three budgeting alternatives were formed via different functions.

Rolling budgets generate improved forecasts and include the forecasting function (Comshare, 2001; Serven, 2002). Activity-based budgeting increases the sophistication of the operational planning (Ansari et al., 1999; Hansen and Torok, 2004) and includes the operational function (Hansen, 2011). Beyond budgeting switches employee compensations from budget-based to relative performance contracts (Ekholm and Wallin, 1994; Hope and Fraser, 2003) and includes the performance evaluations functions.

The research found that all these variants of budgeting cannot be taken into consideration as a budgeting alternative. The impact of improving forecasting is distinct from improving operational planning, which, in turn, is different from improving performance evaluations (Hansen, 2011). Each alternative produces its own pattern of direct and indirect effects among the organization that are orthogonal in practice. This approach provides an opportunity to apply these functions separately such that only the planning processes will be affected.

The Originality and Innovation of the Topic

This dissertation attempts to address why enthusiasm for good public organization often ends with entropy and disorder. Most research seems to assume that effective management in the public sector has the same basic qualities as effective management in the private sector (Bower, 1977, 131). Business strategy has been called the art of imbalance – the application of massive resources to limited objectives. In contrast, a public institution's strategy might be called the art of the imperfect – the application of limited resources to massive objectives (Bower, 1977, 135).

Studies of organizational performance have overwhelmingly relied on evidence gathered from private sector firms. Nevertheless, researchers have witnessed increasing interest in enhancing effectiveness and efficiency in the public sector, in turn generating considerable investment in the deployment of performance metrics in such settings (Carmona and Grönlund, 2003). Though extant evidence provides many perceptive insights into the specifics of performance frameworks in public sector organizations, little is known about the measurement of organizational performance in military related activities.

Most questions concerning strategy arise in addressing business concerns about the substance and implementation of the strategy where managers are anxious that their actions align with a proper objective. There is an even more important strategy question, however, relating to the process of strategy formulation that the organization's management team will use to develop and implement a plan. Although executives are understandably obsessed with finding the right strategy, they can actually wield greater leverage by managing the process used to develop the strategy – by making sure that the right process is used in the right circumstance (Clarton and Raynor, 2003) to empower an entire organization rather than a minority group.

One reason, then, that public sector executives find it hard to mobilize resources in order to achieve objectives is that time horizons are short but institutional response times are long (Bower, 1977). Moreover, managing the tension between creative innovation and predictable goal achievement is the essence of management control - vision versus satisfaction. Effective managers scan for disruptive changes that signal the need to reconfigure an organization's structures, capabilities, capital, and technologies. It can be argued that management control systems act as filters that homogenize information, thereby removing signals of disruptive environmental change. Accordingly, management control systems limit search routines and experimentation – hardly a prescription for innovation and opportunity-seeking (Simons, 1995).

In our case, the relationship between the econometric analysis and strategic planning of military expenditure is examined since economics is the study of

allocating resources under constraints. Using the Balanced Scorecard application based on the Utility Function principles will allow the organizational management to overcome important barriers to strategy implementation by interrelation of military planning and budgeting processes. In addition, the Edgeworth-Pareto principle will also be integrated into the strategic model. Also we extend earlier work in the area of solving multicriteria choice problems using quantitative information on the relative importance of criteria (Noghin, 2005).

Thus new research contributions into management practices are as follows:
- The creation of a unique management system, based on the main strategic concepts using the Utility Function Principle;
- The development of prerequisites for a conceptual approach of determining an optimal strategy and controlling methods of the organization's resources by utilizing the decision-making process;
- The implementation of alternative methods for forecasting measures at the planning stage and potential for using mathematical models in strategic management.

In addition, the future directions for research will employ the following measures of practical significance:
- to adapt the Balanced Scorecard into the organizational performance according to market changes and opportunities;
- to improve methods of employing the Utility Function in the decision-making process;
- to develop mathematical modelling that will allow estimation of the quantitative behaviour of the system.

It is hoped that all the proposed techniques will improve the calculations of strategic perspective plans and the development of the budgetary policy by taking into account the features of expenses distribution among operational business and non-profit organizations.

PART 1.   THEORETICAL BACKGROUND: THE BALANCED SCORECARD PERSPECTIVE

1.1.   The Balanced Scorecard: Basic Concepts

The BSC allows analysis of the most important elements of a company's development strategy including partnerships and teamwork even on a global scale. Further, it makes companies attractive and gives them additional advantages (Kaplan and Norton, 2005).

By the 1980s, many executives were convinced that traditional measures of financial performance did not let them manage effectively and wanted to replace them with operational measures (Kaplan and Norton, 2005). As companies around the world continue to transform themselves for competition that is based on information, their ability to exploit intangible assets has become far more significant than their ability to invest in and manage physical assets. The BSC enables a company to align its management processes and focus the entire organization on implementing long-term strategy (Kaplan and Norton, 1996).

After its inception in the early 1990s, the Balanced Scorecard spread rapidly through firms, starting in the US and quickly reaching the rest of the world. Its diffusion was so rapid that as early as 1997, it was labelled as one of the most influential management instruments of the 20th century (Sibbet, 1997, 12). "By 2005, a study conducted by Bain and Company on management tools stated that 57% of 960 international executives reported using the BSC" (Rigby, 2005, 13). "In 2007, this percentage increased to 66% out of a sample of 1221 firms" (De Geuser et al., 2009). "Also over 65% of companies in the United States and Europe use some kind of BSC approach and it is touted for use in managing production, IT, and other functional areas of a business. Further, with the passing of the Government Performance and Results Act of 1993, all U.S. government agencies were required to adopt a BSC for reporting their activities. The scorecard has subsequently been widely adopted throughout municipal, country, and state governments" (Conger, 2011).

According to Norreklit (2003), "the extensive diffusion and use of the BSC is mainly due to the 'pathos' of the situations in which it has been implemented and the 'ethos' of Kaplan and Norton". Through a detailed semantic analysis, Norreklit (2003, 610) described how the BSC inventors used rhetorical mechanisms to promote the system and showed that the BSC "appeals both through pathos and through ethos" but very little through 'logos'. Therefore, it appears that managers are minded to use the BSC because it was created by trusted (ethos) academics and practitioners using a rhetoric that appealed essentially to managers' emotions (pathos) and only little to their rationality (logos). Norreklit (2003, 610) even argued that Kaplan and Norton "blur the logos" (De Geuser et al., 2009).

Based on the critique of extant irrelevant approaches, the BSC takes an innovative and rather sympathetic posture facilitated by its open challenge of finance-focused frameworks. Its foundations relate to other fashionable discourses, for instance on intangible assets or intellectual capital, the beyond budgeting idea, and the employee perspective (Ax and Bjørnenak, 2005). Nevertheless, the BSC is primarily a power instrument, inasmuch as it clearly claims to improve strategy execution (Bourguignon et al., 2004). In an interview with Jürgen Daum (Daum, 2002), Norton insists that "what we have learned from working with organizations, is, if you want to execute your strategy, then you have to put the strategy at the centre of your management system. You should educate people about the strategy" (Gumb and Vassili, 2011).

The BSC is likely to impact performance through a variety of means. Kaplan and Norton (2001) propose the Strategy-Focused Organisation framework to explain how the BSC contributes to a firm's performance. The framework distinguishes five possible sources of performance: (1) top management support given to BSC implementation, (2) the use of the BSC to translate strategy, (3) the use of the BSC to align the organisation, (4) the implication of everyone in the design and implementation of the BSC, and (5) the introduction of a continuous process of strategy formation through the BSC (De Geuser et al., 2009).

Ittner et al. (2003) summarized these functions as increasing measurement diversity and improving alignment with a firm's strategy. Braam and Nijssen (2004) used a very similar typology, contrasting a comprehensive performance measurement tool and one for strategy implementation. Speckbacher et al. (2003) argued that the latter function should be split into two sub-roles: "one describing strategy and the other helping managers to implement it". The first role, the description of strategy, is associated with the concept of the strategy map. Kaplan and Norton (2001, 26) explicitly ascribed this function to the BSC. They stressed the fact that the "BSC makes a unique contribution by describing strategy". They expressed it in terms of a cause-and-effect model, leading to the concept of a 'strategy map'. Over time, and through practical application, the Balanced Scorecard evolved into the second sub-role – that of a strategy implementation enabler. This evolution was partly inspired by the constructive approach in management accounting research (Kasanen et al., 1993; De Geuser et al., 2009).

1.2.   The Balanced Scorecard as a Management System of Military Resources

Investigations of organizational performance have increased during the past several years (Neely, 1999). The idea that "performance measurement matters" has resulted in the proliferation of various frameworks of organizational performance: these include Performance Measurement (Lynch and Cross, 1991), the Results and Determinants Framework (Fitzgerald et al., 1991), Performance Measurement for World Class Manufacturing (Maskell, 1991), the Balanced Scorecard (Kaplan and

Norton, 1992, 1996), the Cambridge Performance Measurement Design Process (Neely et al., 1996, 1997), the Reference Model of Integrated Performance Measurement System (Bititci et al., 2000), and the Performance Prism to name a few. At the same time, both public sector and non-profit organizations have experienced increasing demands for more effective decision-making and more efficient management of resources (Brunsson, 1994; Brignall and Modell, 2000).

The BSC provides a means of communicating vision and strategy to everyone in the organization; it provides a means for linking strategic goals to individual performance. By measuring and monitoring performance, feedback to the executive group is provided. The executive group can then adjust its strategy, objectives, and initiatives based on the success of ongoing efforts (Conger, 2011).

In a performance oriented era, organizational efficiency and effectiveness plays a central role regardless of the industry or sector involved. Accordingly, the performance aspects in the defence sector began to be viewed and considered with increasing interest in the last decade. As an institution that is considered "the last shield of defence in wartime, and the care keeper of national security for socio political stability and economic growth during peacetime" (Lee, 2006), the military is a major servant of the public interest.[1]

Hence, one of the most important challenges for the defence institutions and the sector overall is to try to achieve organizational efficiency and effectiveness by building the right performance management architecture. According to the Harvard Business Review website (2010), summarizing the report article: U.S. Army, a Balanced Scorecard Hall of Fame Profile: "the Balanced Scorecard (BSC) enabled the U.S. Army to become leaner, more nimble, and technically advanced to achieve its mission of serving the American people, protecting national interests, and fulfilling military responsibilities. Using an aggressive BSC rollout through automation and education, the U.S. Army managed to transform its organization of military personnel stationed around the globe."[2]

The US Army's success in using a balanced scorecard was such that other American military organisations − including the Defense Finance and Accounting Service (DFAS) and the Defense Logistics Agency (DLA), and the Department of the Army − now put the balanced scorecard at the centre of their logistical planning. One US military body's website says that they have all "successfully implemented the balanced scorecard principles and methodology to drive results in their organisation". From the sample list of organisations stated, it is apparent that the balanced scorecard can be leveraged by government agencies, including defence, state and local government, service organisations, and manufacturers"[3]

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[1] "The Balanced Scorecard in Defence". Balanced Scorecard Review. http://www.balancedscorecardreview.com/pages/bsc-in-practice/by-industry/bsc-in-defense-105.html
[2] "The Balanced Scorecard in Defence". Balanced Scorecard Review. http://www.balancedscorecardreview.com/pages/bsc-in-practice/by-industry/bsc-in-defense-105.html
[3] "Balanced scorecard working for the US military". Advanced Performance Institute. http://www.ap-institute.com/Balanced%20scorecard%20working%20for%20the%20US%20military.html

According to Gillis (2004), one of the key characteristics of the Canadian Department of National Defense (DND) Performance Management framework is the Balanced Scorecard. As the main purpose of the defence forces is not financially driven, but is primarily directed towards delivering improved national security for citizens, the DND Balanced Scorecard perspectives correspond to the four major key areas. Another major defence institution that is adopter and user of the Balanced Scorecard is the United Kingdom Ministry of Defence. The Ministry of Defence (2009) bases its annual performance reporting entirely on the institutional Balanced Scorecard framework.[4]

These findings allow the construction of a general strategy model through focusing on military resources management processes which frame the future BSC model comprising the four perspectives: Resources (Budgeting), Management and Control, Innovation and Staff, and Customer (Estonian Defence Forces) (Figure 1).
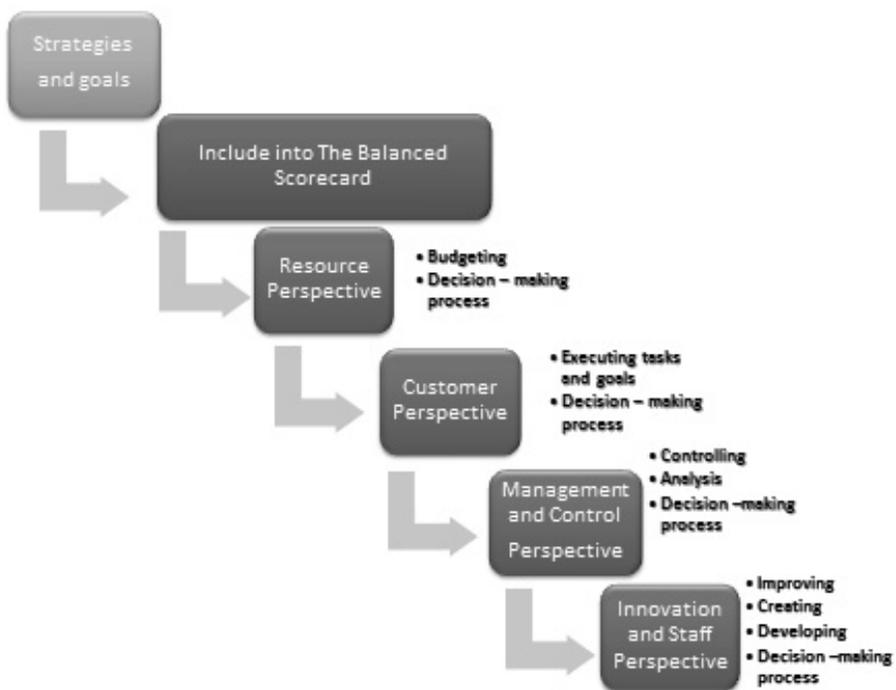
Figure 1. The Balanced Scorecard for the Estonian Defence Forces

This methodology establishes a four-perspective BSC model, which can improve measurements related to budgeting and planning, and controlling systems. The given model is presented in Studies I, III, and IV, which address the creation of a general management system for allocating military resources.

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[4] "The Balanced Scorecard in Defence". Balanced Scorecard Review. http://www.balancedscorecardreview.com/pages/bsc-in-practice/by-industry/bsc-in-defense-105.html

PART 2. THEORETICAL BACKGROUND: UTILITY THEORY, MULTICRITERIA CHOICE, AND UTILITY FUNCTION MODEL

2.1. Introduction to Utility Theory

"*Utility theory provides a methodological framework for the evaluation of alternative choices made by individuals, firms and organizations. Utility refers to the satisfaction that each choice provides to the decision maker. Thus, utility theory assumes that any decision is made on the basis of the utility maximization principle, according to which the best choice is the one that provides the highest utility (satisfaction) to the decision marker*"[5].

The mathematical form of an expected utility theory was established by Gabriel Cramer (1728) and Daniel Bernoulli (1738), who sought to explain the so-called St.Petersburg paradox[6]. Expected utility (EU) models are concerned with choices among risky prospects whose outcomes may be either single or multidimensional. The key characteristics of this general maximization model are: (1) a holistic evaluation of alternatives, (2) separable transformations on probabilities and outcomes, and (3) an expectation-type operation that combines probabilities and outcomes multiplicatively (after certain transformations) (Schoemaker, 1982).

Within this general EU model different variants exist depending on (1) how utility is measured, (2) what type of probability transformations are allowed, and (3) how the outcomes are measured (Schoemaker, 1982).

As Peter Fishburn (1976) has noted, the concept of cardinal utility has psychological and empirical as well as measurement-theoretic aspects which together with such related terminology as 'measurable', 'additive', 'determinate', 'intensive', and 'linear' utility has given rise to considerable confusion as to its precise meaning. The term 'cardinal utility' goes back to John R. Hicks and R. G. D. Allen (1934) who argued that only ordinal preference was needed in economic theory (Walsh, 1970), thereby dispensing with neoclassical utility (Schoemaker, 1982).

According to Amos Tverski (1967) there are "several advantages in distinguishing cardinal utility measures constructed under certainty, denoted v(x), from those constructed under risk, denoted *u(x)*. Firstly, it emphasizes that there exist different types of cardinal utility, even within each category, which only have to

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[5] Utility Theory: Encyclopedia of Management. http://www.enotes.com/management-encyclopedia/utility-theory
[6] "The St. Petersburg paradox is a classical situation where a naïve decision criterion (which takes only the expected value into account) would recommend a course of action that no (real) rational person would be willing to take. The paradox can be resolved when the decision model is refined via the notion of marginal utility (and it is one origin of notions of utility functions and of marginal utility), by taking into account the finite resources of the participants, or by noting that one simply cannot buy that which is not sold (and that sellers would not produce a lottery whose expected loss to them were unacceptable)"

be related monotonically. Secondly, by examining $u(x) = f(v(x))$, an Arrow-Pratt type measure of intrinsic risk aversion may be defined and empirically measured, namely $-f''(v(x))/f'(v(x))$ (Bell and Raiffa, 1979). Thirdly, the construction of $u(x)$ may be simplified by first examining the nature of $v(x)$, especially in the case of multiattribute utility" (Schoemaker, 1982).

The difference lies in the way the utility function is constructed: that is, under certainty or risk. Which expectation model will provide a better prediction is an empirical question. Jacques Bernoulli (1713), a relative of Daniel, had earlier evaded this circular definition by distinguishing the concept from its measurement. He defined probability as a 'degree of confidence' which for a given event may vary from person to person (Schoemaker, 1982).

2.2. Multicriteria Choice and Utility Function Model

A solution in the context of a multidimensional and complex environment should indicate an optimal decision under given circumstances in precisely defined temporal and spacial limits. It implies tackling conflicting situations and solving derived problems (Dixon, 1966), thereby seeking to choose the single best answer (Haarstrick and Lazarevska, 2009).

Formulation and proof of this principle is a central theme of this chapter. According to Noghin (2005) multicriteria choice must be specified as a set of feasible solutions within which a person makes a choice. "Let us denote this set by X; we shall call it a set of alternatives. To make the choice possible, the minimal number of elements of this set equals two. The number of alternatives is not bounded above; it can be either finite or infinite. Moreover, the type of alternatives does not have any meaning. It might be projecting solutions, lines of behavior, political or economical strategies, short- or long-term plans, etc".

Choice is impossible without a person who makes the choice in order to achieve his/her personal goals. This person (or the whole team oriented towards certain goals) who makes a choice and is responsible for all its consequences is said to be a decision maker (DM). Usually, a 'selected alternative' means that one which ideally satisfies the wishes, interests, or goals of the DM. An attempt by the DM to reach a definite goal can be expressed mathematically in terms of maximization (or minimization) of a real-valued function (criterion) defined on the set X. Often we have to deal with several functions at once. This can occur, for example, when the research phenomenon, object, or process is considered from different points of view; in order to formalize each of them it is necessary to introduce an individual function. 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).

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

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

$f_1, f_2, ..., f_m$, $m \geq 2$ 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:

$$f(x) = (f_1(x) \ f_2(x), ..., f_m(x)) \qquad \qquad \textbf{(1)}$$

To illustrate the main function we describe some basic concepts of multiple criteria analysis and present the Edgeworth-Pareto principle.

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

$y = f(x) = (f_1(x) \ f_2(x), ..., f_m(x)) \in \Re^m$ 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).

Pareto Axiom (in terms of alternatives). For any pair of alternatives x', x'' $\in$ X we have $f(x') \geq f(x'') \Rightarrow x' \prec_x x''$.

Dealing with the *quantitative* information on the relative importance of criteria, we mean that all criteria $f_1, f_2 ..., f_m$ 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 a 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, or other currency units; in measuring the length of objects we use metres, inches, feet, yards, and so forth. 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 (Noghin, 2005).

2.3. The Utility Function: The Analytic Hierarchy Process and its foundation

In order to employ the main principles underlying the Utility Function it is necessary to establish the analytic hierarchy process that represents a structured technique dealing with a complex series of actions and decisions.

The analytic hierarchy (step-down) process provides a comprehensive and rational framework for structuring a solution to a certain problem by representing and quantifying its elements in the form of Figure 2 where the step-down process and alternatiive approaches are presented and described.
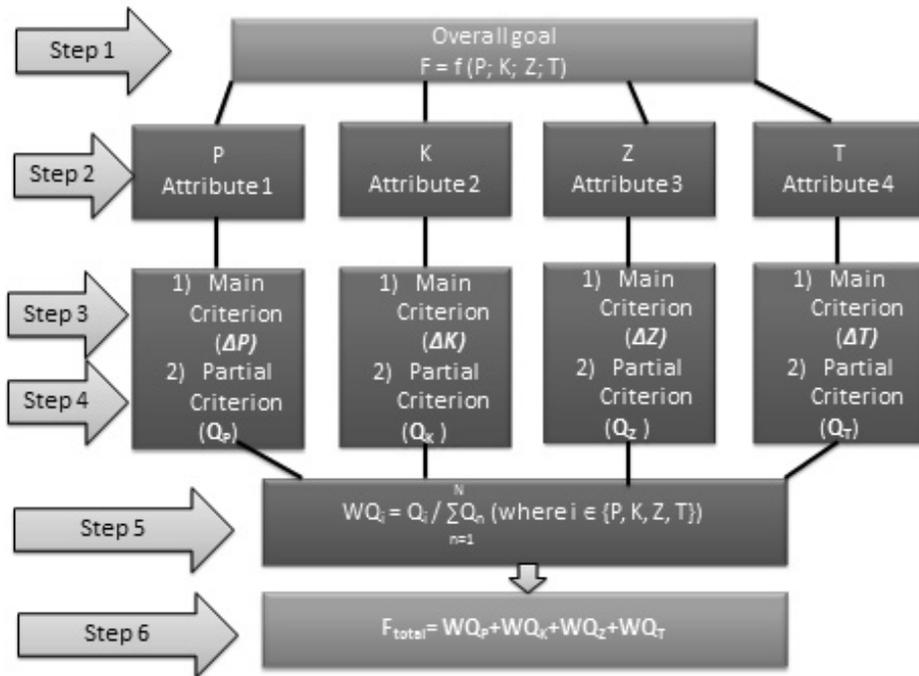
Figure 2. The General Scheme of Using the Utility Function

Figure 2 shows the main components (or attributes) named in our case P, K, Z, and T of the Utility Function, and how they are used in the process of transformation (calculation) and final optimal decision.

Thus the general scheme of using and constructing the Utility Function consists the following steps:

Step 1. The overall goal : Definition of a goal and problem identification

First of all, it is necessary to point out that the decision-making process for optimal solutions is very important at the stage of defining the goal and problems, as well as identifying the decision maker [a person or whole team oriented towards certain goals] who makes a final choice and is responsible for the whole decision-making process.

Secondly, it is possible to reach a definite goal using mathematical calculations. It means that the goal can be expressed mathematically in terms of maximization (or minimization) of a real-valued function (criterion).

Moreover, the quantitative approach to the decision-making process favours a mathematical calculation procedure, which is the most favourable instrument when:
- The goal and problem are new and require a complex approach;
- The results will have significant implications at the final stage;
- An existing experience (objective and/or subjective) is insufficient to make a decision;
- The definition of 'right' attributes and components to achieve the goal and to resolve problems.

Step 2. Defining and selecting relevant attributes and components

The process of defining and selecting relevant attributes and components is very important, because components themselves contain a specific set of attributes or elements. It is important to mention here that the utility-based performance measures towards to the goal present the maximum value of every component and the total sum of the utility assessment.

The conceptual approach directed to the optimization of monitoring processes implies that the decision-making process adopts different attributes (for example, in tendering: potential price for goods or services; quality of goods or services; evaluations of price/quality ratio of goods or services; financial stability of the supplying company).

Step 3. Calculation of the main relevant criteria related to attributes

Here the main activity is the data gathering process in order to collect the necessary data for the decision criteria. Thus the calculation of main utility parameters involves the finding of coefficients of the best value according to the main criteria $(\Delta P; \Delta K; \Delta Z; \Delta T)$.

Step 4. Calculation of the partial relevant criteria related to attributes

Next, values of the main criteria should be compared with estimated coefficients of partial utility of other factors (attributes). In order to make this calculation the author proposes the use of the transformation function (Studies) for the main factor through the values of (ΔP; ΔK; ΔZ; ΔT), which will compute the coefficient of partial utility (Q_P; Q_K; Q_Z; Q_T).

Step 5. Calculation of the average values of utility coefficients

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

$$WQ_i = Q_i / \sum_{n=1}^{N} Q_n \text{ (where i} \in \{P, K, Z, T\}) \tag{2}$$

The determination of an optimal indicator can be obtained by addition of all indicators. However this action will, in turn, lead to the appearance of significant mistakes (including the risk of similar values). In this case it is appropriate to use the partial utility coefficients which will lead the initial results to the one general denominator and will best reflect the integral estimation.

Step 6. Building the decision matrix and verification of the results

After reducing all of the studied criteria to a single equivalent of mathematical model, it is appropriate to express one integral form (Gorbunov and Kozin, 2007):

$$F_{total} = WQ_P + WQ_K + WQ_Z + WQ_T \tag{3}$$

In order to complete the step-down process the author builds a decision matrix of utility coefficients and, in accordance with received data, the optimal utility coefficient has the maximum value of an indicator of utility.

The advantage of using pseudo-objective quantitative performance criteria over subjective qualitative beliefs is to provide a relative measure of sourcing effectiveness that directly measures the financial effectiveness of a solution. Performance related metrics can be used for estimating and playing 'what if' scenario planning. This is a very useful criterion in national defence planning since it allows one to assess hypothetical strategies and develop appropriate responses.

It follows that the analysis of a general utility function and iterative methodology discovering process create a template for identifying special variables and functions for envisioned perspectives. This forms the main BSC model (the description is reflected in the following Studies). More details will be provided in the next chapter.

PART 3.   THE STRATEGY MAPS AS ONE OF THE MANAGEMENT CONTROL SYSTEM TOOLS OF MILITARY RESOURCES

3.1   The Concept of Strategy

This chapter addresses the strategy concept methodology and its assumptions concerning the strategic management system formation process. Typically, the strategy is not a stand-alone management process; it is one step in a logical continuum that ubiquitously moves an organization from a high-level mission statement to the pragmatic work performed by frontline and back-office employees. A vision void of action is just a dream. The overarching mission of the organization provides the starting point by defining why the organization exists or how a business unit fits within a broader organizational architecture. The mission and the core values that accompany it remain fairly stable over time. "The organization's vision paints a picture of the future that clarifies the organization's direction and helps individuals understand why and how they should support the organization. In addition, the vision sets the organization in motion, from the stability of the mission and core values to the dynamics of strategy, the next step in the continuum" (Kaplan and Norton, 2004).

Robert Burgelman´s work (1983, 1991) on the nature and context of strategy process is also useful in grounding the concept of interactive control system. Consistent with the distinction between a top-down strategy process and a bottom-up emergent strategy process, Burgelman distinguishes between 'induced' and 'autonomous' strategic behavior. Induced strategic behaviour focuses on fitting an organization's distinctive competencies to the environment through administrative mechanisms, such as planning, organizational goals, and reference to critical performance variables. In the autonomous strategic process, top management's role is strategic recognition rather that strategic planning. Top management needs to facilitate the activation of strategic context determination processes to find out which of the autonomous initiatives have adaptive value for the organization and deserve to become part of the organization's strategy (Simons, 1995).

Needless to say, all management control systems are formed using the strategy. As a rule, one of the main and most challenging tasks of building a balanced system of management and control of military resources is to choose the right indicators from the vast number of options reflecting the key performance factors for each of the strategic areas of the development.

The strategy-making process is conscious and analytical. It is often based on rigorous analysis of data on market growth, segment size, customer needs, competitors' strengths and weaknesses, and technology trajectories. Strategy in this process is typically formulated in a project with a discrete beginning and end, and then implemented from the top down (Clarton and Raynor, 2003).

The decision-making 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. Once the hierarchy is built, the decision maker systematically evaluates its various elements, comparing them to one another in pairs. In making the comparisons, the decision maker can use concrete data about the relative meaning and importance of the elements. The analytic hierarchy process converts these evaluations to numerical values that can be processed and compared over the entire problem (Haarstrick and Lazarevska, 2009).

A measurement system is very important. For maximum impact, therefore, it should focus on the entity's strategy – how it expects to create future, sustainable value. In designing BSC, therefore, an organization must measure the critical few parameters that represent its strategy for long-term value creation (Kaplan and Norton, 2004).

In Study III, the author presents a strategic planning and controlling methodology for the public sector by utilizing different tested approaches. How to implement the Process Perspective (the functional component of the Balanced Scorecard) as a new alternative method of budgeting limited resources is also discussed. The focus is to change the conceptual analysis directed towards military long-term goals and tasks where the state budgeting process should account for dynamically specified features, which define the crux of the military goals and tasks. As pressure from the outside intensifies, organizations are forced to find ways to either diffuse or eliminate inefficient methods by changing their practices (Powell and DiMaggio, 1991). The conceptual analysis and practical experience directed to the execution and control of the budgetary funds show that the topic is vitally important for Defence Force planning.

By identifying the categories of an organization's resources as the internal manifestations of the entire organization's capital structure, a strategic model with measureable results can be created based on variables such as:
- physical capital resources (Williamson, 1975),
- human capital resources (Becker, 1964), and
- organizational capital resources (Tomer, 1987).

Physical capital resources include the physical technology used in a firm, a firm's plant and equipment, its geographic location, and access to raw materials.

Human capital resources include the training, experience, judgement, intelligence, relationships, and insight of individual managers and workers in a firm.

Organizational capital resources include a firm's formal reporting structure, its formal and informal planning, controlling, and coordinating systems, as well as informal relations among groups within a firm and between a firm and those in its environment (Barney 1991).

The application of Strategy Maps provides an opportunity to *a priori* identify and potentiallysolve problems connected with planning processes and state budget execution, and implements an effective method for control over the process of governance and accountability. The given approach attempts to identify and to rationalize objectives and solutions as acceptable for different decision levels of military structure. By providign a coherent, logical analysis and objective framework this provides managers with an opportunity to automate the collection of data which assists the decision-making process.

3.2   The Strategy Map: Process of Creating the Strategic Management System

In order to build a measurement system that describes the strategy, we need a general model of strategy. Carel von Clausewitz, the great military strategist of the nineteenth century, stressed the importance of a framework to organize thinking about strategy. "The first task of any theory is to clarify terms and concepts that are confused…Only after agreement has been reached regarding terms and concepts can we hope to consider the issues easily and clearly and expect to share the same viewpoint with the reader" (Kaplan and Norton, 2004).

For example, when you construct a building, you must install a variety of wiring types for lighting, heating and cooling, appliances, and so on. The wires differ in size, colour, and purpose. When you design an organization (or system), you must install a variety of performance measures. Measures are always important for organization. As the Chief Technical Officer of Microsoft stated: "To have scale you have to have accountability, and to have accountability you have to have numbers" (Simons, 2007).

Measurement provides the feedback for managing a process, product, or business. Further, metrics provide a discipline for developing objective and meaningful decision criteria from information based on fact. In most organizations, thousands of measures are taken of every facet of business life, but measures should have meaning within their context (Conger, 2011).

According to Robert Simons (2007) in any business, there are two types of measure: financial and nonfinancial. For financial measures, the unit of measurement is money: revenues, expenses, and profit. Nonfinancial measures are denominated in units other than money: quantities, reject rates, or market share.

The author establishes a framework describing strategies for designing the Strategy Map (Figure 3), which also relates to scorecard perspectives including several important elements (see Figure 1). In general, all perspectives presented here have their own optimality models (the utility functions) created by the author. All models include a decision-making process and they are defined as simplified representations of reality and tested by several predictions.

In accordance with data and parameters calculations Schoemaker (1982), Noghin (2005), Gal, Stewart, and Hanne (1999), Belton and Stewart (2002), Intriligator (2002), Gorbunov and Kozin (2007), and in line with the proposed approach, we have tested the decision-making process and directed the selection of strategic elements from the variety of planned military resources.

It is necessary to mention that our example is intentionally oversimplified for illustrative purposes. As with any modeling paradigm, assumptions are made to simplify real-life scenarios in order to create an idealized model; further simplifications are then made to turn the model into a management system. Through such simplifications, error is introduced to the model and is accounted for in the stochastic dynamics of scenario playing. However, in practice, most needs can be accommodated by carefully defining and collecting the information used in the calculations in a pseudo-deterministic paradigm.

The following general Strategy Map illustrates the macro levels of strategic management system where, regardless of which approach is used, a Strategy Map provides a uniform and consistent way to describe that strategy. Thus, objectives and measures can be established and managed for all information agents to utilize. The Strategy Map provides the missing link between strategy formulation and strategy execution (Kaplan and Norton, 2004).
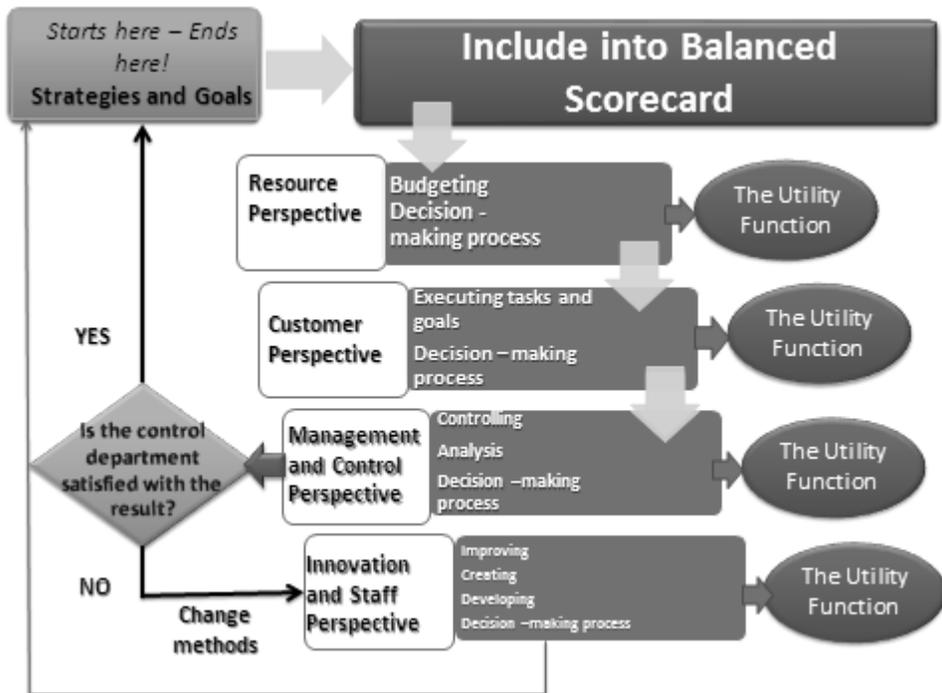
Figure 3. The General Strategy Map for the Estonian Defence Forces

This model provides an effective view of critical factors affecting an organization and leads to the execution of strategic tasks as well as establishing opportunities for future implementation.

The proposed strategic management system incorporates:

Resources (Budgeting):

Study I discusses the Financial Perspective as an alternative method of budgeting that focuses on the conceptual analysis change concerning military long-term goals and tasks. The research is devoted to constructing economic and mathematical models that encapsulate the essence of utility.

There are several important moments of the budget planning process, in particular:
- forecasting improvement through the decision-making process and its pathways;
- integration of the Financial Perspective into the strategic military budgeting system,
- discovery that all these components have one common and unique element in the decision-making basis.

This key element is a measure of utility and thus the utility function might be used for identifying key variables, strategy development, and showing potential bottlenecks in the budgeting system that could be improved upon.

In general, the goal function has the additive linear form (Gorbunov and Kozin, 2007):

F = f (P; K; N; T;…*n*) (4)

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

a) *F = The total assessment of the utility element of decision-making;*
b) P - Total amount of budget (total planning sum);
c) K - Quality of planning processes (possibility of strategic goals and tasks execution);
d) N - Cost (total amount of budget) and quality ratio;
e) T - Time spent on strategic goals and tasks execution

The quantification of the given function will provide an opportunity to combine all feasible indicators into a single consolidated system and consider it from the mathematical standpoint rather than a preconceived narrative with potential bias. By summarizing all the results, we have discovered that the implementation of BSC into the Defence Forces' managerial process provides many insights into the overall process of deploying performance metrics in public sector organizations.

It not only provides information, but assists decision makers in identifying key aspects, measuring them, and justifying their assumptions.

Customer (Estonian Defence Forces):

The managerial staff of a project choose the supplier that offers delivery terms in a commodity market, military-oriented services meeting their requirements, and providing the maximum utility from the transaction. The goods and military-oriented services is a set of goods and services intended to satisfy the military requirements of the State by means of purchase and sale in the market of the state purchases.

In Study II, the utility function is fleshed out into the managerial process. The utility, value or 'usefulness' might be used in a process of selecting a supplier of goods and services for military purposes from the standpoint of the state customer. In summary, the multinomial problem of the final selection of the potential supplier serves as a comparative assessment of options based upon quantitative (numeric) and qualitative (Boolean) indicators used in the calculation of production, economic, and financial activity.

In general, the goal function consists of the additive form (Gorbunov and Kozin, 2007):

F = f (P; K; N; Z; F;…*n*) (5)

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

a) *F = The total assessment of the utility element of decision-making;*
b) P - Potential product price;
c) K - Quality of products supplied;
d) N - Content parameters of energy values (food energy) in each ingredient of dry-pack;
e) Z - Evaluation of price/quality ratio of products;
f) F - Financial stability (financial state) of the supplier

In the given example, the goal function attains a new form by adding extra indicators which are especially important for a customer while selecting the supplier *viz*. content parameters of energy values (food energy) in each ingredient of dry-pack (N), evaluation of price/quality ratio of products (Z) and financial stability (financial state) of the supplier (F).

By using the example of selecting the "dry-pack" food supplier for assessing the points of utility, we were able to achieve the most effective value for public tendering. Such approaches provide the Defence Forces with quality products

contained in the "dry-pack" having an affordable price, which in turn will make the utilization of the military budget more effective.

The results of the estimation give the opportunity to take well-founded economical decisions in the placing of state defence orders and in developing an objective and competitive mechanism for the purchase of military goods and services.

Management and Control:

Study III suggests that the utility function can be used in the strategic planning process to identify as well as create value. The main chapters of the research have considered a range of techniques covering the internal environment of military resources management and the evaluation of strategic options in particular. The coefficient method as a component of the Process Perspective Model has proved that budgetary funds can be planned and distributed according to goals and objectives. This technique can be very productive for the redistribution of means if military tasks undergo any changes.

In general, the goal function consists of the additive form (Gorbunov and Kozin, 2007):

F = f (P; K; Z; N; T;…*n*) (6)

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

a) ***F = The total assessment of the utility element of decision-making;***
b) P - Cost estimation (Budget execution);
c) K - Quality assessment of executing processes (possibility of strategic goals and tasks execution);
d) Z - Cost estimation (budget execution) and quality ratio;
e) N - Decision-making process;
f) T - Time spent on strategic goals and tasks execution

In the example given, the goal function is formed by adding other indicators which play an important role for a customer by highlighting the importance of 'time' in the strategic planning process: decision-making process (N) and time spent on strategic goals and tasks execution (T).

Also our study examines the deployment of the BSC and the performance measurement system that enables executive management to align performance indicators with the goals and strategies of the organization (Lipe and Salterio, 2000). Moreover, it is possible to implement a feedback system by analyzing planned and actual data, as well as variations. In other words, the new Strategic Maps will create suitable conditions for effective solutions of strategic objectives and military tasks, and will optimize processes and military spending as a whole.

PART 4.   AN INFORMATION TECHNOLOGY APPROACH TO THE DEFENCE BUDGETING PROCESS

4.1.   Managing Innovation: Implementing the e-Budget application

In every industry, innovation is the engine that drives exponential growth and constant change. For any organization that seeks to achieve and sustain success over time – which is every company in theory – the most critical element of the strategy is identifying how to efficiently and effectively use limited resources. "Yet, as almost every research study on the subject reveals, not only are most companies, but executives, managers, and frontline employees lack confidence in their organization's ability to achieve those objectives" (Donlon, 2007).

To sustain competitive advantage, organizations must continually innovate. Successful innovation – creating new products, services, and processes that are well matched to customers' needs and expectations – drives customer acquisition and margin enhancement. Without innovation, an organization's value proposition can be limited to price only for its currently commoditized products and services (Kaplan, 2003).

The phrase IT inspires a range of interpretations. To some, it simply means computer hardware and software. To others, it is the informational capital asset: the informational infrastructure, applications, and connectivity upon which modern enterprise depends (Gold, 1992).

Study IV presents an iterative introduction into a theory of relative importance of criteria. The work examines the deployment of the BSC and the performance measurement system that enables executive management to align performance indicators with the goals and strategies of the organization (Lipe and Salterio, 2000). The best solutions are offered by the Balanced Scorecard model and by its functional component the Innovation and Staff Perspective, which makes the planning process for military expenditure more effective.

In the case study, the author developed a project method of managing the military resources by identifying their fundamental characteristics. Also the paper uncovers essential features of the budgeting system of the Estonian Defence Forces and provides a unique Balance Scorecard Technology (key element of e-Budget concept) as an implementation substitute. The author is inclined to believe that the e-Budget application will enter perfectly into the management process for military resources and will guarantee the accurate control of defence spending in particular. For the creation of an e-Budget platform we are using the Balanced Scorecard model which will include additional elements connected with budgeting and planning (Figure 4). All these modules are connected to each other and all the information is provided reliably. The whole process of the military organization was taken as a basis whilst creating this model.
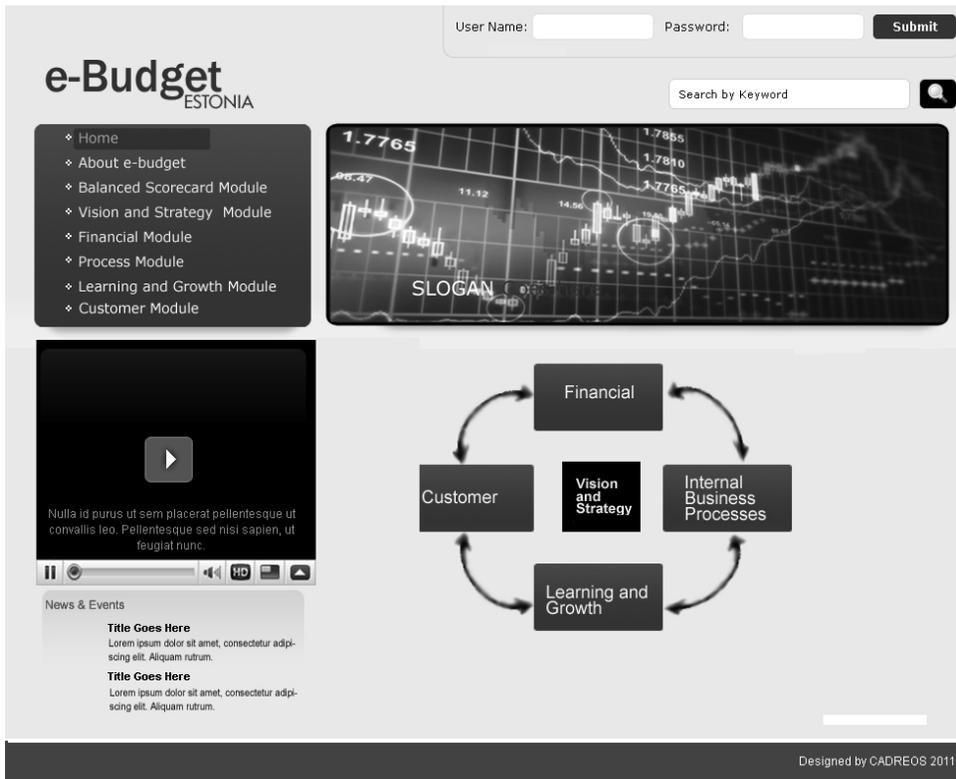
Figure 4. The title page of the future e-Budget portfolio (designed by Cadreos, web-page: www.cadreos.com).

Using an IT approach to the defence budgeting process and the Balanced Scorecard, in particular, will enable a more clear focus on the budgeting system of the Estonian Defence Forces. This is particularly important because it gives an opportunity to establish alternative ways for many other conceivable development paths that support a flexible system implementation.

The proposed methods of Study IV focus on the assessment of the BSC impact on organisational performance and, based on the Strategy-Focused Organization framework, to examine how the BSC enhances organisational performance (De Geuser et al., 2009).

Moreover, the main target is to create a special action plan for the achievement of military tasks. It is already possible to demonstrate a positive outcome of our research. In addition, Study IV establishes the unique concept of the e-Budget software. However, the case review also illustrates one of the most crucial issues in building and implementing the IT techniques into the BSC: it requires a direct linkage with the military objectives.

PART 5. PUBLICATIONS

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

Maritana Sedysheva

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). 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.

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).
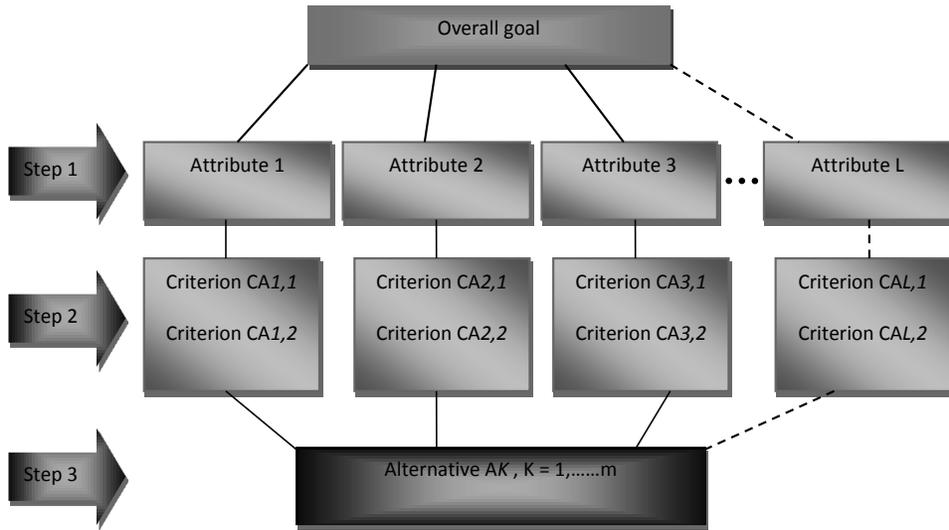
Figure 1. General scheme of the Analytic Hierarchy Process (*Source: by* Haarstrick and Lazarevska, 2009*)*

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:

f_1 , f_2 ,..., f_m, 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*:

$$\mathbf{f} = (\mathbf{f_1, f_2, \dots f_m})$$ (1)

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

$y = f(x) = (f_1(x)\ f_2(x),...,f_m(x)\ \in \Re^m$ 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

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

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 $f = (f_1, f_2,..., f_m)$ defined on X. Let us introduce the following set

$Y = Y \times Y \times ... \times Ym,$ where

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

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; Z; T;...n) (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*
- P - Total amount of budget (total planning sum)
- K - Quality of planning processes (possibility of strategic goals and tasks execution)

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- Z – 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).
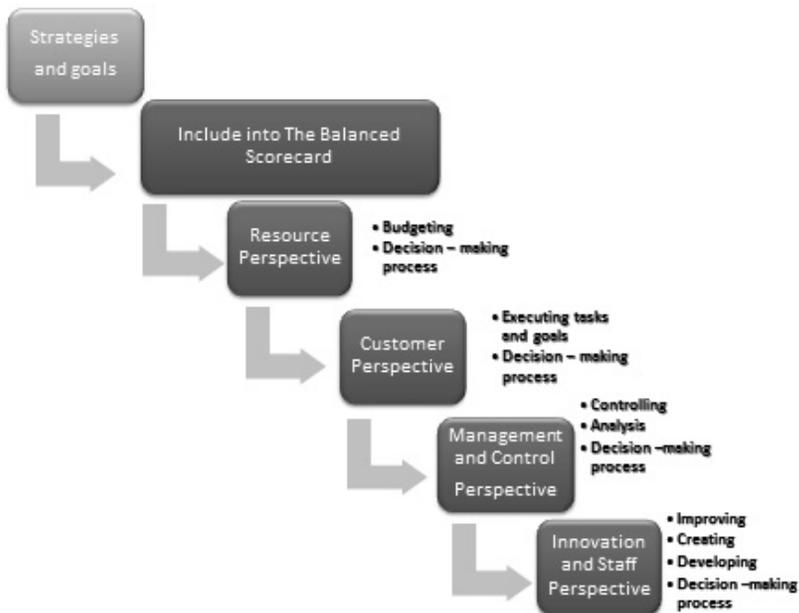
Figure 2. The Balanced Scorecard for the Estonian Defence Forces (*Source: by author)*

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.

Figure 3. The Strategic Map of Step-Down Procedure (*Source: by author*)

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):

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

$\boldsymbol{\Delta P}$ – 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 $\Delta \boldsymbol{P}$ 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).

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

Q_P – 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** (<u>Source:</u> *made by the author):*

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

ΔK – the coefficient of optimal quality
R_i – 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):

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

Q_K – 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 ΔZ determined by the *function nr 7* (Gorbunov and Kozin, 2007):

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

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 Qz. For this manipulation the transformation *function nr 8* (Gorbunov and Kozin, 2007) (price / quality through the values of *ΔZ*) will be used.

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

Q_Z – 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).

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

Q_T – 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, Q_P	1,0000	0,0000	0,2846
coefficient of partial utility of optimal quality, Q_K	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, Q_Z	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, Q_T	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):

$$WQ_i = Q_i / \sum_{n=1}^{N} Q_n \text{ where} \tag{11}$$

WQ_i – the coefficient of total value
Q_i – the coefficient of partial utility for each indicator
N - Number of strategies (budgets)

$\sum_{n=1}^{N} Q_n$ - 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):

$$F_{total} = WQ_P + WQ_K + WQ_Z + WQ_T, \text{ where} \tag{12}$$

F_{total} – the total assessment of the utility (set of elements which have influence to the decision making)
WQ_P – the total coefficient of partial utility of optimal total amount of budget (total planning sum)
WQ_K – the total coefficient of partial utility of optimal quality
WQ_Z – the total coefficient of partial utility of optimal of cost/quality
WQ_T – 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
WQ_P	0,7784	0,0000	0,2216
WQ_K	0,3330	0,3337	0,3333
WQ_Z	0,7789	0,0000	0,2211
WQ_T	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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2. THE UTILITY FUNCTION" AS ONE OF OPTIMIZATION TOOLS OF THE MILITARY PROCUREMENT

Maritana Sedysheva

ABSTRACT

Purpose - The present paper proposes methods of public tendering, evaluation and choice of potential suppliers of goods and services for the Estonian Defence Forces are considered in connection with the utility function.

Design/methodology/approach - The offered method of utility function shows the link between the quality of offered goods and services with informational and financial resources of a supplier.

Findings - The results of the calculations based on utility function lead to better solutions for the Defence Forces procurement and make it possible to develop the system of public tendering and Estonian Defence Forces budget management.

Research limitations/implications - The statements are based on current problems with public tenders. In our case this problems are closely connected with military expenditure planning and budget application technique and lead to irrational usage of public funds.

Practical implications - By using "utility" the author offers a new method of selecting the potential supplier is serving as a comparative assessment of options based on quantitative and qualitative indicators used in the calculation of production and economic and financial activity.

Social implications - The framework itself proved helpful for the Estonian Defence Forces in questions of Public Tendering and Purchasing Management.

Originality/value - The paper introduces the unique system which will have considerable interest in the practice and research of the public tendering. This 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.

Introduction

Needless to say that *purchasing management* as a part of any enterprise is interesting and at the same time complicated process. Of its rationality and correctness of the organization in the main level will depend the effectiveness of

the organization or an enterprise. Untimely or unplanned purchases may cause the increase of the burden on the budget of the organization, cause the enterprise downtime and become the main factor influencing the delay in the delivery of final products. All of the above mentioned factors can be negatively reflected in the organization reputation, its popularity among customers. Management of the procurement procedure is an essential part of management.

One of the main questions for every enterprise is «How to effectively plan the procurement process in the company?» Each organization, in particular, *state organization*, should analyze its abilities as the customer, and possibilities of suppliers, further it is necessary to choose a *strategy,* on which purchases will be carried out, and to define a *purchase* and *control method*.

However, let's get back to reality here in Estonia. Through government contracts the Republic of Estonia decides an important socio-economic problems, providing scientific research, also creates conditions to perform military tasks and to ensure the necessary level of defensibility of the Estonian Defense Forces.

The Ministry of Defence of Estonia and the Estonian Defense Forces choose the supplier which offers delivery terms on a commodity market and military-oriented services, meeting their requirements and providing the maximum utility from the transaction. The goods and military-oriented services is a set of the goods and services which are intended to satisfy military requirements of the State by means of purchase and sale in the market of the state purchases.

In this assessment the usefulness of military goods and services act as a set of mandatory and optional benefits, which satisfy the specific needs of man and the state in its national defence, and contributes to solving the problem of qualitative changes of the modern image of the Estonian Defence Forces.

The author is inclined to believe that the *„utility"* or usefulness can be used when selecting a supplier of goods and services for military purposes from the standpoint of the state customer. As a basis will be considered an example: selection of the „dry-pack food" supplier for the Estonian Defence Forces. In fact, the choice of a „dry-pack food" or food supplies is a very difficult and responsible process for the Defence Forces that requires certain skills and knowledge. In addition, the food composition of a „dry-pack food" (Carbohydrates, Proteins, and Fats and etc.) should contain certain components and standards that were developed and approved by special legal acts and documents of Food Safety and Quality Certificates[7].

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[7] In Estonia the food sphere (included handling of raw material for food and food, self-control of a food handling operator and governmental supervision) is regulated by the Food Act and Directive of the European Parliament and the European Council 178/2002/EEC, establishing general legal principles and requirements in food area, founding European Food Safety Administration and establishing the procedures, connected with food safety (OJ L 031, 01.02.2002, pp. 1–24). The food sphere is, in addition to the Food Act and its implementing acts, regulated by numerous other laws and regulations and the EU legislation that is directly applicable.

According to the Estonian Public Procurement Act the contest may be won by a supplier who offers the lowest price. At the same time, the law does not indicate specific criteria for evaluating a product or service. It means that customer himself chooses methods for selecting the supplier, which in turn makes the process of public tendering inefficient. In many cases, the «cheap tender» has a poor quality and forces state agencies to spend their budget more than it was planned before.

In summary, the multicriteria problem of the final selection the potential supplier is serving as a comparative assessment of options based on quantitative and qualitative indicators used in the calculation of production and economic and financial activity.

The utility function includes several factors:
  • Potential product price
  • Product quality
  • Energy value in each ingredient in a military dry-pack
  • Price and quality ratio
  • Financial status of a potential supplier

The proposed method of public tendering through the use of utility assessment will help to be guided not only by the concept of efficiency of budget spending on defense but also to take into account the usefulness of the goods and services purchased from a position of economic and financial evaluation of suppliers.

Basic Concepts of Utility in Terms of Economic Theory

In general, the term *"utility"* (usefulness) is extremely widespread in the economic theory. According to William Stanley Jevons: "A true theory of economy can only be attained by going back to the great springs of human action — the feelings of pleasure and pain. A large part of such feelings arise periodically from the ordinary wants and desires of body or mind, and from the painful exertion we are continually prompted to undergo that we may satisfy our wants"(*Jevons, 1993*).

The term *„utility"* - the ability of goods or services to satisfy a human need. The usefulness of a product or service is a feeling of satisfaction or the pleasure the person gets while consuming them (*McConnell and Boue, 2000*).

Austrian economists (Carl Menger, Eugen von Böhm-Bawerk) hold that utility was considered as a psychological reality, a feeling that is independent of anyone outside observation, and directly measurable quantity. Alfred Marshall pointed out that "Utility is taken to be correlative to Desire or Want. It has been already argued that desires cannot be measured directly, but only indirectly by the outward phenomena to which they give rise: and that in those cases with which

economics is chiefly concerned the measure is found in the price which a person is willing to pay for the fulfilment or satisfaction of his desire". *(Gorbunov and Kozin, 2007).*

Theories, allowing direct or indirect measurement of the utility received in economics, called the theories of ***cardinal utility***. Opponents 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).*

In brief, „utility" in economics, is related to product characteristic properties; the utility is referred as the content of the usefulness; the primary interest of „The Marginal Utility School": how to maximize the usefulness? All economic units aspired to one overall aim as participants in market transactions. Universal (general) „utility" does not mean the unity of its content in relation to different economic units. Furthermore, some contemporary authors hold that „utility in the market economy as a concept is closely related to end-users".

Theoretical Background

In the literature for instance quality problem has been addressed by using the Lancaster theory of relative qualities among different items of a good.

It is difficult for anyone working on the economics of quality to ignore Lancaster's theory of quality in consumer demand. It is probably the most influential theory of consumer choice of quality in the economic literature and it is also very influential in marketing. It is used in applications relating to a wide range of goods and services. The theory was presented in two papers and two books (Lancaster 1966, 1971, 1975, 1979). (Bowbrick,1994).

Lancaster's theory "originated from the observation that traditional demand theory was ignoring highly pertinent and obvious information, the properties of goods themselves" (Lancaster, 1971, p.2) and he proposed to concentrate on this aspect "After all, one would expect information on the properties of goods to be more easily obtainable and to be more universal in character, than properties of individual's [sic] preference orderings" (Lancaster, 1971, p.2). (Bowbrick,1994).

The first assumption, basic to everything that follows, is that each good has characteristics relevant to the choices people make on goods (Lancaster, 1971 p.7). (Bowbrick,1994).

"*The good, per se, does not give utility to the consumer; it possesses characteristics, and these characteristics give rise to utility*" (Lancaster,1966, p.134). It is assumed that all characteristics are quantitative and objectively measurable (Lancaster, 1971 p.5). This is an assumption on how individuals perceive the characteristic as well as on its being objectively measurable. (Bowbrick, 1994**).**

The basic paradigm assumes that goods give rise directly to characteristics. It is however possible to assume that the "characteristics are derived from consumption activities in which goods, singly or in combination, are the inputs" (Lancaster, 1971, p.47). The two-stage model assumes that each activity is linear and requires goods in fixed proportions. (Bowbrick, 1994**).**

Various choice problems are studied within a framework of decision making analysis. With the help of utility analysis one can realize some choice more effectively to avoid inappropriate solutions. (Noghin, 2005).
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. However, up to nowadays this principle has not been justified.

The multicriteria problem extended in such a way was called a multicriteria choice problem. To solve this problem means to find a set of selected alternatives, which may consist of one or more elements. In terms of the multicriteria choice model the Edgeworth-Pareto principle 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 three objects mentioned above. (Noghin, 2005).

Basic Tools and Methods of Utility Function

Choice is impossible without a person who makes this choice in order to achieve his/her personal goals. This person [or the whole team oriented towards the certain goals] who makes a choice and is responsible for all its consequences is said to be a decision maker (DM). Usually, by a selected alternative we mean that one which is ideal for satisfaction of wishes, interests or goals of the DM. A strive of the DM to reach a definite goal can be expressed mathematically in terms of maximization (or minimization) of a real-valued function (criterion) defined on the set X. (Noghin, 2005).

It is often we have to deal with several functions at once. This can occur, e.g., when the researched phenomenon, object, or a process is considered from different points of view; and in order to formalize each of them it is necessary to introduce an individual function. 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).

Throughout this paper we shall assume that there are m real-valued functions

$f_1, f_2, ..., f_m$, $m \geq 2$ defined on the set of alternatives X. These functions are said to be optimality criteria or goal functions (Noghin, 2005).

The real-valued functions $f1, f2, ..., fm$ compose a *vector criterion* (Noghin, 2005):

f = (f_1, f_2, …… f_m) (1)

For every alternative $x \in X$, the m-dimensional vector (*outcome*)
$y = f(x) = (f_1(x) \; f_2(x), ..., f_m(x)) \in \Re^m$ 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

$Y = \{y \in \Re^m \mid y = f(x) \text{ for some } x \in X\}$

This set is called a *set of vectors* (or *outcomes*) (Noghin, 2005).
Side by side with a set of selected alternatives, a *set of selected vectors (selected outcomes)* can be introduced as follows
$SelY = f(\text{Sel } X) = \{y \in Y \mid y = f(x) \text{ for some } x \in \text{Sel } X\}$

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 (Noghin, 2005).

Consider $f = (f1, f2, ..., fm)$ defined on X. Let us introduce the following set

$Y = Y \times Y \times ... \times Ym$, where
$Yi = fi(X)$, $i = 1, 2, ..., m$. Obviously, $Y \subset Y^{\char`^} \subset Rm$.

Recall that $\succ Y$ is a preference relation defined on Y. *(Noghin, 2005).*

Axiom 1 (an extension of the preference relation). *There exists an irreflexive and transitive extension of the relation $\succ Y$ to the set $Y^{\char`^}$ (that will be denoted by $\succ$)* (Noghin, 2005).

By Axiom 1, the preference relation $\succ Y$ is a restriction of some irreflexive and transitive relation $\succ$ defined on $Y^{\char`^}$. (Noghin, 2005).

For arbitrary two vectors $y', y'' \in Rm$, one and only one of the following three cases may occur:
$y' \succ y''$
$y'' \succ y'$
neither $y' \succ y''$ nor $y'' \succ y'$

Recall that $f(x') \succ f(x'') \Leftrightarrow x' \succ_x x''$ for all $x', x'' \in X$.

It is clear that irreflexivity and transitivity of $\succ$ imply the same characteristics of both the relations $\succ y, \succ x$. (Noghin, 2005).

The advantage of performance coefficients is their ability to provide a relative measure of sourcing effectiveness that ties directly to financial effectiveness and can be used for estimation and "what if" scenario planning. If designed and implemented correctly, they are useful for any level of engagement, from simple projects to big tenders in public procurement.

Decision-making process directed to selection of the „dry-pack food" supplier should represent a multistage process involving use of utility indicators and might be established in the following sequence:

Model building;
Formation and Structuring of the source data;
Calculation of Partial utility parameters;
Determination of Total utility indicator;
Determination of Degree of Influence into Total utility indicator.

The first stage of the research is devoted to economic and mathematical models construction. In general, the chain function has the form (Gorbunov and Kozin, 2007):

F = f (P; K; N; Z; F;...*n*), where   **(2)**

P - Potential product price;
K - Quality of products supplied;
N - Content parameters of energy values (*food energy*) in each igredient of dry-pack;
Z - Evaluation of price / quality ratio of products;
F - Financial stability (financial state) of the supplier.
The second stage is directed to information gathering and data analysis.

Calculation of above mentioned utility parameters will be also included (*function 2*).

In the third stage of the research calculations of partial utility parameters will be made. The transformation of parameters into partial utility parameters must be done by using the conversion functions, based on functions representing a mathematical model.

Background of Public Procurement in Estonia

The general principles constituting the basis of the national public procurement law (*Public Procurement Act)* of Estonia are in general those derived from the Community Directives and recognized in all Member States. These are, in particular, ensuring fair competition, efficient employment of pecuniary means, open and transparent proceedings.

Most of the procedural rules for awarding public procurement contracts apply to contracts which estimated value is equal or exceeds the national value thresholds, which are approximately *125 000 €* in the case of purchase of goods or ordering for services, and *4 845 000 €* in the case of contracting for works.

In case of public procurement contracts which value is below the national value threshold but higher than *10 000 €* for goods and services or *30 000 €* in the case of works, the publication rules for contract award notices apply.

In Estonia there are four main procedures for awarding public procurement contracts: open, restricted and negotiated procedure, the latter with- or without prior publication of a contract notice. (See figure 1).

The "Utility Function" as Optimization Tool of Military Procurement

On the basis of a state order and by using the „dry-pack" specifications – „dry-packs" should be divided into two types of food rationing (for simplicity of calculations will be established only two types of rationing). In accordance with specifications every „dry-pack" rationing must include certain components that contain a specific set of food and energy values. In addition, dry-packs should have a certain shelf life. Table 1 and Table 2 show the basic data about the content of the components and a set of nutritional values (see Table 1 and 2).

Tabel 1 Military dry-pack nr 1[8]

Dry-pack nr 1 Ingredient	Weight, g	Calories, kcal	Carbohydrate, g/100g	Proteins, g/100g	Fats, g/100g
A	155,00	634,00	105,40	13,90	18,60
B	170,00	527,00	114,00	20,00	4,60
C	115,00	272,00	0,90	7,90	25,00
D	400,00	432,00	32,00	40,00	16,00
E	400,00	400,00	40,00	16,00	20,00
F	100,00	540,00	42,80	14,00	34,80
G	24,00	100,00	24,00	-	-

[8] Source: made by the author

H	3,00	-	-	-	-
I	90,00	82,00	20,00	0,36	0,09
J	100,00	356,00	-	17,00	32,00

Tabel 2 Military dry-pack nr 2[9]

Dry-pack nr 2 Ingredient	Weight, g	Calories, kcal	Carbohydrate, g/100g	Proteins, g/100g	Fats, g/100g
A	150,00	646,00	85,50	15,00	18,50
B	170,00	527,00	114,00	20,00	4,60
C	115,00	281,00	1,38	7,50	25,40
D	400,00	464,00	18,00	40,00	26,00
E	400,00	400,00	32,00	32,00	16,00
F	100,00	539,00	45,00	13,30	33,90
G	24,00	100,00	24,00	-	-
H	3,00	-	-	-	-
I	90,00	87,00	19,00	0,36	0,02
J	100,00	356,00	-	17,00	32,00

Let's assume that the base price will be:

(1) Dry-pack nr 1 – **11,20 €**
(2) Dry-pack nr 2 - **10,75 €**

The tender for the supply of dry-packs on the public Defense Contracts signed up so far **3** (**three**) companies:

(1) Company nr 1
(2) Company nr 2
(3) Company nr 3

Cost (Price) Estimation
Calculation of the partial utility of PA- ***parameters of the acquisition costs*** of production implementation is a two-step process. The first stage involves the calculation of coefficients - the best value supplier **ΔP**, defined by the *function 3* (Gorbunov and Kozin, 2007):

ΔP = (P – P min) / (P max - P min), where　　　　　　　　　　**(3)**

ΔP – the coefficient of optimal price
P – the current value of supplier's price
P min – the minimal value of all proposed prices
P max – the maximum value of all proposed prices

At the second stage, the values of *ΔP* compared with the estimated coefficients of partial utility of the other factors. For this, using the transformation function *(3)* for the factor *"Price"* through the values of ΔP compute the coefficient of partial utility Q_P *(function 4, (Gorbunov and Kozin, 2007)*.

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

Q_P – the coefficient of partial utility of optimal price
ΔP – the coefficient of optimal price

Results are presented in Table 3 (See Table 3). The maximum value of the partial utility of optimal price corresponds *Company nr 1 – 1,0000.*

Tabel 3 Coefficient of partial utility of optimal price[10]

Coefficient of Utility	Company nr 1		Company nr 2		Company nr 3	
	Dry-pack nr 1	Dry-pack nr 2	Dry-pack nr 1	Dry-pack nr 2	Dry-pack nr 1	Dry-pack nr 2
Price Provider, €	10,85	10,55	11,00	10,75	11,10	10,65
The coefficient of optimal price, *ΔP*	0,0000	0,0000	0,5000	1,0000	1,0000	0,6667
The coefficient of partial utility of optimal price, Q_P	*1,0000*	*1,0000*	*0,2222*	*0,0000*	*0,0000*	*0,1200*

Assessment of Quality of Products

To assess the quality of products, we need to have a certain set of numerical values in absolute or relative terms. Coefficients of partial utility concerning the quality of products defined by experts. For these questions, the Department of Nutrition exists in the structure of the Estonian Defense Forces, which deals with nutrition, including the conduct of various tests related to nutrition of the Defence Forces. For more detailed investigation commission was formed a, which consisted not only of nutrition experts, but also some officials from other departments who were selectively invited.

Totally, the commission included **12 (twelve)** people. The quality of products was estimated by each component using the scale or so-called *the satisfaction scale*:

1 - Unsatisfactory
2 - Partly satisfactory
3 - Satisfactory

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[10] Source: made by the author

4 - Average
5 - Above average
6 - Good
7 - Excellent

The coefficient of optimal quality (*ΔK*) is carried out using the **function 5** (*Gorbunov and Kozin, 2007*):

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

ΔK – is the coefficient for optimal quality
R_i – is the current value
Z – is the total sum of current value
N – is the total value of participants

We believe that the offered method for estimating the quality of products is necessary for a public tender implementation. This method reflects interrelation of an objective estimation of quality and taste preferences of soldiers, which in a combination with other indicators makes a tender management service more efficient.

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

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

Q_K – the coefficient of partial utility of optimal quality
ΔK – the coefficient of optimal quality

Finally, after all calculations we have received below-mentioned values (see Table 4).

Tabel 4 Coefficient of partial utility of optimal quality[11]

Coefficient of Utility	Company nr 1		Company nr 2		Company nr 3	
	Dry-pack nr 1	Dry-pack nr 2	Dry-pack nr 1	Dry-pack nr 2	Dry-pack nr 1	Dry-pack nr 2
coefficient of partial utility of optimal quality, Q_K	8,7170	*8,7424*	*8,7310*	8,7290	8,7292	8,7303

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[11] Source: made by the author

Table 4 shows that most appreciated quality represent *Company nr 1 (Dry-Pack nr 2) - 8,7424* and also *Company nr 2 (Dry-pack nr 1) – 8,7310.*

Content parameters of energy value (food energy) in each ingredient of dry-pack

Calculations based on calorie content of food for each component, which were supplied by providers, will be conducted in accordance with *function 7 (Source: made by the author*), the baseline will be taken the data given in **Tables 1** and **2.**

N = U / Ubasic, where   **(7)**

N – the coefficient of energy value
U – the current value
Ubasic – the basic parameter of energy value

The average coefficient of energy values will be established using the *function 8* (Source: made by the author):

Q_N = ∑N / ∑C, where   **(8)**

Q_N – the average coefficient of energy value
∑N – the total coefficient of energy value
∑C – the total amount of components in the „dry-pack"

Every product has its own energy value, measured in kilocalories. The calorie content of food is listed in the specifications for a public tender performance. We are inclined to believe that proposed formulas (formula nr 6, formula nr 7) and an average coefficient calculation will guarantee the quality and norms execution which are important in a potential supplier selection. The results of these calculations are presented in **Table 5** (see Table 5).

Tabel 5   Energy value coefficient[12]

Coefficient of Utility	Company nr 1		Company nr 2		Company nr 3	
	Dry-pack nr 1	Dry-pack nr 2	Dry-pack nr 1	Dry-pack nr 2	Dry-pack nr 1	Dry-pack nr 2
Average coefficient of energy values, Q_N	0,9900	0,9400	0,9400	0,9000	0,9700	0,9600

By using common indicators of calorie content, the highest rates shows *Company nr 3 0,9700 and 0,9600.*

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[12] Source: made by the author

Evaluation of price and quality of products

The calculation of the partial utility of the estimate "***Price / Quality***" of products will be conducted using the results established in **Tables 3 and 4.** In accordance with it, indicators of *„Price"* coefficients will be shared with indicators of *"Quality"* coefficients. Optimizing the choice is based on coefficient of optimality *ΔZ* determined by the ***function nr 9*** (Gorbunov and Kozin, 2007):

$$\Delta Z = (Z - Z_{min}) / (Z_{max} - Z_{min}), \text{ where} \qquad (9)$$

ΔZ - coefficient of optimal price/quality ratio
Z – the current value of price/quality provider
Z min – the minimal value of all proposed values
Z max – the maximal value of all proposed values

The values obtained were comparable to estimated coefficients of partial utility of other factors necessary to calculate the coefficient of partial utility **Q**z using the transformation ***function nr 10*** *(Gorbunov and Kozin, 2007)* for the factor of price / quality through the values of *ΔZ.*

$$Q_z = (1-\Delta Z) / (1+\Delta Z)^2, \text{ where} \qquad (10)$$

Q_z – the coefficient of partial optimal evaluation of price/quality
ΔZ – the coefficient of optimal evaluation of price/quality

To form a table of initial data it is necessary to use the coefficient of partial useful surface and the actual values of prices (see **Table 6**). The given analysis has revealed that despite the high quality estimates which have ***Company nr 1 (Dry-pack nr 2) and Company nr 2 (Dry-pack nr 1),*** most appreciated evaluation of price/ quality was established by ***Company nr 2 (Dry-pack nr 2) and Company nr 3 (Dry-pack nr 1)***. However, general indicators of the partial utility coefficients were owned by the ***Company nr 1.***

Tabel 6 Coefficient of optimal evaluation of price / quality[13]

Name of coefficient	*Company nr 1*		*Company nr 2*		*Company nr 3*	
	Dry-pack nr 1	**Dry-pack nr 2**	**Dry-pack nr 1**	**Dry-pack nr 2**	**Dry-pack nr 1**	**Dry-pack nr 2**
Price Provider, *€*	10,85	10,55	11,00	10,75	11,10	10,65

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[13] Source: made by the author

coefficient of partial utility of optimal quality, Q_K	8,7160	8,7420	8,7310	8,7280	8,7290	8,7300
evaluation of price/ quality	*19,5020*	*18,8730*	*19,6990*	*19,2460*	*19,9330*	*19,1280*
coefficient of optimal evaluation of price/ quality, ΔZ	0,5930	0,0000	0,7790	0,3510	1,0000	0,2400
coefficient of partial optimal evaluation of price/quality, Q_Z	*0,1600*	*1,0000*	*0,0690*	*0,3540*	*0,0000*	*0,4920*

Such an assessment can be a factor with a certain amount of influence on choice of supplier when the reliability and financial status of potential partners or customers are not a priority.

Financial stability (state) of the potential supplier
Calculations of the partial utility of the financial state of the supplier should be based on accounting reports. The number of estimates of financial indicators can be arbitrary; however, they all should give a full picture of the financial state of the company.
In general, they should meet the following requirements:

(1)   should be maximally informative and provide a holistic picture of the financial stability of the company;
(2)   should have the same orientation (growth factors means improving the financial status);
(3)   to pay off according to the accounting reporting of the enterprise;
(4)   make it possible to carry out pre-rating acceptance in comparison with other companies for a number of periods;
(5)   for all indicators should be specified numerical specifications of satisfactory level or a range of changes.

The most objective estimation of the financial state can be received using Altman's factorial models (Z-Score). *(Chernov, 2001)*. They are used for measurement of the financial health and, in particular, distress status of companies. Moreover, they served as a powerful diagnostic tool that forecasts the probability of a company entering bankruptcy within a 2 year period.

The Z-Score formula for predicting bankruptcy is a linear combination of five common business ratios, weighted by coefficients and by using profit-and-loss reports.

Altman's test function involves multiplication of several relative indicators in each of which to the sum of the residual book value of assets and liabilities of the

company normalized the most dependent on system of accounting the sum of profit (***function nr 11,*** (Gorbunov and Kozin, 2007):

F=0,717X1+0,847X2+3,107X3+0,42X4+0,995X5   **(11)**

Zones of Discrimination *(Chernov, 2001)*:

If ***F <1.8,*** so-called "Distress" Zones (the company is standing near the bankruptcy);

If this value falls in the range ***1.8 <F<2.7,*** so-called "Grey" Zones (the company may become non-creditworthy);

If ***F> 2.7,*** so-called "Safe" Zones (this indicates a fairly stable financial position of a business entity).

Evaluations of the financial condition of the suppliers on the basis of the Altman's criterion are shown in **Table 7** (see Table 7). Calculations showed that the highest rate of the supplier's reliability has a ***supplier*** **nr 3** - ***1,9000***.

Table 7 Financial status of a potential supplier[14]

Indicator	Company nr 1	Company nr 2	Company nr 3
X1 - Equity/Total assets	0,5220	0,5710	0,6090
X2 - Retained income/Total assets	0,0210	0,0240	0,3100
X3 – Pre-tax income/Total assets	0,0290	0,0270	0,0190
X4 - Market value of equity/ Borrowed capital	0,9150	0,7500	0,6410
X5 - Total sales (revenue)/Total assets	0,9790	0,6800	0,8790
F=0,717X1+0,847X2+ +3,107X3+0,42X4+0,995X5	**0,8400**	**1,5100**	**1,9000**

In order to obtain an objective total estimation of utility and potential supplier selection, it is necessary to find average values on the separate parameters, calculated for each dry-pack rationing (average value of 2 rationings), because coefficients of the financial state of the enterprise are given for each company as a whole. In addition, all the coefficients of the partial utility will lead to the one general denominator using the ***function nr 12*** (Gorbunov and Kozin, 2007):

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[14] Source: made by the author

$$WQ_i = Qi / \sum_{n=1}^{N} Q_n, \text{ where} \tag{12}$$

WQ_i – The coefficient of total value

Q_i – The coefficient of partial utility for each indicator

N - Number of suppliers

$\sum_{n=1}^{N} Q_n$ - Total current value

The results are presented in **Table 8** (see Table 8).

Table 8 Matrix of partial utility of suppliers[15]

Indicator	Company nr 1	Company nr 2	Company nr 3
Price, Q_P	10,70	10,85	11,00
Quality, Q_K	8,7297	8,7300	8,7298
average coefficient of energy values, Q_N	0,9636	0,9215	0,9658
Price/Quality, Q_Z	19,1878	19,4731	19,5309
Financial status of a potential supplier, Q_F	0,8400	1,5100	1,9000

After reduction of all studied criteria for a single equivalent of a mathematical model of optimization appropriate to express in integral form (***function nr 13***) (Gorbunov and Kozin, 2007):

$$F_{total} = WQ_P + WQ_K + WQ_N + WQ_Z + WQ_P, \text{ where} \tag{13}$$

Ftotal – the total assessment of the utility of a supplier
WQ_P – the total coefficient of partial utility of optimal price
WQ_K – the total coefficient of partial utility of optimal quality
WQ_N – the total coefficient of energy values
WQ_Z – the total coefficient of partial utility of optimal of price/quality
WQ_F – the total coefficient of the financial state of suppliers

Apparently from **Table 9** (see Table 9), the ***supplier* nr 3** has the maximum value of an indicator of utility.

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[15] Source: made by the author

Table 9 Matrix of the total coefficients of utility of suppliers[16]

Indicator	Company nr 1	Company nr 2	Company nr 3
Price, WQ_P	0,3297	0,3346	0,3356
Quality, WQ_K	0,3333	0,3333	0,3333
Average coefficient of energy values, WQ_N	0,3380	0,3232	0,3388
Price/Quality, WQ_Z	0,3297	0,3346	0,3356
Financial status of a potential supplier,WQ_F	0,1976	0,3553	0,4471
F_{total}	**1,528**	**1,681**	**1,790**

In the Table 9 presented the results of the total coefficients of utility of suppliers.

Discussion

This paper uses a theoretical model to examine the questions: How measure a quality? And how making decisions? How will introducing a specific methods alternative affect the performance measures of the individual services purchasing in the organization?

According to Lancaster the first assumption, basic to everything that follows, is that each good has characteristics relevant to the choices people make on goods (Lancaster, 1971 p.7). In his earlier paper (Lancaster,1966) a stronger assumption had been made. "*The good, per se, does not give utility to the consumer; it possesses characteristics, and these characteristics give rise to utility*" (Lancaster,1966, p.134).

It is assumed that all characteristics are quantitative and objectively measurable (Lancaster, 1971 p.5). This is an assumption on how individuals perceive the characteristic as well as on its being objectively measurable (Bowbrick, 1994).

In our case we are used the Pareto principle method and it is a major of one within a framework of multicriteria decision analysis. Since this one is usually rather wide, the following problem arises: which Pareto-optimal alternatives should be excluded in order to reduce the Pareto set and thus to facilitate a choice?

In order to solve this problem, one needs additional knowledge of the decision maker preferences. Depending on the type and the volume of the additional

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[16] Source: made by the author

information, numerous approaches were developed. However, it is necessary to remark that almost all these approaches are only heuristic, since nobody knows when one or another approach can guarantee really the best choice (Noghin, 2005).

This paper presents a successive introduction to a theory of relative importance of criteria. First of all, the expression "one criterion is (relatively) more important than another with a pair of positive parameters" is defined. The corresponding definition has simple logic and is clear not only for researchers but also for those persons who are responsible for a choice and inexperienced in mathematics. The last circumstance is important if we take into account the fact that information on the relative importance is often elicited from these persons. And the better they understand a sense of the relative importance the more exact information they can represent for researchers (Noghin, 2005).

For the testing procedure has been created and applied the integral financial economic estimate of the military goods and services supplier. This methodology is based on quantitative compound information on the relative importance of criteria This method reflects interrelation of material, information and financial flows and allows to determine complex integral indicator taking into consideration the following factors: costs, quality of goods, energy value, correlation of cost/quality; financial state of the supplier.

By using the example of selecting the „dry-pack food" supplier for the Estonian Defence Forces assessing the points of utility, we were able to achieve the most effective approach for public tendering. Such approach will provide the Defence Forces with quality products contained in the „dry-pack" having an affordable price, which in turn will make the execution of the military budget more effective.

The results of the estimation give the possibility to take both well-founded economical decisions in placing of the state defence orders and in developing the competitive mechanism of the military goods and services purchase.

Besides, the developed methodology can be used in combination with other well-known approaches to solve different multicriteria choice problems.

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Figures

Figure 1 Procedures of Public Procurement[17]
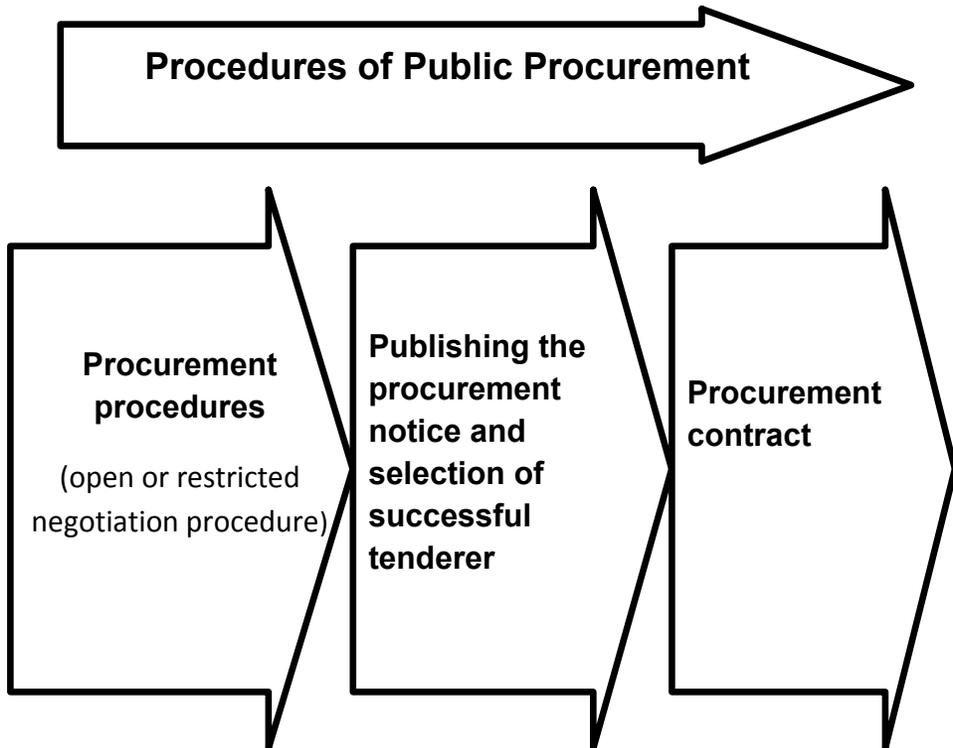
The figure 1 shows the public procurement procedures. For the purposes of this act, "public procurement" means purchasing of goods, contracting for provision of services, organizing design contests, contracting for public works and granting of works and service concessions by the contracting authority and contracting for works by the concessionaire of works concession.

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[17] Source: made by the author

3. STRATEGIC MANAGEMENT SYSTEM AND METHODS OF CONTROLLING AS KEY ELEMENTS OF MILITARY EXPENDITURE POLICY-MAKING PROCESS

Maritana Sedysheva

Abstract

Purpose - The present paper proposes a conceptual approach to determining an optimal strategy development process and controlling of the defence spending by utilizing the decision-making system adopted in the Republic of Estonia.

Design/methodology/approach - The author offers a part of the Balanced Scorecard model named "Management and Control Perspective" as one of the improvement tools for the system of planning military expenditures and effective utilization of budgetary funds.

Findings - The results show that 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.

Research limitations/implications – One suggestion for further research might be established as a way of improvement and development of methods directed to application of the utility function in the decision-making process. This approach will improve calculations of strategic perspective plans and will reveal the essence of the budgetary policy on the whole by taking into consideration expenses features of the business and non-profit organizations.

Practical implications - By using the Balanced Scorecard the author offers a new strategic method of planning and controlling the military expenditure in the Estonian Defence Forces.

Originality/value - The present paper provides direct evidence of the alternative methods forecast measures and possibility of using mathematical models in the strategic planning process.

Keywords – Budgeting, Military expenditure, Resource Based View, Strategy Maps, Utility Function, Balanced Scorecard, Mathematical Modelling, the Estonian Defence Forces.

Paper type Case study

1.   Introduction

The formation of the defence budget is an important question for the state policy. Military expenditures are the integral component of the state budgets in the overwhelming majority of the countries all over the world. Their amount varies „country to country" and this indicator fluctuates from 0,5 % to 10 % of Gross Domestic Product (GDP). The formation of the defence budget has its own special features in each particular state.

For example, Estonia – is a small country, which has formed its Defence Forces from zero point and has practically no heavy armament (tanks, heavy artillery, Defence Forces-co-operation aircraft etc). In addition, Estonia has no funds for the acquisition of such armament. It is right to mention here that Estonia, as well as other NATO member states, was obliged to assign about 2% from GDP for defence expenses.

In January 2009, the New Defence Development Plan for 2009-2018 (Estonian Ministry of Defence, 2009) was adopted. The defence planning foreseen by it is twofold – strengthening the initial self defence capability and contributing the international security might be separate fields by definition but yet inseparable and strongly interrelated tasks in practice. The new plan is to harmonise the national defence planning in Estonia with the NATO planning cycle and will be reviewed every four years.

The development plan focuses on a number of important spheres including the following: increasing the initial defence capability, participation in international operations, increasing host nation support, the reorganization and development of the Defence League, and continued improvement of service quality. Estonia also wants to improve the efficiency of the recruitment system within the framework of the development plan while ensuring a continued increase of wages and motivations for defence force members (Estonian Ministry of Defence, 2009).

The military budget as itself is the portion of the Republic of Estonia discretionary main budget that is allocated to the Ministry of Defense, or more broadly, the portion of the budget that goes to any defense-related expenditures. In particular, the military budget is planned each year. It is based on long-term and mid-term development plans, as well as the state budget strategy and the budget law. The military expenditure planning process occurs „stage by stage" and passes all necessary levels.

By linking the long-term (10 years) and mid-term (4 years) development plans and one year planning documents, Estonia has ensured the possibility of a capacity-based, systematic development of military national defence. A long-term strategic overview has been now provided, which allows for assessing the expedience of resource consuming supply procurements and investments in infrastructure against

the priorities of developing military capacities and availability of resources that are required for capacity development (personnel, equipment, infrastructure) (Estonian Ministry of Defence, 2009).

The basic priorities and tasks are formed at political and strategic levels (by the Ministry of Defence and by the Headquarters of the Estonian Defence Forces); the detailed planning of the budget occurs at tactical and operative levels (by military structures and by Units of the Defence Forces).

The main issue and one of the weakest sides of the existing system is that there are no straight methods and mechanisms of detailed planning and control of military expenditure at all, the certain strategy of management in particular. Also an absence of the detailed analysis of the state budget execution leads to a poor control of resources and grows into the „rash money wasting ". In this connection the author highlights a necessity of pointing several new contributions to the existing management system.

Integrating the Balanced Scorecard with the organization´s planning and budgeting process is critical for creating a Strategy-Focused Organization. Most organizations use the budget as their primary management system for establishing targets, allocating resources, and reviewing performance. Yet more than half of surveyed companies indicated that their budgeting and performance review processes were done separately from the strategic planning process. With budgets serving as the primary means used to exercise control in organizations, management attention becomes riveted on achieving short-term financial targets (Kaplan and Norton, 2000).

The performance of each of the strategic options can be reported in the Balanced Scorecard (Kaplan and Norton, 1996), in order that their relative merits can be assessed. This sets performance indicators for each of the main organizational objectives, usually grouped under such headings as „citizen and user results", „process improvement result", „organizational learning and development results" and „financial results". While this technique was originated for reporting in the private sector, it has now also become popular in public sector organizations in the UK and USA (Bovaird T, Löffler, E, 2009, p. 72).

In this paper the author considers strategic planning and controlling in the public sector using different approaches. This paper examines the Process Perspective (the functional component of the Balanced Scorecard) 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. In addition, the present paper will present the utility function modifications and

methods of selection as improvement tools of the whole defence spending process. Special attention will be given to cardinal utility, which is used in various models as well as the manner in which probabilities are incorporated (Schoemaker, 1982). 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 spending 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 Maps) by reflecting the special features of the strategic management of military resources.

The author is convinced that the state budgeting process should always take into account all the specific features, which define an essence of the military goals and tasks. As the pressures from the outside grow, organizations are led to find ways to either diffuse or eliminate this pressure by changing their practices (Powell and DiMaggio, 1991).

The conceptual analysis and practical experience directed to the execution and controlling of the budgetary funds existence show that the given topic is very important and vital for the Defence Forces.

2.   Literature review

The Balanced Scorecard, since its introduction in 1992, has evolved into the centerpiece of a sophisticated system to manage the execution of strategy. The effectiveness of the approach is derived from two simple capabilities:

(1)   the ability to clearly describe strategy (the contribution of Strategy Maps);
(2)   the ability to link strategy to the management system (the contribution of Balanced Scorecards).

The net result is the ability to align all units, process, and systems of an organization to its strategy. Figure 1 describes a simple management framework for the strategy execution. The approach adds several important features to the classic „plan-do-check-act" closed-loop, goal-seeking process introduced by Deming in the quality movement (Kaplan and Norton, 2006) (Take in Figure 1).

According to Peeter Lorents (2006), before starting with the main activity or a process all the preparatory processes should be monitored, evaluated and analyzed.

He underlines that control is an act or a process according to which a situation coincides with the planned tasks. In other words we should answer to another main question: does the system (its development stage or current state) correspond with our planned goals and objectives or not (Lorents, 2006).

It is no exaggeration to consider expected utility theory as the major paradigm in decision making since the Second World War. It has been used prescriptively in management science (especially decision analysis), predictively in finance and economics, descriptively by psychologists, and has played a central role in theories of measurable utility (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 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).

In addition, our research is devoted to important behavioral decision aspects that are currently ignored in the utility theory. In turn the author suggests to add the behavioral dimension to the utility model. This implementation will expand an essence of the utility model and will allow organizations to be motivated by the main behavioral aspects (cost/quality, time and etc.)

Finally, the discussion section synthesizes the divergent strands of research, which have a potential to transform the utility model into the powerful strategy planning system in the future (Schoemaker, 1982).

3.   Theoretical Background and Methods of Utility Function

The mathematical form of an expected utility theory is originated by Gabriel Cramer (1728) and Daniel Bernoulli (1738), who sought to explain the so-called St.Petersburg paradox[18] (Schoemaker, 1982).

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[18] "The St. Petersburg paradox is a classical situation where a naïve decision criterion (which takes only the expected value into account) would recommend a course of action that no (real) rational person would be willing to take. The paradox can be resolved when the decision model is refined via the notion of marginal utility (and it is one origin of notions of utility functions and of marginal utility), by taking into account the finite resources of the participants, or by noting that one simply cannot buy that which is not sold (and that sellers would not produce a lottery whose expected loss to them were unacceptable)"

According to Amos Tversky (1967) there are several advantages in distinguishing cardinal utility measures constructed under certainty, denoted v(x), from those constructed under risk, denoted *u(x)*. Firstly, it emphasizes that there exist different types of cardinal utility, even within each category, which only have to be related monotonically. Secondly, by examining $u(x) = f(v(x))$, an Arrow-Pratt type measure of intrinsic risk aversion may be defined and empirically measured, namely - *f''(v(x))/f'(v(x))* (Bell and Raiffa, 1979). Thirdly, the construction of *u(x)* may be simplified by first examining the nature of *v(x)*, especially in the case of multiattribute utility (Schoemaker, 1982).

Moreover, choice, as itself, is impossible without a concept of a 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 consequences is 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 a set with certain criteria and input variables that can be measured.

In fact, the mathematical formulation of the problem could be presented in next way. Further details are elaborated in several sources: Schoemaker, (1982), Noghin (2005), Gal, Stewart, and Hanne, (1999), Belton and Stewart (2002), Intriligator (1975), Gorbunov and Kozin (2007).

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

$f_1, f_2, ..., f_m$, $m \geq 2$ defined on the set of alternatives *X*. These functions are said to be optimality criteria or goal functions (Noghin, 2005).

The real-valued functions $f1$, $f2$,..., $f\,m$ compose a *vector criterion* (Noghin, 2005):

$$\mathbf{f} = (\mathbf{f_1}, \mathbf{f_2}, \dots \mathbf{f_m}) \tag{1}$$

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

$y = f(x) = (f_1(x)\ f_2(x),...,f_m(x)) \in \Re^m$ 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).*

Pareto Axiom (in terms of alternatives). For any pair of alternatives x', x'' ∈ X we have f (x') ≥ f (x'') ⇒ x X x ' f ''.

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
$i = 1,2,...,m$.

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 defence 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; Z; N; T;...*n*)   **(2)**

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

- *F = the total assessment of the utility of element of decision making*
- P - Cost Estimation (Budget Execution)
- K - Quality Assessment of Executing Processes (possibility of strategic goals and tasks execution)
- Z - Cost Estimation (budget execution) and quality ratio
- N – Decision – making process
- 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). Management and Control Perspective, which is posed on the top of the system and lying inside a strategic planning process, will be realized 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 Figure 2). Figure 2 shows a step-down procedure, which represents the transition from high-level strategy to budgeting for local operations.

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 (Take in Figure 3). Once the hierarchy is built, the decision maker systematically evaluates its various elements, comparing them to one another in pairs. In making the comparisons, the decision maker 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).

4.   The Resource Based View: Physical, Human, and Organizational Capital Resources

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.
According to Jay Barney (Barney 1991) in the firm resources may be included assets, capabilities, organizational processes, firm attributes, information, knowledge, etc. controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness (Daft, 1983). In the language of traditional strategic analysis, firm resources are strengths that firm can use to conceive of and implement their strategies (Learned, Christensen, Andrews, & Guts, 1969, Porter, 1981) (Barney 1991).

In our case we included three classified categories of organization´s resources: physical capital resources (Williamson, 1975), human capital resources (Becker, 1964), and organizational capital resources (Tomer, 1987). Physical capital resources include the physical technology used in a firm, a firm´s plant and equipment, its geographic location, and access to raw materials. Human capital resources include the training, experience, judgment, intelligence, relationships, and insight of individual managers and workers in a firm. Organizational capital resources include a firm´s formal reporting structure, its formal and informal planning, controlling, and coordinating systems, as well as informal relations among groups within a firm and between a firm and those in its environment (Barney 1991).

The organization´s planning, operations, and control processes allocate resources, drive action, monitor performance, and adapt the strategy as required. Even if enterprises develop a good strategy and align their organizational units and employees to it, misaligned management systems can inhibit its effective execution. Planning and control systems alignment exists when the management systems for planning, operations, and control are linked to the strategy (Kaplan and Norton, 2006) (Take in Figure 4).

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 5).

The Process Perspective will be used as an example and in our case – *Management and Control Perspective*, which will allow us to consider statements and strategic tasks application.

5.   The "Utility Function": A New Approach to Optimal Strategic Planning Process in the Estonian Defence Forces

In accordance with an available literature review, data and parameters calculations Schoemaker, (1982), Noghin (2005), Gal, Stewart, and Hanne, (1999), Belton and Stewart (2002), Intriligator (1975), Gorbunov and Kozin (2007), and in line with the general new approach (Take in Figure 4) we have examined the decision-making process directed to the selection of strategic elements from the variety of planned military resources.

It is necessary to mention here, that our example is intentionally oversimplified for illustration purposes. However, in practice, most needs can be accommodated by carefully defining and collecting the information used in the calculations.

And on the basis of a second function (***function nr 2***) and the utility-based performance measures towards to the strategic planning we will present the maximum value of every component and the total sum (total amount) 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 strategic planning process begins from an analysis and review of all needed aspects and 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 plans (projects);
- Finally, it is necessary to choose an optimal project in accordance with received estimations and results (Take in Table 1 and Table 2).

In accordance with non-disclosure agreements: assume that we have four plans (*Project 1, Project 2, Project 3, Project 4*), where the sum of each budget (total amount of budget) is:

- Strategic plan (*Project 1*) **- XXX €**
- Strategic plan (*Project 2*) **- XXX €**
- Strategic plan (*Project 3*) **- XXX €**
- Strategic plan (*Project 4*) **– XXX €**

Further all these four plans will be taken as an initial data for our research.

In the next section the author proposes to divide the overall utility function into several components, which in turn are forming the uniform model: *Cost*

Estimation, Quality Assessment of Executing Processes, Cost Estimation and quality ratio, Decision – making process, Time spent on strategic goals and tasks execution.

5.1 Cost Estimation (total planning sum)

Typically, 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):

$$\mathbf{\mathit{\Delta P}} = (P - P\ min) / (P\ max - P\ min), \text{ where} \qquad \qquad \textbf{(3)}$$

ΔP – 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 $\mathbf{\mathit{Q_P}}$ (***function nr 4,*** Gorbunov and Kozin, 2007).

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

$\mathbf{\mathit{Q_P}}$ – 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 ***Project 2 – 1,000.***

5.2 Quality Assessment of Executing Processes *(possibility of strategic goals and tasks execution)*

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 executing process addressed to the main tasks is assigned by every department and military personnel.

The quality of execution 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):*

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

ΔK – the coefficient of optimal quality
R_{in} – the current value
Z – the total sum of current value
N – the total value of participants

The parameters of quality (*Q_K*) 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):

$$\mathbf{\mathit{Q_K}} = (1 - \Delta K) / (1 + \Delta K)^2, \text{ where} \tag{6}$$

Q_K – the coefficient of partial utility of optimal quality
ΔK – the coefficient of optimal quality

Table 1 shows that the most appreciated quality represents ***Project 2 – 6,2504***

5.3 Cost Estimation (budget execution) 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):

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

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) (cost / quality through the values of ΔZ) will be used.

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

Q_z – 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 *Project nr 4,* the general indicators of the partial utility (coefficients) were owned by the *Project nr 2.*

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 Decision – making process

In principle, every process (planning, controlling or estimating) is including different decision´s components. Traditionally, the process is passing under a certain „scenario" called the bottom-up approach. However, the distribution of limits or decisions held by Ministry of Defence and the Headquarters of the Estonian Defence Forces. In our case we examine estimates of the decision-making process based on last year annual statistics and the prognosis of change related to the budget execution or plans. And it is obvious that modifications and corrections can appear at all stages of the planning process. However, all these invasions affect certain categories of expenses, time limits and material resources, which in turn are not taken into consideration at the final analysis of the task performance and budget execution. In other words, less changes we have, the more effective a project will be and on the contrary.

The monitoring process is based on "ideal" prognosis. The ideal prognosis as a baseline is setting a selection standard or average data statistics. The choice of the partial utility will be conducted in accordance with *function nr 9* (Gorbunov and Kozin, 2007).

$$Q_N = Npc/Np, \text{ where} \tag{9}$$

Q_N – the coefficient of partial optimal evaluation of decision – making process (the number of decisions)

Npc – the "real" number of decisions
Np – the number of the prognosis of decisions

The result has shown that the best value of decision-making process belongs to **Project nr 4**.

5.5 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 10** (Gorbunov and Kozin, 2007).

$$\varDelta T = (T – T\text{ min}) / (T\text{ max} - T\text{ min}), \text{ where} \tag{10}$$

$\varDelta T$ – 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 11** (Gorbunov and Kozin, 2007).

$$Q_T = (1-\varDelta T) / (1+\varDelta T)^2, \text{ where} \tag{11}$$

Q_T – the coefficient of partial optimal evaluation of spending time
$\varDelta T$ – the coefficient of optimal evaluation of spending time

The made calculations have shown that the highest optimal value belongs to **Project nr 1.**

Table 1 The partial utility coefficient matrix [19]

Coefficient of Utility	*Strategy nr 1*	*Strategy nr 2*	*Strategy nr 3*	*Strategy 4*
	Project 1	Project 2	Project 3	Project 4
Total Planning Sum, €	XXX	XXX	XXX	XXX
The coefficient of optimal cost, ΔP	0,5712	0,0000	0,8885	1,0000

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[19] Source: made by the author

The coefficient of partial utility of optimal cost, Q_P	0,1737	1,0000	0,0313	0,0000
The coefficient of partial utility of optimal quality, Q_K	*6,2400*	*6,2504*	*6,2454*	*6,2464*
evaluation of cost/quality	*12590,3241*	*11929,5465*	*12935,2224*	*13058,2166*
The coefficient of optimal evaluation of price/ quality, ΔZ	0,5854	0,000	0,8910	1,0000
The coefficient of partial optimal evaluation of cost/quality, Q_Z	0,1649	1,0000	0,0305	0,0000
The coefficient of partial optimal evolution of decision-making process, Q_N	*0,9091*	*0,6818*	*0,8182*	*0,9545*
The coefficient of spending time, ΔT	0,0000	1,0000	0,8929	0,6429
The coefficient of partial utility of spending, Q_T	1,0000	0,0000	0,0299	0,1323

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 12* Gorbunov and Kozin, 2007):

$$WQ_i = Q_i / \sum_{n=1}^{N} Q_n, \text{ where} \tag{12}$$

WQ_i – the coefficient of total value
Q_i – the coefficient of partial utility for each indicator
N - Number of strategies (projects)

$\sum_{n=1}^{N} Q_n$ - 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 13*, Gorbunov and Kozin, 2007):

$$F_{total} = WQ_P + WQ_K + WQ_Z + WQ_N + WQ_T, \text{ where} \tag{13}$$

F_{total} – the total assessment of the utility (set of elements which have influence to the decision making)
WQ_P – the total coefficient of partial utility of optimal total amount of budget (total planning sum)

WQ_K – the total coefficient of partial utility of optimal quality
WQ_Z – the total coefficient of partial utility of optimal of cost/quality
WQ_N – the total coefficient of partial utility of optimal of making-decision process
WQ_T – the total coefficient of the time spent on strategic goals and tasks execution[20]

Table 2 The consolidation matrix of utility coefficients[21]

Coefficient of Utility	Strategy nr 1	Strategy nr 2	Strategy nr 3	Strategy 4
	Project 1	Project 2	Project 3	Project 4
WQ_P	0,1442	0,8299	0,0260	0,0000
WQ_K	0,2498	0,2502	0,2500	0,2500
WQ_Z	0,1380	0,8365	0,0255	0,0000
WQ_N	0,2703	0,2027	0,2432	0,2838
WQ_T	0,9710	0,0000	0,0290	0,1285
F_{total}	**1,7731**	**2,1193**	**0,5737**	**0,6623**

In accord with **Table 2** (Take in Table 2), the ***Project nr 2*** has the maximum value of an indicator of utility.

Conclusion

Traditional budgeting has had many critics in recent years with those critics doubting its relevancy in the rapidly and frequently changing business environment. The need to utilize a more flexible form of budgeting to reflect that changing environment is lying on the surface. In this case the author recognizes this need for rapid reaction, implementation and circulation of plans by introducing the Balanced Scorecard linking it with Utility Function principles is an imaginative approach to strategy implementation. This approach might be used not only in Estonia but it is universally relevant to military budget decision-makers around the world. Needless to say, the defence budget management systems differ on an international basis. However, the uniqueness of the Balanced Scorecard lies in its adaptability oneself to new or different conditions. The four perspectives which comprise the BSC (Financial, Customer, Internal, Innovation and learning) might be formed according to the specifics of the country/organization and even a small research group. As well as the utility function via insertion necessary factors or indicators.

The research reviewed in this article suggests that the utility function can be used in the strategic planning process. The main chapters of the research have considered a range of techniques covering the internal environment of military resources management and the evaluation of strategic options in particular. The

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[20] (this criterion is an independent factor and can not be calculated into the WQP, because it is an independent value, which is allocated by a separate position)
21 Source: made by the author

coefficient method as a component of the *Process 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.

In part it depends on the ability of given organizations to conform to, and become legitimated by, environmental institutions. In institutionally elaborated environments, sagacious conformity is required: leadership (in a university, a hospital, or a business) requires an understanding of changing fashions and governmental programs. But this kind of conformity- and the almost guaranteed survival which may accompany it—is possible only in an environment with a highly institutionalized structure. In such a context an organization can be locked into isomorphism, ceremonially reflecting the institutional environment in its structure, functionaries, and procedures (Powell and DiMaggio, 1991).

In our case we deal with a public organization which is most influenced by institutional pressures because outputs are very difficult to evaluate and the flow of resources is more shielded from sudden interruption by collective action problems. And the most obvious solution is to change is to adopt those routines and structures that are defined by law or government agencies as legitimate. To do so may ensure survival by minimizing conflict (*normative isomorphism* by Powell and DiMaggio, 1991).

In addition, this paper presents a successive introduction into a theory of relative importance of criteria. First of all, the expression "one criterion is (relatively) more important than another with a pair of positive parameters" is defined. The corresponding definition has simple logic and is clear not only for researchers but also for those persons who are responsible for a choice and inexperienced in mathematics. The last circumstance is important if we take into account the fact that information on the relative importance is often elicited from these persons. And the better they understand a sense of the relative importance the more exact information they can represent for researchers (Noghin, 2005).

Also our study examines the deployment of the Balanced Scorecard and the performance measurement system that enables executive management to align performance indicators with the goals and strategies of the organization (Lipe and Salterio, 2000). The best solutions are offered just by *the Balanced Scorecard* model and by its functional component Process Perspective (in our case the Management and Control Perspective), which makes military expenditure planning process more effective. This model will allow the Estonian Defence Forces to overcome important barriers to strategy implementation by interrelation of military planning and budgeting processes.

Management control systems are critical levers for strategic change and renewal. Managing the strategy process in ways that are appropriate to the circumstance can

greatly improve the odds that a venture can succeed. The strategic planning process should use initiatives to help the organization achieve its strategic objectives, not as ends in themselves. Opponents of this view will say that public sector and nonprofit organizations are especially guilty of often confusing initiative completion as the target rather than improvements in mission objectives and agency effectiveness.

Moreover, it is possible to implement a feedback by analyzing planned and actual data, as well as variations. In other words, the new Strategic Maps will create suitable conditions for effective solutions of strategic objectives and military tasks, and will optimize processes and military spending as a whole.

The future research might improve and develop methods of using utility function in the decision-making process. This approach will give an opportunity to streamline future calculations of strategic perspective plans and the development of the budgetary policy by taking into account expenses features related to business and non-profit organizations.

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Figures
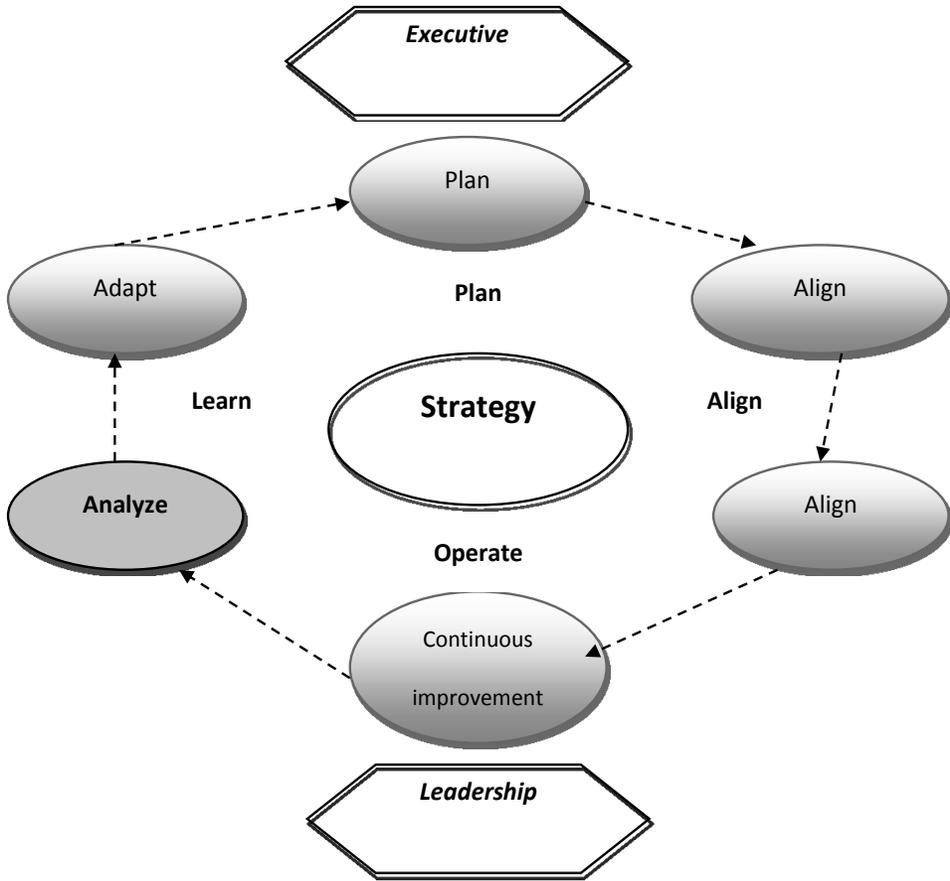
Figure 1. Strategy map (*Source: Kaplan and Norton, 2006*)

The Balanced Scorecard

Management and Control Perspective

Resource (Budgeting) perspective

Customer (Defence Forces) Perspective

Management and Control Perspective

Innovation and Staff Perspective

Process

Controlling

Analysis

Decision – making process

Model building;

Formation and structuring of the source data;

Calculation of Partial utility parameters;

Determination of Total utility indicators;

Determination of Degree of Influence into Total utility indicator.

Criterias

Cost Estimation (budget execution)

Quality Assessment of Executing Processes

Cost Estimation (budget execution) and quality ratio

Decision – making process

Time spent on strategic goals and tasks execution

Figure 2. The Strategic Map of Step-Down Procedure (Management and Control Perspective) (*Source: by author*)

Innovation and Staff Perspective

Rules, Methods, measuring

Change methods

Management and Control Perspective

Analysis, Control and Decision – making process

Does the control department satisfy with the result?

NO

A new approach to creating the budgeting of military expenditure

YES

Figure 3. The Strategic Map of the analytic hierarchy process (*Source: by author*)

Figure nr 4. Planning and control systems alignment (*Source: Kaplan and Norton, 2006*)

Figure 5. The Balanced Scorecard for the Estonian Defence Forces (*Source: by author)*

4. THE BALANCED SCORECARD AND THE NEW IT APPROACH TO THE DEFENCE BUDGETING PROCESS

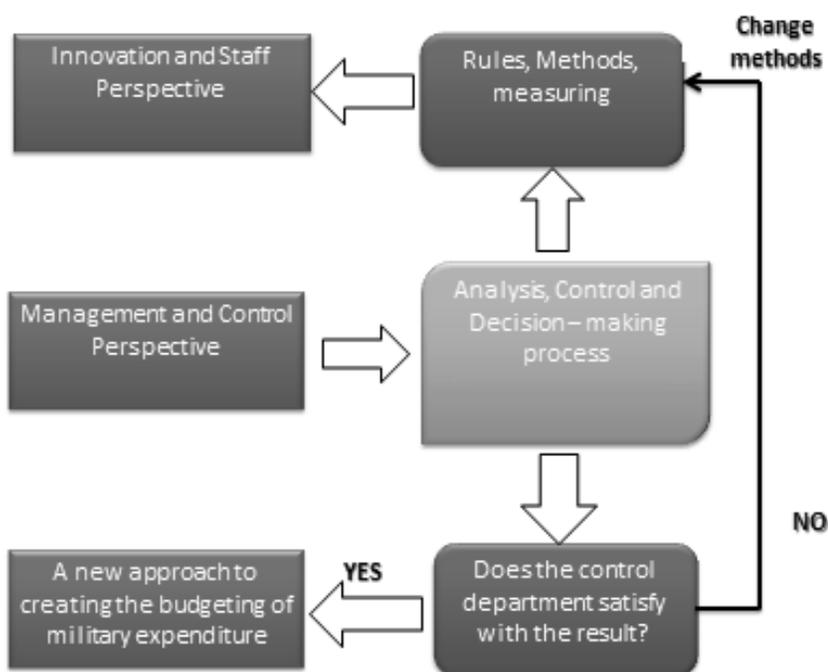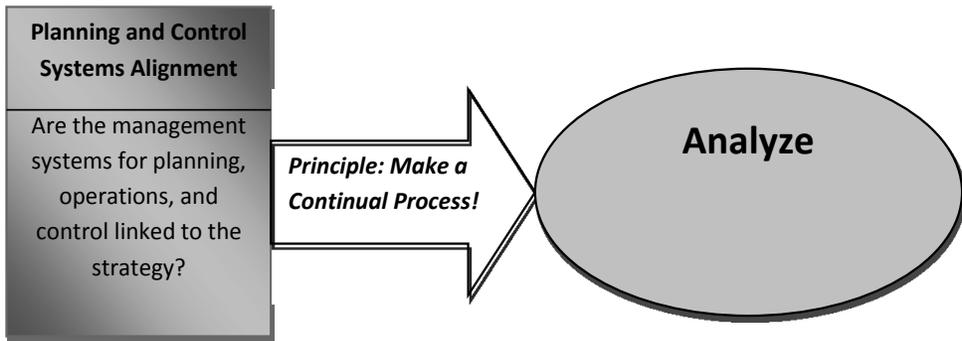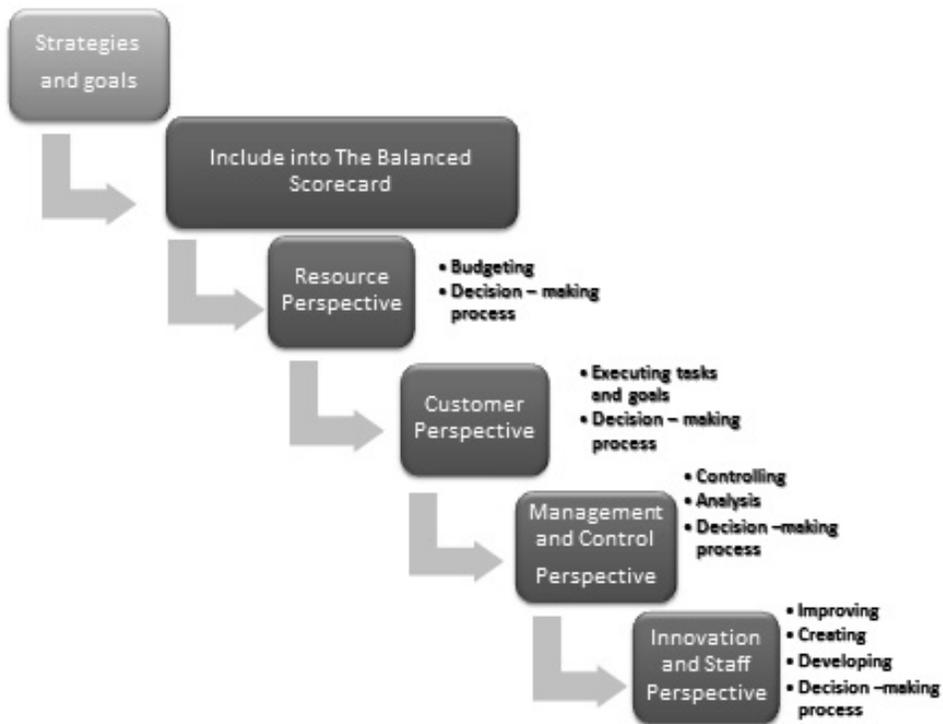**Maritana Sedysheva**

Abstract

The rapid development in the field of measurement methods and techniques that has taken place over recent years offers new opportunities for designers of measurement systems through the use of virtual instruments; for example, balanced scorecards.

This paper tackles two research questions: (1) how does the Balanced Scorecard (BSC) contribute to organizational performance, and (2) does it represent a new method of military resources management by applying a unique e-Budget platform (mathematical model included).

The results showed that the Balanced Scorecard application using the "utility function" will allow the Estonian Defence Forces to overcome important barriers to implementing strategy via the interrelation of military planning and budgeting processes. Moreover, the Balance Scorecard focuses on monitoring some easy-to-measure indicators that provide a traditional view of military spending.

Key words: Balanced Scorecard, e-Budget, Defence Forces, Utility Function, Performance Measurement, IT Technology, Estonia

Introduction

The aim of the paper is to provide an overview of existing research studies concerning the essence of BSC development and to establish some new approaches to the defence budgeting process using the information technology (IT) application "e-Budget platform". The author presents the e-Budget portfolio as the functional part of the e-Budget software by using the "utility function", which in turn might have practical applications in the future.

The "e-Budget" software (application software) is a final product of the proposed approach. e-Budget portofolio- its functional part, the title page-view and its main sections with future modules. e-Budget platform- its information technology (IT) application based on the science approach using the utility function.

When performance measures are added to the financial metrics, the result is not only a broader perspective on the organization's health and activities, it is also a powerful organizing framework. A sophisticated instrument panel can coordinate and fine-tune an organization's operations and businesses so that all activities are aligned with its strategy (Kaplan and Norton, 1996).

The phrase "information technology" inspires a range of interpretations. To some, it simply means computer hardware and software. To others, it is an information capital asset – the information infrastructure, applications and connectivity upon which modern enterprises depend (Gold, 1992).

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 defence forces. A study that addresses military spending would expand extant knowledge about the universe of settings that enforce performance measurement systems; it would also advance our understanding about the design of performance frameworks in government organizations (Carmona and Grönland, 2003).

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

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

All the methods proposed will be established as a single consolidated system of strategic budgeting (or Strategy Map) by reflecting the special features of the strategic management of military resources. The proposed budgeting method through the use of utility assessment will help guide the concept of efficient budgetary spending on defense as well as take into account the usefulness of strategic planning in terms of economic and financial evaluation.

The motivation for our paper is to formally assess the impact of the BSC on organisational performance and, based on the Strategy-Focused Organisation framework, to examine how the BSC enhances organisational performance (Geuser, Mooraj and Oyon, 2011). Case research is particularly appropriate for research within the IT area because researchers in this field often lag behind practitioners in discovering and explaining new methods and techniques (Benbasat et al., 1987). This is certainly true for the BSC and its application to IT. The BSC is becoming a popular technique with its concepts supported and dispersed by consultants. A single case design is appropriate when "the investigator has access to a situation previously inaccessible to scientific observation" (Yin, 1994). Like Benbasat et al. (1987), we believe "that the case research strategy is well-suited to capturing the knowledge of practitioners and developing theories from it" (Van Grembergen et al., 2003).

Analytical framework

Kaplan and Norton (1992, 1993, 1996, 2007) introduced the BSC at the enterprise level. Their fundamental premise is that the evolution of a firm should not be restricted to a traditional financial evaluation, but should be supplemented with measures concerning customer satisfaction, internal processes and the ability to innovate. Results achieved within these additional perspective areas should assure future financial results and drive the organization towards its strategic goals while keeping all four perspectives in balance (Van Grembergen et al., 2003).

Therefore, the BSC Model of the system analysis includes four important perspectives, which can be not only financial but also non-financial:

Financial;
Process;
Learning and Growth;
Customer.

Further, it is necessary to point out that the BSC in the Estonian Defence Forces comprises four perspectives: Resources (Budgeting), Management and Control, Innovation and Staff, and the Customer (Estonian Defence Forces).
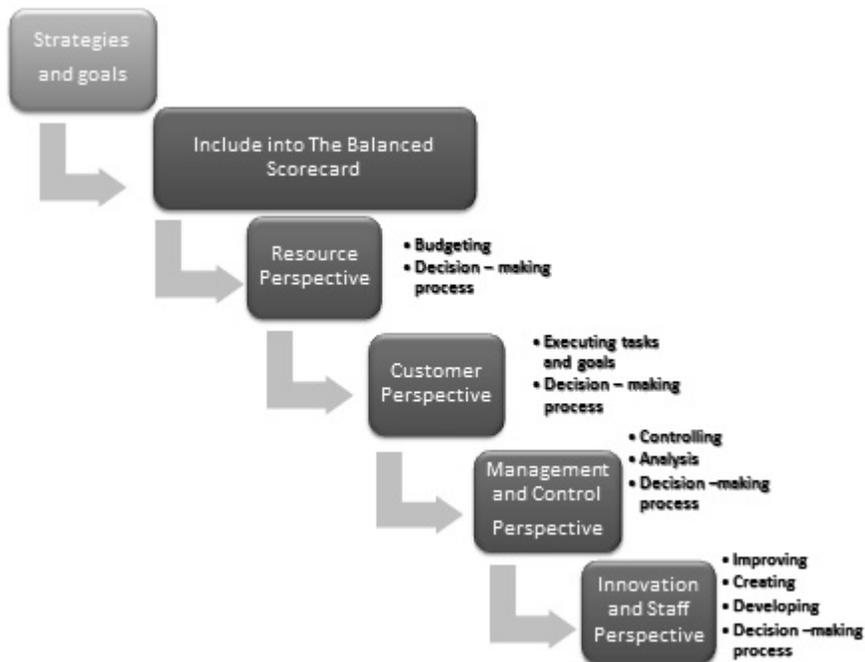

Figure 1. The Balanced Scorecard for the Estonian Defence Forces (*source: compiled by the author)*

Investigations of organizational performance have increased in recent years (Neely, 1999). The idea that "performance measurement matters" has resulted in the proliferation of various frameworks of organizational performance. These include Performance Measurement (Lynch and Cross, 1991), the Results and Determinants Framework (Fitzgerald *et al.,* 1991), Performance Measurement for World Class Manufacturing (Maskell, 1991), the BSC, the Cambridge Performance Measurement Design Process (Neely et al., 1996, 1997), the Reference Model of Integrated Performance Measurement System (Bititci *et al.*, 1998), and the Performance Prism to name a few. At the same time, both public sector and non-profit organizations have experienced increasing demands for more effective decision-making and more efficient management of resources (Brunsson, 1994; Brignall and Modell, 2000). Pressures from constituents have brought about the deployment of market-based control models in nonprofit and government organizations (Kaplan and Norton, 2001), such as health care agencies (Van Peursem, Pratt and Lawrence, 1995) and local governments (Palmer, 1993) (Carmona and Grönland, 2003).

Robinson (2007) suggests budgeting is the financial component of performance management, broadly referring to financial processes designed to "strengthen the linkage between funding and results" using information in the performance management systems". Lu (1998) notes that performance budgeting has evolved from simple input and output measures to measures of efficiency and program effectiveness, but that the success of such systems hinges on the quality of measures (addressed above) and acceptance by decision-makers. Grizzle (1987) also notes that properly constructed incentives for managers and budgeters must be aligned with performance information. Sub-optimal behaviour can result from mismanaging both actions and resources according to separate performance indicators, and sub-optimal behavior may occur at different levels of an organization (Webb and Candrev, 2010).

According to the utility theory, people maximize their utility wherever possible. Utility was originally viewed as a measurable quantity, so that it would be possible to measure the utility of each individual in the society with respect to each good available in the society, and to add these together to yield the total utility of all people with respect to all goods in the society. Society could then aim to maximise the total utility of all people in society, or equivalently the average utility per person. This conception of utility as a measurable quantity that could be aggregated across individuals is called *cardinal utility*.

As Peter Fishburn (1976) has noted, the concept of cardinal utility includes such aspects as psychological, empirical as well as measurement theoretical, which along with such related terminology as "measurable," "additive," "determinate," "intensive," and "linear" utility has given rise to considerable confusion as to its precise meaning. The term "cardinal utility" goes back to John R. Hicks and R. G. D. Allen (1934), who argued that only ordinal preference was needed in economic theory, thereby dispensing with neoclassical utility (Vivian Walsh, 1970) (Schoemaker, 1982).

Various choice problems are studied within the framework of decision-making analysis, where 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).

Theoretical Background and Methods of Utility Function

According to Amos Tverski (1967), there are several advantages in distinguishing cardinal utility measures constructed under certainty, denoted v(x), from those constructed under risk, denoted $u(x)$. Firstly, it emphasizes that there exist different types of cardinal utility, even within each category, which only have to be related monotonically. Secondly, by examining $u(x) = f(v(x))$, an Arrow-Pratt type measure of intrinsic risk aversion may be defined and empirically measured; for example as, $f''(v(x))/f'(v(x))$ (Bell and Raiffa, 1979). Thirdly, the construction of $u(x)$ may be simplified by first examining the nature of $v(x)$, especially in the case of multi-attribute utility (Schoemaker, 1982).

Choice is impossible without the concept of a person who makes this choice in order to achieve his or 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 the 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.

In fact, the mathematical formulation of the problem could be presented in the following way. Further details are elaborated in several sources: Schoemaker, (1982), Noghin (2005), Gal, Stewart, and Hanne, (1999), Belton and Stewart (2002), Intriligator (1975), Gorbunov and Kozin (2007).

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

$f_1, f_2,..., f_m, M \geq 2$ defined on the basis of the set of alternatives *X*. These functions are said to be optimality criteria or goal functions (Noghin, 2005).

The real-valued functions f1, f2,..., f m compose a vector criterion (function No. 1) (Noghin, 2005):

f = (f₁, f₂,… fₘ) (1)

For every alternative, the *m*-dimensional vector (*outcome*) 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).

Pareto Axiom (in terms of alternatives). For any pair of alternatives x', x'' ∈ X we have $f(x') \geq f(x'') \Rightarrow x' \prec_x x''$

Dealing with the *quantitative* information on the relative importance of criteria, we mean that all criteria $f1, f2 ,..., fm$ have numerical values. Therefore, $yi = fi\,(x) \in R$ for every $x \in X$ and all $i = 1,2,...,m$. According to the Edgeworth-Pareto principle, the Pareto set includes all selected vectors or analogue 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 the 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 (Noghin, 2005).

The advantage of performance coefficients is their ability to provide a relative measure of sourcing effectiveness that ties directly to financial effectiveness and can be used for estimations and "what if" scenario planning. If designed and implemented correctly, they are useful for any level of engagement, from simple projects to large tenders in public procurement.

In accordance with the available literature, data and parameter calculations (Schoemaker, 1982; Noghin, 2005; Gal, Stewart, and Hanne, 1999; Belton and Stewart, 2002; Intriligator, 1975; Gorbunov and Kozin, 2007), we decided to use a performance research approach, elaborated from the BSC study. For our research question we adopted the research framework, design and methodology using the decision-making process involved in selecting food suppliers for the Estonian Defence Forces.

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 has the form *(function No. 2)* (Gorbunov and Kozin, 2007):

F = f (P; K; N; Z; F;…n) (2)

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

F = the total assessment of the utility of the element of decision-making
P - potential product price
K - quality of products supplied
N - estimated reliability of the supplier

Z - evaluation of the price/quality ratio of the products
F - financial stability (financial state) of the supplier

The second stage of the research is directed to information gathering and data analysis. The calculation of the abovementioned utility parameters will also be included (*function No. 2*) (Intriligator, 2002).

In the third stage of the research, partial utility parameters will be calculated. The transformation of parameters into partial utility parameters should be carried out using the conversion functions, based on functions representing a mathematical model.

The Strategy Map and The New System Design

Another key step is to develop strategic objectives – the "DNA" of the strategy. The objectives are expressed as continuous improvement actions that can be documented, measured and implemented through initiatives and projects. Once developed, the objectives are linked to form a "strategy map." The strategy map graphically indicates how the organization creates value for customers, stakeholders and employees. The strategy map is constructed by linking strategic objectives using cause and effect relationships. A strategy map is one of the most effective communication tools an organization can use to build transparency, alignment and a focus on results. The figure below shows how objectives are linked in cause-effect relationships to define a strategy story of how value is created for customers and business owners (Balanced Scorecard Institute, www.balancedscorecard.org).

According to Peeter Lorents (2006), before starting with the main activity or process, all the preparatory processes should be monitored, evaluated and analyzed. He underlines that control is an act or a process according to which a situation coincides with the planned tasks. In other words, we should answer another main question: does the system (its developmental stage or current state) correspond with our planned goals and objectives or not (Lorents, 2006).

For this reason, the analysis and proposed methods might develop a system of *Multi-Criteria Decision-Making* (or a Strategy Map) by taking into account the specifics of the strategic management of military resources.
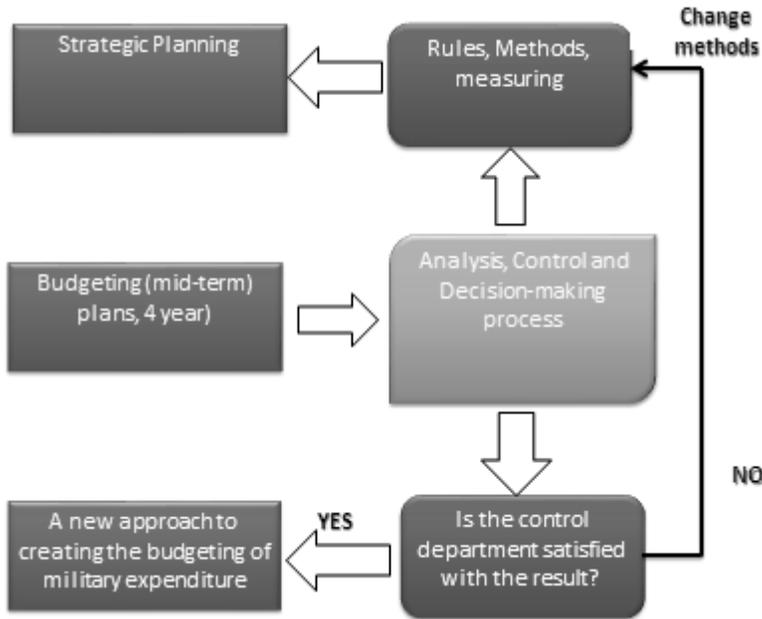
Figure 2. The Strategic Map of the analytic hierarchy process (*source: compiled by the author)*

As seen in Figure 2, the transition from a high-level strategy to budgeting for local operations is presented as a step-down procedure, which covers all main stages of the decision-making performance from BSC formation to criteria selection.

In fact, all state organizations in Estonia are provided with high-quality software, including financial solutions. However, there are no special budgetary programs that in turn create an array of problems connected with the planning, execution and control of public funds. For example, the Ministry of Defence is still using "self-made tables" from EXCEL or ACCESS for budget planning processes.

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. Once the hierarchy is built, the decision maker systematically evaluates its various elements, comparing them to one another in pairs. In making the comparisons, the decision maker 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).

The author is confident that this investigation may be of interest for several reasons. First of all, an e-Budget portfolio, based on a strategic approach, will solve many

problems connected with the planning and control of military resources. Secondly, this module can be developed for use in the private sector in future.

Each of these perspectives has to be translated into corresponding metrics and measures that assess the current situation. These assessments need to be repeated periodically and aligned with pre-established goals and benchmarks. Essential components of the IT BSC are the cause and effect relationships between measures. These relationships are articulated using two key types of measures: outcome measures and performance drivers (Van Grembergen et al., 2003).

The design feature of any interactive control system, which includes different types of measures – the system focus and the planning horizon – depends on such factors as different technologies, the degree of regulation and protection and the complexity of the value chain.

The "Utility Function" and the Balanced Scorecard Model

Multi-Criteria Decision-Making (MCDM) will be used as an example, which will allow us to consider the application of statements and strategic tasks. In other words, a mathematical model (utility function) will be used to select an optimal coefficient, which is posed on top of the system and within the decision-making process, in order to make the process itself more transparent and effective. This approach is particularly useful for forecasting prognoses.

The selection process in food suppliers will be taken as an example, and will be examined on the basis of the second function (see ***function No. 2***) and 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 for strategic planning will present the maximum value of every component and the total sum of the utility assessment. All further tables are formed in accordance with the resulting estimations (Table 1 and Table 3) and will be used in questions of an optimal supplier.

In accordance with <u>non-disclosure agreements,</u> assume that we have six potential suppliers, where the *Total Procurement Cost* is (for example):

- Supplier No. 1 - **178 m €**
- Supplier No. 2 - **179 m €**
- Supplier No. 3 - **165 m €**
- Supplier No. 4 - **167 m €**
- Supplier No. 5 - **174 m €**
- Supplier No. 6 - **172 m €**

Cost (Price) Estimation

Calculating the partial utility of PA – the **parameters of the acquisition costs** of production – is a two-step process. The first stage involves calculating coefficients for the best value supplier **ΔP**, defined by **function No. 3** (Gorbunov and Kozin, 2007):

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

ΔP – the coefficient of optimal price
P – the current value of supplier's price
P min – the minimal value of all proposed prices
P max – the maximum value of all proposed prices

During the second stage, the values for **ΔP** are compared with the estimated coefficients of the partial utility of the other factors. To this end, using transformation function *(3)* for the factor *"Price"* through the values for ΔP compute the coefficient of partial utility **Q_p** *(function No. 4,* (Gorbunov and Kozin, 2007).

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

Q_P – the coefficient of the partial utility of optimal price

ΔP – the coefficient of the optimal price

Table 1 presents the results obtained from the above calculation, and as can be seen the maximum value of the partial utility of optimal price corresponds to Supplier No. 3 – 1,0000.

Assessment of the Quality of Products

To assess quality, subjective numerical values are represented in absolute or relative terms. The coefficients for partial utility concerning quality are assigned by nutrition experts and military personnel. The quality of products was estimated for each component using the following satisfaction scale:

1 – Unsatisfactory
2 – Partly satisfactory
3 – Satisfactory
4 – Average
5 – Above average
6 – Good
7 – Excellent

The coefficient for optimal quality (**ΔK**) is calculated using **function No. 5** (Gorbunov and Kozin, 2007):

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

ΔK – is the coefficient for optimal quality
R_{in} – is the current value
Z – is the total sum of current value
N – is the total value of participants

The parameter for quality (Q_K) is calculated using the conversion formula directed to the factor *"Quality"* and transformed into the partial utility (**function No. 6**, Gorbunov and Kozin, 2007):

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

Q_K – is the coefficient for the partial utility of optimal quality
ΔK – is the coefficient for optimal quality

Table 1 shows that the most appreciated quality represents **Supplier No. 2 – 8,7430.**
Estimates of the reliability of the supplier

In our case we examine estimates of food delivery times based on annual statistics and the prognosis for change fixed in the tender's contracts. The monitoring process is based on proposed data and real food delivery times. The choice of the partial utility will be conducted in accordance with **function No. 7** (Gorbunov and Kozin, 2007).

$$Q_N = N_{pc} / N_p, \text{where} \tag{7}$$

Q_N – is the coefficient for the partial optimal evaluation of delivery times
N_{pc} – is the "real" number for the delivery times
N_p – is the number for the proposed delivery times
The result has shown that the best value for the delivery times belongs to **Supplier No. 1 – 0,9091** (Table 1).

Evaluation of the price and quality of the products

The calculation of the partial utility concerning the correlation between price and quality will be conducted using the results for **Price** and **Quality.** Accordingly, indicators for **Price,** or the coefficients, will be shared with indicators for **Quality,** or the coefficients. Optimizing the choice is based on the coefficient for optimality ΔZ determined by **function No. 8** (Gorbunov and Kozin, 2007):

$\mathit{\Delta Z}$ = (Z - Zmin) / (Zmax - Zmin), where **(8)**

$\mathit{\Delta Z}$ – is the coefficient for the optimal cost/quality ratio
Z – is the current value of cost/quality
Z min – is the minimal value of all proposed values Z max – is the maximal value of all proposed values

The values obtained were comparable to the estimated coefficients for the partial utility of the other factors necessary for calculating the coefficient for partial utility Q_Z using transformation *function No. 9 (Gorbunov and Kozin, 2007)* for the factor of price/quality through the values for $\mathit{\Delta Z}$.

Q_Z = (1-ΔZ) / (1+ΔZ)², where **(9)**

Q_Z – is the coefficient of the partial optimal evaluation of price/quality
ΔZ – is the coefficient for the optimal evaluation of price/quality

To form a table of initial data, it is necessary to use the coefficient of partial useful surface and the actual values for prices.

Table 1 The partial utility coefficient matrix[22]

Coefficient for Utility	Supplier No. 1	Supplier No. 2	Supplier No. 3	Supplier No. 4	Supplier No. 5	Supplier No. 6
Price Provider, $\text{\euro}$	178.0 (mln)	179.0 (mln)	165.0 (mln)	167.0 (mln)	174.0 (mln)	172.0 (mln)
The coefficient of optimal price, $\mathit{\Delta P}$	0.9286	1.0000	0.0000	0.1429	0.6429	0.5000
The coefficient of partial utility of optimal price, Q_P	*0.0192*	*0.0000*	*1.0000*	*0.6563*	*0.1323*	*0.2222*
coefficient of partial utility of optimal quality, Q_K	*8.7186*	*8.7430*	*8.7315*	*8.7308*	*8.7238*	*8.7291*
The coefficient of the delivery times, Q_N	*0.9091*	*0.6818*	*0.8182*	*0.9545*	*0.7345*	*0.8267*
evaluation of price/ quality	*20.4162*	*20.4735*	*18.8972*	*19.1278*	*19.9454*	*19.7042*
coefficient of optimal evaluation of price/ quality, ΔZ	0.9636	1.0000	0.0000	0.1463	0.6650	0.5120

[22] Source: compiled by the author

coefficient of partial optimal evaluation of price/quality, Q_Z	0.0094	0.0000	1.0000	0.6497	0.1208	0.2135

The analysis has revealed that despite the high *quality estimates* for **Supplier No. 2**, and the most appreciated *reliability estimations* established by **Supplier No. 1**, general indicators of the partial utility coefficients belong to **Supplier No. 3.**

Financial stability (the state) of the potential supplier

Calculations of the partial utility of the financial state of the supplier should be based on accounting reports. The number of estimates of financial indicators can be arbitrary; however, they should all give a full picture of the financial state of the company.

In general, they should:
- be informative and provide a holistic picture of the financial stability of the company;
- have the same orientation (growth factors means improving the financial status);
- pay off according to the accounts reporting in the enterprise;
- make it possible to carry out pre-rating acceptance in comparison with other companies for a number of periods;
- include numerical specifications of a satisfactory level or a range of changes for all indicators.

The most objective estimation of the financial state of the company can be achieved using Altman's factorial models (Z-Score) *(Chernov, 2001)*. They are used to measure the financial health and, in particular, the distress status of companies. Moreover, they serve as a powerful diagnostic tool that forecasts the probability of a company entering bankruptcy within a 2 year period.

The Z-Score formula for predicting bankruptcy is a linear combination of five common business ratios (*Equity/Total assets, Retained income/Total assets, Pretax income/Total assets, Market value of equity/Borrowed capital, Total sales (revenue)/Total assets*) weighted using coefficients and profit-and-loss reports (***function No. 10,*** (Gorbunov and Kozin, 2007):

$$F=0,717X1+0,847X2+3,107X3+0,42X4+0,995X5 \qquad (10)$$

Zones of Discrimination *(Chernov, 2001)*:

If **F <1.8,** the company is in the "Distress" Zone (near bankruptcy).

If this value falls in the range *1.8 <F<2.7,* the company is in the "Grey" Zone (the company may become non-creditworthy)

If *F> 2.7,* the company is in the "Safe" Zone (indicating a fairly stable financial position for a business entity).

Evaluations of the financial condition of suppliers on the basis of Altman's criterion are shown in **Table 2** (see Table 2).

Table 2 Financial status of a potential supplier[23]

Indicator	Supplier No. 1	Supplier No. 2	Supplier No. 3	Supplier No. 4	Supplier No. 5	Supplier No. 6
X1 - Equity/Total assets	0.5220	0.5710	0.6090	0.5450	0.6230	0.5430
X2 - Retained income/Total assets	0.0210	0.0240	0.0310	0.0340	0.1340	0.0280
X3 – Pre-tax income/Total assets	0.0290	0.0270	0.0190	0.0340	0.0210	0.0220
X4 - Market value of equity/Borrowed capital	0.9150	0.7500	0.6410	0.6300	0.9200	0.7610
X5 - Total sales (revenue)/ Total assets	0.9790	0.6800	0.8790	0.9780	0.6780	0.8670
F=0,717X1+0,847X2+ +3,107X3+0,42X4+0,995X5	**1.8406**	**1.5052**	**1.6658**	**1.7629**	**1.6864**	**1.6637**

The calculations showed that the highest level of reliability can be found in *Supplier No. 1 – 1,8406.*

In order to obtain an objective total estimation of utility and potential supplier selection, it is necessary to find average values for the separate parameters. And all coefficients of partial utility will lead to one general denominator (*function No. 11*, Gorbunov and Kozin, 2007):

$$WQ_i = Q_i / \sum_{n=1}^{N} Q_n, \text{ where} \tag{11}$$

WQ_i – is the coefficient for the total value
Q_i – is the coefficient of the partial utility for each indicator
N - number of suppliers

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[23] Source: compiled by the author

$$\sum_{n=1}^{N} Q_n - \text{is the total current value}$$

When reduction of all studied criteria for a single analogue of a mathematical model is done, it is necessary to consolidate all obtained results into one general formula (***function No. 12)*** (Gorbunov and Kozin, 2007):

$$F_{total} = WQ_P + WQ_K + WQ_N + WQ_Z + WQ_P, \text{ where} \tag{12}$$

F_{total} – is the total assessment of the utility of a supplier
WQ_P – is the total coefficient of partial utility for optimal price
WQ_K – is the total coefficient of partial utility for optimal quality
WQ_N – is the total coefficient of partial utility for optimal delivery times
WQ_Z – is the total coefficient of partial utility for optimal price/quality
WQ_F – is the total coefficient of the financial state of suppliers

Table 3 The consolidation matrix of utility coefficients[24]

Indicator	Supplier No. 1	Supplier No. 2	Supplier No. 3	Supplier No. 4	Supplier No. 5	Supplier No. 6
Price, WQ_P	0.0095	0.1095	0.4926	0.3233	0.0652	0.1095
Quality, WQ_K	0.1665	0.1667	0.1667	0.1667	0.1666	0.1667
The coefficient of the delivery times, WQ_N	0.1846	0.1679	0.1661	0.1938	0.1491	0.1679
Price/Quality, WQ_Z	0.1722	0.1662	0.1594	0.1613	0.1682	0.1662
Financial status of a potential supplier, WQ_F	0.0047	0.1071	0.5016	0.3259	0.0606	0.1071
F_{total}	**0.5374**	**0.7173**	**1.4865**	**1.1710**	**0.6097**	**0.7173**

Apparently from **Table 3,** ***Supplier No. 3*** has the maximum value for the sum of all indicators of utility.

Creating the e-Budget Cascade

The creation of any program or system demands certain knowledge and skills. The term "system or systems" includes a certain set of elements (i.e. the ordered set of elements according to Lorents, 2006). All elements should be interconnected, and it is crucial that all elements or parts be designated or defined in detail in order to build a truly powerful system.

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[24] Source: compiled by the author

To create an e-Budget module we use the BSC model, which will include additional elements connected with budgeting and planning.

All these modules are connected with each other and all the information is presented consistently. In creating this model the whole process of a military organization was taken as the basis.

Using this new IT approach in the defence budgeting process, and the BSC in particular, will make it possible to focus more clearly on the budgeting system of the Estonian Defence Forces. This is particularly important because it offers an opportunity to establish alternatives for many other conceivable development paths that support flexible system implementation.

First of all, such an approach will solve many problems connected with budgeting and the use of public funds, it will help reduce the time invested in planning and budget analysis and it will improve the control process. And most importantly, the need to draw up various "self-made" tables and reports will disappear.

Secondly, by using this program (module) it is possible to make not only the general budget, but also separate projects or plans that in turn will create an overall picture of the annual budget.
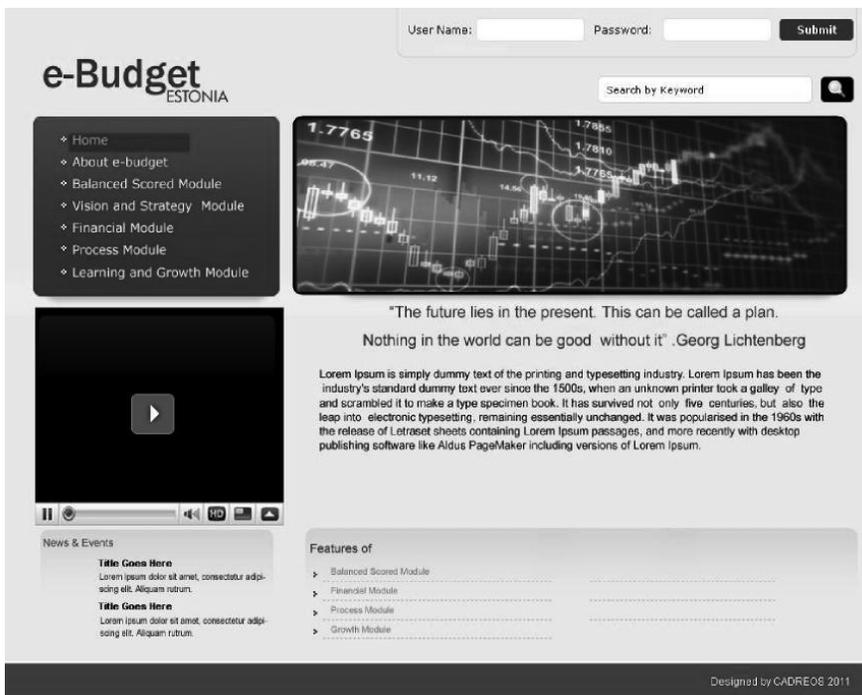

Figure 3. The title page of the future e-Budget software (designed by Cadreos: www.cadreos.com).

Conclusion

Many organizations adopted the initial concepts of BSC to improve their performance measurement system (Kaplan and Norton, 2007). The research reviewed in this article suggests that the utility function can also be used in the strategic planning process. The main chapters here have considered a range of techniques covering the internal environment of military resources management and the evaluation of strategic options in particular. The coefficient method as a component of the process perspective model has proved that budgetary funds can be planned and distributed according to goals and objectives. This technique can be very productive in the redistribution of means if military tasks change.

Our study examines the deployment of the BSC and performance measurement system so executive management can align performance indicators with the goals and strategies of the organization (Lipe and Salterio, 2000). The best solutions are offered by the Balanced Scorecard model and by its functional element Innovation and Staff Perspective which makes the process of planning military expenditure more effective. This model will allow the Estonian Defence Forces to overcome important barriers to strategy implementation through the interrelation of military planning and budgeting processes.

In our case, the BSC IT application will allow the Estonian Defence Forces to overcome important barriers to strategy implementation through the interrelation of military planning and budgeting processes.

Moreover, our main target was to create a special program for strategic management of military defence spending. It is possible to confirm the positive outcomes from our research even now.

In addition, this paper establishes the unique concept of the e-Budget software. However, the case review also illustrates one of the most crucial issues in building and implementing the IT techniques into the BSC: it requires a direct linkage with the military objectives.

Accordingly, we suggest that future research addressed to the Estonian Defence Forces may enhance our understanding of the role of the balanced scorecard in making public sector organizations more effective.

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PART 6. CONCLUSION

6.1. Discussion of the research results

"However beautiful the strategy, you should occasionally look at the results" (Sir Winston Churchill 1874-1965)[25].

A 'beautiful' strategy application does not always lead to a positive result. Without a pragmatic implementation, strategy for the sake of strategy is wasted capital. A 'good' result depends upon the choice of an enlightened pathway and general tasks formulation based on measurable and achievable goals. Particularly when dealing with defence forces, which literally involve life and death decisions, strategy aims and formation of implementable tasks play the key role in success. In this respect, our main target of the research is both totally justified as well as achievable.

New ideas and experiments must be encouraged at all levels. For control systems to facilitate this process, they must have special design attributes (Simons, 1995). The term 'system' includes a certain set of elements (the ordered set of elements according to Lorents, 2006) where all elements are interconnected. It is important to designate and/or define in detail all elements or parts in order to build a truly powerful system.

Investigation of organizational performance has overwhelmingly relied on evidence gathered from private sector firms. Nevertheless, the past several years have witnessed increasing interest in enhancing effectiveness and efficiency in the public sector, in turn generating considerable investment in the deployment of performance metrics in such settings. Though observational evidence provides many perceptive insights into the specifics of performance frameworks in public sector organizations, little is known about the measurement of organizational performance in public organization's work (Carmona and Grönlund, 2003). Our investigation shows the necessity of deploying the Balanced Scorecard into the Defence Forces' management system.

The results show that all four research tasks have a positive impact on military expenditure policy-making processes:

The first research task: *To create a methodology and preconditions of the implementation of the Balanced Scorecard model for the military expenditure planning process by comparing prerequisites with existing models.*

The Balanced Scorecard should encourage business units to link their financial objectives and thus serve as the focal point for the goals and measures for other

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[25] http://www.quotedb.com/quotes/3460

scorecard perspectives. Every measure selected should be part of a link of cause-and-effect relationships that culminate in improved financial performance. The scorecard should tell the story of strategy, starting with the long-term financial objectives, and then link 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-term economic performance (Kaplan and Norton, 1996). In accordance with the described experience and informative sections we have learned how the BSC model might improve the calculation of perspective plans and to make processes for military expenditure planning and control more effective.

Atkinson and Epstein (2000, 27) mention that performance indicators should conform to criteria of measurability and completeness that characterize organizational performance frameworks. The lasting influence of managerialism on 'new' public management (Brignall and Modell, 2000), however, results in a celebration of measurability on the part of government agencies which may instil a bias in performance towards the development of easily measurable concepts (Carmona and Grönlund, 2003).

Our research has shown that the application of BSC, in particular, has a tangible value in order to make choices and define carefully a mission and targeted constituents (Kaplan, 2000). The case study presents the long-term perspectives of the organization's vitality by providing a superior execution of military expenditure based on mathematical modelling. The BSC establishment does not conflict with the main goals of an organization. On the contrary, the BSC can make objectives explicit to units in different stages of a managerial pyramid and reduce the noise of subjective political rhetoric.

According to the results, which were obtained in Studies I, III, and IV, the author establishes the Balanced Scorecard model as a way of making the military expenditure planning process more effective. Moreover, this model will enable the Estonian Defence Forces to overcome important barriers to strategy implementation by interrelation of military planning and budgeting processes.

The second research task: *To analyze an instance of the Utility Function modifications and to provide streamlined calculations of strategic perspectives, plans, and contributions to the development of a budgetary policy.*

One obvious advantage of using the utility function is its multifunctionality. It affects all stages of the management process and allows streamlined calculations of strategic perspective plans by taking into account all existing risks.

In order to test this research task an integral financial economic estimate of military expenditure was created. This approach is based on quantitative compound information on the relative importance of criteria. Moreover, it reflects an interrelation of material, information, and financial flows and allows determination

of a complex integral indicator by taking into consideration the important factors. All four studies show "the realistic assumptions of an obtained model and how it might be used in a process of making the correct predictions" (Bowbrick, 1994). As an example, the selection process of (1) budgetary strategic elements (Study I); (2) the "dry-pack food" suppliers (Study II); (3) the utility-based performance measures towards to strategic planning (Study III) and the optimal suppliers (Study IV) were examined. All these objects of investigation were tested using the main utility functions (see functions. 2, 3, 4) and by using several indicators.

The author has included different components that contain a specific set of attributes and elements. The utility-based performance measures for strategic planning presented the maximum value of every component and the total sum of the utility assessment. All results are presented in accordance with the result estimations (Tables. 1, 2, 3, 4).

Further, a short estimation of how the utility function modifications provide an opportunity to streamline calculations of strategic perspective plans (*initial data - in the following Studies I- IV)* and make the information available to stakeholders. <u>Study I:</u> It is necessary to find average values of separate parameters in order to obtain an objective total estimation of utility concerning the selection of an optimal financial plan. When all study criteria are reduced into a single analogue of a mathematical model, it is necessary to consolidate all obtained results into one general formula (***function nr 7,*** Gorbunov and Kozin, 2007):

$$\mathbf{F_{total}= WQ_P+WQ_K +WQ_Z+WQ_T,} \text{ where} \qquad (7)$$

a) $\mathbf{F_{total}}$ – the total assessment of the utility (set of elements which have influence on the decision-making)
b) $\mathbf{WQ_P}$ – the total coefficient of partial utility of optimal total amount of budget (total planning sum)
c) $\mathbf{WQ_K}$ – the total coefficient of partial utility of optimal quality
d) $\mathbf{WQ_Z}$ – the total coefficient of partial utility of optimal of cost/quality
e) $\mathbf{WQ_T}$ – the total coefficient of the time spent on strategic goals and tasks execution.

Table 1. The consolidation matrix of utility coefficients (optimal financial plan)

Coefficient of Utility	*Strategy nr 1*	*Strategy nr 2*	*Strategy nr 3*
	Budget 1	**Budget 2**	**Budget 3**
WQ_P	0.7784	0.0000	0.2216
WQ_K	0.3330	0.3337	0.3333

WQ$_Z$	0.7789	0.0000	0.2211
WQ$_T$	0.9710	0.0000	0.0290
F$_{total}$	**2.8614**	**0.3337**	**0.8049**

In accordance with Table 1, Budget 1 has the maximum value of an indicator of utility.

Study II: It is necessary to find average values of separate parameters in order to obtain an objective total estimation of utility and the potential "dry-pack food" supplier. When all study criteria are reduced into a single analogue of a mathematical model, it is necessary to consolidate all results into a single general formula (**function nr 8,** Gorbunov and Kozin, 2007):

$$F_{total}= WQ_P+WQ_K +WQ_N+WQ_Z+WQ_F, \text{ where} \tag{8}$$

a) F_{total} – the total assessment of the utility of a supplier
b) WQ_P – the total coefficient of partial utility of optimal price
c) WQ_K – the total coefficient of partial utility of optimal quality
d) WQ_N – the total coefficient of energy values
e) WQ_Z – the total coefficient of partial utility of optimal of price/quality
f) WQ_F – the total coefficient of the financial state of suppliers

Table 2. The consolidation matrix of utility coefficients (optimal "dry-pack food" supplier)

Coefficient of Utility	*Company nr 1*	*Company nr 2*	*Company nr 3*
WQ$_P$	0.3297	0.3346	0.3356
WQ$_K$	0.3333	0.3333	0.3333
WQ$_N$	0.3380	0.3232	0.3388
WQ$_Z$	0.3297	0.3346	0.3356
WQ$_Z$	0.1976	0.3553	0.4471
F$_{total}$	**1.528**	**1.681**	**1.790**

It can be seen from Table 2 that Company nr 3 has the maximum value of an indicator of utility.

Study III: It is necessary to find average values of separate parameters in order to obtain an objective total estimate of utility concerning the selection of an optimal strategic plan. When all study criteria are reduced into a single analogue of a mathematical model, it is necessary to consolidate all obtained results into one general formula (**function nr 9**, Gorbunov and Kozin, 2007):

$$\mathbf{F_{total}} = \mathbf{WQ_P} + \mathbf{WQ_K} + \mathbf{WQ_Z} + \mathbf{WQ_N} + \mathbf{WQ_T}, \text{ where} \qquad (9)$$

a) F_{total} – the total assessment of the utility (set of elements which have influence to the decision-making)
b) WQ_P – the total coefficient of partial utility of optimal total amount of budget (total planning sum)
c) WQ_K – the total coefficient of partial utility of optimal quality
d) WQ_Z – the total coefficient of partial utility of optimal of cost/quality
e) WQ_N – the total coefficient of partial utility of optimal of making-decision process
f) WQ_T – the total coefficient of the time spent on strategic goals and tasks execution

Table 3. The consolidation matrix of utility coefficients (optimal strategic plan)

Coefficient of Utility	Strategy nr 1	Strategy nr 2	Strategy nr 3	Strategy 4
	Project 1	Project 2	Project 3	Project 4
WQ_P	0.1442	0.8299	0.0260	0.0000
WQ_k	0.2498	0.2502	0.2500	0.2500
WQ_Z	0.1380	0.8365	0.0255	0.0000
WQ_N	0.2703	0.2027	0.2432	0.2838
WQ_T	0.9710	0.0000	0.0290	0.1285
$\mathbf{F_{total}}$	**1.7731**	**2.1193**	**0.5737**	**0.6623**

In accordance with Table 3, Project 2 has the maximum value of an indicator of utility.

Study IV: It is necessary to find average values of separate parameters in order to obtain an objective total estimate of utility and optimal supplier including delivery terms. When all study criteria are reduced into a single analogue of a mathematical model, it is necessary to consolidate all obtained results into one general formula (*function nr 10*, Gorbunov and Kozin, 2007):

$$\mathbf{F_{total}} = \mathbf{WQ_P} + \mathbf{WQ_K} + \mathbf{WQ_N} + \mathbf{WQ_Z} + \mathbf{WQ_F}, \text{ where} \qquad (10)$$

a) $\mathbf{F_{total}}$ – the total assessment of the utility of a supplier
b) $\mathbf{WQ_P}$ – the total coefficient of partial utility for optimal price
c) $\mathbf{WQ_K}$ – the total coefficient of partial utility for optimal quality
d) $\mathbf{WQ_N}$ – the total coefficient of partial utility for optimal delivery times
e) $\mathbf{WQ_Z}$ – the total coefficient of partial utility for optimal price/quality
f) $\mathbf{WQ_F}$ – the total coefficient of the financial state of suppliers

Table 4. The consolidation matrix of utility coefficients (optimal supplier)

Coefficient of Utility	Supplier nr 1	Supplier nr 2	Supplier nr 3	Supplier nr 4	Supplier nr 5	Supplier nr 6
WQ_P	0.0095	0.1095	0.4926	0.3233	0.0652	0.1095
WQ_K	0.1665	0.1667	0.1667	0.1667	0.1666	0.1667
WQ_N	0.1846	0.1679	0.1661	0.1938	0.1491	0.1679
WQ_Z	0.1722	0.1662	0.1594	0.1613	0.1682	0.1662
WQ_F	0.0047	0.1071	0.5016	0.3259	0.0606	0.1071
F_{total}	**0.5374**	**0.7173**	**1.4865**	**1.1710**	**0.6097**	**0.7173**

It can be seen from Table 4 that Supplier nr 3 has the maximum value of the sum of all indicators of utility.

In summary, the utility function modifications could literally be used in any field of economics and might significantly improve the quality of the final result.

The third research task: *To create the e-Budget platform and Strategy Maps by developing the appropriate conditions for effective solutions of strategic objectives and military tasks, in order to optimize the military spending process as a whole.*

The Strategy Maps and the e-Budget's platform play a practical role in the process of strategic management. They both create a 'fertile field' for budgeting, which is the cornerstone of the management control process in nearly all organizations, but despite its widespread use, it is far from perfect.

The strategy map illustrates the cause-and-effect relationships that link desired outcomes in the customer and financial perspectives to outstanding performance in critical internal processes-operations management, customer management, innovation, and regulatory and social processes. These critical processes create and deliver the organization's value proposition to targeted customers and also promote the organization's productivity objectives in the financial perspective. Further, the strategy map identifies the specific capabilities in the organization's intangible assets – human capital, information capital, and organization capital – that are required for delivering exceptional performance in the critical internal processes (Kaplan and Norton, 2004).

Thus, the perspective Balanced Scorecard for the Estonian Defence Forces comprises four elements: Resources (Budgeting), Management and Control, Innovation and Staff, and Customer (Estonian Defence Forces). The strategy map (see Figure 2)

provides a visual representation of the strategy and management control system. It provides a great view of how objectives in these four perspectives integrate and combine into the mathematical model. Theoretically, all of these processes must be performed at an outstanding level, and be 'in harmony' with each other in order to achieve the organization's main strategy (Kaplan and Norton, 2004).

The case study is particularly appropriate in the area of IT implementation because researchers in this field often lag behind practitioners in discovering and explaining new methods and techniques (Benbasat et al., 1987). This approach certainly favours further application for the BSC. Nowadays the BSC is becoming a popular technique with its concepts supported and disseminated by consultants. It is necessary to mention that using a software product will potentially allow everyone in the organization to clearly understand the cause-and-effect relationships of the decision-making process as well as the measurable outcomes. Accountability is a key in determining effective policy. This requires that the organization will align to the strategy and monitor results via continuous real-time feedback mechanisms which are available to all levels of the managerial pyramid. The e-Budget's platform is a technology application of a Balanced Scorecard model, presented in an easy-to-use, web-based solution with widespread access. Using this new IT approach to the defence budgeting process and the Balanced Scorecard, in particular, will enable a clearer focus on the budgeting system. This approach provides an opportunity to establish alternative ways for many other conceivable development paths that support a flexible system implementation.

The fourth research task*: To investigate the role of the decision-making process, as a component of the Process Perspective, in accordance with the goals and visions of an organization.*

As defined at www.businessdictionary.com, management is "*the organization and coordination of the activities of an enterprise in accordance with certain policies and in achievement of defined objectives*".[26]

Thus, a rational decision-making process is a cognitive process which is made up of a logical step-by-step process. In this process the emphasis is on thinking things through and also on weighing the outcomes and alternatives before arriving at a final decision.

This dissertation introduces a strategic management system based on the BSC model by including concepts of a multiple-criteria analysis and on the basis of the Edgeworth-Pareto principle. "This principle allows the managerial staff to exclude from the set of all alternatives those ones that are explicitly ineligible. The remaining alternatives form a Pareto set. Nowadays this problem is a major one within a framework of multi-criteria decision analysis." (Noghin, 2005).

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[26] http://www.businessdictionary.com/definition/management.html

Depending on the type and volume of the additional information, numerous approaches have been developed where almost all of the approaches are heuristic. The main information is quantitative information on the relative importance of criteria. That is why many of the proposed approaches (e.g., the Analytic Hierarchy Process) are based on the weights, which in a definite sense reflect the relative importance of criteria. However, these weights are not well-defined. They are usually assigned by experts (Noghin, 2005).

To avoid problems it is necessary to define a concept of the relative importance of criteria. This definition must be absolutely clear not only for researchers but also for ordinary people; otherwise, the Decision-Maker will not be able to assign 'true' parameters of the relative importance in order to express his/her preferences most exactly (Noghin, 2005).

In the last decade, performance measurement has emerged as the most important public sector reform of many years, surpassing even management by objectives, total quality management, zero-based budgeting, and program planning and budgeting in the speed and breadth of its adoption (Gilmour and Lewis, 2006). Performance measurement is closely related to the idea of performance budgeting, or performance-based budgeting, which seeks to link the findings of performance measurement to budget allocations (Joyce, 1999). Both performance measurement and performance budgeting are part of a worldwide effort to transform public management (Kettl, 2000). These reforms are intended to transform public budgeting systems from the control of inputs to a focus on outputs or outcomes in the interest of improving operational efficiency and promoting results-oriented accountability. These experiences have significant relevance for public sector reforms in countries which lag behind these advanced reforms (Aristovnik and Seljak, 2009).

Identifying strategy and, moreover, communicating strategic initiatives are both necessary as well as mandated by agent motivation. "Strategic initiatives enter the resource allocation process from two sources – deliberate and emergent. In circumstances of sustaining innovation and certain low-end disruptions, the competitive landscape is clear enough that strategy can be deliberately conceived and implemented. Rather than executing a strategy, managers in this circumstance need to implement a process through which a viable strategy can emerge" (Clarton and Raynor, 2003).

To summarize, our research focusses on three executive leverage points of the strategic management system established for the Estonian Defence Forces.

The first point encompasses the management of a budget structure − results gained from the presented system must be prioritized. The second point provides discovery-driven planning – a disciplined process that accelerates learning on what will and won't work. Last but not least, the third point is to vigilantly ensure that

emergent strategy processes are being followed in the appropriate circumstances for each component in the public organization. This is a challenge that few executives have mastered, and it is one of the most important contributors to innovative ideas in organizations.

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SUMMARY IN ESTONIAN

Kaitsekulude kavandamise ja kasutamise alused riigikaitse alase tegevuse ning arengu juhtimisprotsessis (Eesti kaitseväe näitel)

Töö aktuaalsus

Üha laienev globaliseerumine, tehnoloogia ning tootmise arengu kiire tempo, lisaks inimeste ressursimahukad vajadused ja samas ressursside puudujäägid, viivad vältimatult mitmete konfliktideni rahvusvahelisel tasandil. See asjaolu tekitab turvalisuse säilitamise ja arendamise ning vastavate kulutustega seonduvaid probleeme praktiliselt igas riigis.

„Eesti kaitseplaneerimise senist arengut on iseloomustanud ideaalsete lahenduste otsingud, mis suudaks anda vastused kõikidele sõjalise riigikaitse valdkonnas kerkinud ja kerkivatele küsimustele. Samal ajal on selge, et piiratud ressursside ja muutuvate julgeolekuriskide taustal on pigem vaja korrastatud protsessi, mis suudab pakkuda ühekordsete lahenduste asemel ajaga kaasas käivaid ning ette vaatavaid ning vajaduse korral paindlikult muudetavaid lahenduskäike Eesti sõjalises riigikaitses – „evolutsioon revolutsiooni asemel““[27].

Kaitseväe vajadused tulenevad organisatsiooni iseloomust ja püstitatud ülesannetest. Puudu on aga kaitsekulude optimeerimise süsteemi mudel ja selle rakendamist toetav tarkvara, mille abil oleks võimalik tagada riigikaitseks eraldatavate ressursside sihipärast planeerimist, kasutamist ja kontrolli. Tulemusliku juhtimissüsteemi arendamine on väga oluline kaitseväe strateegiliste eesmärkide saavutamiseks.

Doktoritöö eesmärk

Eeltoodust tulenevalt on doktoritöö eesmärgiks välja töötada riigikaitseks eraldatavate ressursside strateegilise juhtimise ja optimeerimise süsteemi ning uurida selle rakendatavust Eesti kaitseväe näitel.

Uurimisobjekt

Käesoleva doktoritöö uurimisobjektiks on riigi kaitsekulude planeerimise ning eelarvestamise meetodid.

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[27] Sõjalise kaitse arengukava 2009-2018. http://www.mod.gov.ee/?op=body&id=538

Töö uudsus

Töö uudsus seisneb selles, et kaitseväe ressursside juhtimiseks on välja töötatud uudne strateegilise juhtimise süsteem ja katsetatud seda Eesti kaitseväe näitel. Süsteemi mudel tugineb tasakaalus tulemuskaardi (TTK) ja kasulikkuse (efektiivsuse) funktsiooni (KF) integreeritud kasutamisel. Pakutud strateegilise juhtimise mudelisse on integreeritud Edgeworth'i-Pareto printsiip.

Töö uurimisülesanded

Lähtudes töö eesmärgist püstitas autor alljärgnevad uurimisülesanded:

1. Kasutades TTK printsiipe töötada välja riigikaitseks eraldatavate ressursside strateegiline juhtimise mudel.
2. Analüüsida KF integreerimise võimalusi TTK mudelisse.
3. Luua uus infotehnoloogiline (IT) platvorm, mis realiseeriks kahes eelmises punktis nimetatud mudelitel tugineva riigikaitseks eraldatavate ressursside strateegilise juhtimise ja optimeerimise süsteemi.
4. Uurida strateegilise juhtimise süsteemi abil otsustamise protsessi põhiprintsiipe, mille kohaselt toimub riigi kaitsekulude planeerimine ning eelarveliste vahendite juhtimine.

Töö uurimismetoodika

Töö põhisisuks on eelkõige riigi kaitsekulude planeerimise ning eelarveliste vahendite juhtimise süsteemi analüüs ja optimaalse tasakaalu leidmine võimaluste, vajaduste ning ressursside vahel. Selleks kasutas autor dokumentide analüüsi ja modelleerimise meetodeid alljärgnevalt:

1. Seaduste ja teiste riigi kaitsekulude planeerimist ning eelarvestamist reguleerivate õigusaktide ning alusdokumentide analüüs;
2. Riigi kaitsekulude planeerimise ning eelarvestamise protsesside analüüs;
3. Eesti riigi kaitsekulude planeerimise ning eelarveliste vahendite juhtimise praktikate analüüs;
4. Riigi kaitsekulude planeerimise ning eelarveliste vahendite juhtimise süsteemi kontseptsiooni väljatöötamine;
5. Eesti Kaitseväe jaoks sobiva mudeli kujundamine;
6. Mudeli mõõdetavate kriitiliste edufaktorite ja sobivate mõõdikute valimine ning mõõtmisstandardite püstitamine;
7. Mudeli testimine ja kvantitatiivse analüüsi teostamine Eesti Kaitseväe näitel;
8. Riigi kaitsekulude planeerimise ning eelarveliste vahendite juhtimise IT platvormi projekteerimine.

Mudeli kvantitatiivne analüüs sisaldas järgmisi tegevusi:

1. Eelarvestamise protsessi analüüs;
2. Kuivtoidupaki tarnijate optimaalse valikuprotsessi analüüs;
3. Strateegiliste põhieesmärkide ja ülesannete planeerimise analüüs;
4. „e-Budget" platvormi loomine ja optimaalse tarnija valiku riigihanke protsessi analüüs.

Lisaks analüüsiti otsustamisprotsessi mõjureid eesmärgiga saavutada maksimaalselt efektiivne tulemus. Analüüs koosnes järgmistest etappidest:

1. Tuleviku strateegiatest lähtuvate eesmärkide ja probleemide määratlemine;
2. Vajalike komponentide ja mõõtmismehhanismide valik;
3. KF peakriteeriumite väärtuste leidmine;
4. KF osaliste kriteeriumite väärtuste leidmine;
5. Keskmise kasulikkuse koefitsientide väärtuste leidmine;
6. Tulemuste maatriksi koostamine ja otsuste vastuvõtmine.

Töö ülesehitus

Töö koosneb kuuest (6) peatükist:

1. Esimeses peatükis analüüsitakse TTK põhiprintsiipe ja rakendatavust avalike organisatsioonide juhtimisel.
2. Teine peatükk keskendub KF teooriale ja kasutamise seaduspärasustele. Erilist tähelepanu on pööratud kardinaalse kasulikkuse funktsiooni (*cardinal utility function*) uurimisele.
3. Kolmandas peatükis on analüüsitud riigi kaitsekulude planeerimise ning eelarveliste vahendite juhtimise erinevaid etappe. Tulemusena on koostatud „Strateegiline kaart", mille alusel on välja töötatud IT-portfoolio „e-Budget".
4. Neljandas peatükis on esitatud IT-portfoolio "e-Budget'i" kontseptsioon.
5. Viiendas peatükis on esitatud doktoritöö aluseks olevad avaldatud artiklid. Artiklid käsitlevad pakutud riigi kaitsekulude planeerimise ning eelarveliste vahendite juhtimise mudeli kontseptsiooni ja selle rakendamise praktilisi tulemusi Eesti kaitseväe näitel.
6. Kokkuvõtvas kuuendas peatükis on esitatud töö uurimistulemused ja järeldused.

Töö tulemused ja järeldused

Doktoritöös püstitatud uurimisküsimuste lahendamiseks läbi viidud analüüside ja uuringute tulemused ja järeldused on avaldatud neljas rahvusvahelise eelretsenseeritava teadusajakirja artiklis ning ette kandud kolmel rahvusvahelisel konverentsil.

Töö peamiseks teoreetiliseks tulemuseks ressursside strateegilise juhtimise mudel, mis tugineb tasakaalus tulemuskaardi (TTK) ja kasulikkuse (efektiivsuse) funktsiooni (KF) integreeritud kasutamisel:

1. Pakutud uus ressursside strateegilise juhtimise mudeli raamistik TTK edasiarendamiseks;
2. Loodud uued ressursside juhtimisprotsessi mõõtmismehhanismid, kontseptsioon ja meetodid strateegilise juhtimise mudeli väljatöötamiseks;
3. Loodud ressursside optimeerimise meetmed Pareto-efektiivsuse printsiibi ning KF funktsiooni kasutamise baasil;
4. Väljatöötatud uued otsustusprotsessi (*Decision-making Process*) printsiibid, mis tuginevad KF funktsiooni kasutamisel.

Töö peamine praktiline tulemus on see, et kaitseväe ressursside strateegiliseks juhtimiseks on välja töötatud juhtimissüsteem, mis tugineb töö teoreetilises osas välja töötatud uudsel mudelil. Süsteemi rakendatavust on katsetatud Eesti kaitseväe näitel ja see tagab riigi ressursside efektiivse juhtimise:

1. On rakendatud uued meetmed Eesti kaitseväe eelarvestamisprotsessi tõhustamiseks, ühendades järjest rohkem eelarvestamise poliitikat ja organisatsiooni eesmärke ning optimeerida kaitseväe kulutuste planeerimise protsessi.
2. On toodud välja strateegilise otsustusprotsessi tegurid ja etapid ning loodud sobivad mõõtmisstandardid ja rakendatud need kaitseväe ressursside juhtimissüsteemi loomiseks;
3. On loodud strateegilise juhtimissüsteemi mudelit realiseeriv platvorm "e-Budget";

Pakutud ressursside strateegilise juhtimise mudel hõlmab praktilisi meetmeid ja funktsioone ressursside optimeerimiseks ja sellest tulenevalt võib leida rakendatamist avalikus sektoris laiemalt, tagades riigi ressursside efektiivsema juhtimise.

CURRICULUM VITAE

Personal Information

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Education

2010 - now	**Estonian Business School** (EBS), Estonia, PhD studies
2006 - 2008	**Euroacademy**, Estonia, MBA
2000 - 2004	**Estonian-American Business Academy** (EABA), Estonia, Bachelor Degree in Business Administration

Work Experience

2009 – now (part-time)	**Euroacademy**, Teaching Assistant
2001 – now (full-time)	**Estonian Defence Forces**:
	2010 – now: Logistics Centre Advisor;
	2007-2009: Head of planning and administration Department;
	2005 – 2007: Financial Advisor;
	2004-2005: Accountant
	2001-2003: Secretary
1995 – 2000	**National Resource Centre Ltd**.: Secretary

Professional training and Conferences

2012, (17.-19. June)	19th International Product Development Management Conference, U.K. (Manchester), presentation: „The Balanced Scorecard and the New IT Approach to the Military Procurement Management", [Accepted].
2011, (21.-23. September)	ACCOUNTING AND AUDIT CONVERGENCE 2011 CONVENTION, Romania (Cluj-Napoco),

	presentation:" Building High Performance Strategy of Military Expenditures: the Utility Function in the middle of Defence Budgeting**".
2011, (07.-09. September)	6TH CONFERENCE ON PERFORMANCE MEASUREMENT AND MANAGEMENT CONTROL, France (Nice), presentation: "Strategic Management System and methods of Controlling as Key Elements of Military Expenditure Policy-Making Process"
2011, (01.-04. June)	EURAM 2011 Conference, Tallinn 1 - 4 June 2011, Estonia, presentation: `"The Utility Function" As One Optimization Tools of The Military Procurement`;
2011, (18.-22. May)	6th IMTA Alumni Conference, Russia (Moscow);
2011, (20. -22. April)	European Accounting Association, 34th Annual Congress Association, Italy (Rome);
2010, (October – December)	Public Economics, Tallinn University of Technology, Estonia (Tallinn);
2010, (28. June-02. July)	EDEN Doctoral Seminar on Doctoral Dissertation Writing, EIASM, Lithuania (Vilnius);
2010, (06.-18.June)	IMTA 2010, Finance track (International Management Teaching Academy), CEEMAN, Slovenia (Bled);
2010, spring	Project Management, Estonia, Edunet OÜ
2006-2009	Annual Conferences on Accounting, Estonia, Raamatupija.ee OÜ
2005, autumn	Workshop of "Overview on the Public Procurement Rules", Ireland (Dublin), Addenda OÜ
2005, spring	Seminar on Accounting and Management in Public Sector, Estonia, Addenda OÜ

Languages

> Estonian – Fluent
> Russian – Fluent
> English – Working knowledge
> Polish – Fluent
> French - Elementary proficiency

List of Publications

Sedysheva, M. 2011. Building High Performance Strategy of Military Expenditures: the Utility Function in the middle of Defence Budgeting. *The Annals of the University of Petrosani, Economics,* Volume 11, Issue 4, [Accepted].

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