The article analyses structure and trends of information technology investments, where expenses for information systems (IS) are dominant. Various methods of IS evaluation, which cover full system acquisition process, are taken into account. Critical assessment of IS public procurement process is presented and generalised evaluation criteria are proposed.

**Keywords:** investments, evaluation, information systems, public procurement.

**Introduction**

The world has entered a new stage of social evolution – an information society, which is characterised by knowledge based economy. Information and knowledge become essential strategic resources; they are treated as a source of strategic benefits, as means to win in the competitive struggle. Today’s information technologies (IT) enable creating of efficient infrastructure for information processing and dissemination. Such infrastructure ensures stable rise of economy and trade, management of political and social problems in a real time and global scope. Information systems (IS) are engaged in the solution not only traditional tasks, such as data management, processing, presentation and decision support, they enable to rise competitive ability and help to implement ideas of permanent learning. An essential factor of the twenty first century is time. Persons, organisations and states that are late will suffer defeat in the competitive struggle and fall on evil days.


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IT and IS create basis for productivity growth and greatly contribute to economic prosperity. Nevertheless, the last reports of European Commission (COM, 2006) show that competitive situation in EU is not good enough. Companies heavily assimilate IT. Contribution of IT into productivity growth decreased notably in EU countries at given time compared to the last decade of the twentieth century. This index comprises approximately a half of corresponding indicator in the USA.

European Commission emphasises significance of IT to EU economy permanently and pays great attention to the development of European information infrastructure. The programs eEurope-2002 and eEurope-2005 are the results of those endeavours. One of the main tasks of the aforementioned programs is expanding of e-business and modern public services over Internet. To ensure further expansion of Lisbon strategy (Lisbon Agenda, 2004), political initiative of European Commission i2010 is formulated in (COM, 2005). The initiative i2010 emphasises importance of IT to achieve all intended prioritised goals and points necessity to create common European information space. Few very important proposals are presented in the Aho Group Report (2006) prepared for European Commission: Europe must support universal pervasive technologies, stimulate expansion of innovative and creative markets, European citizens must have benefits from convergence, simplified possibilities to access various information resources and increased possibilities to create and disseminate their own content. Renewed Lisbon strategy emphasises role of public services striving for competitive goals and growth. All tasks defined by i2010 initiative are hot and must be met with a will. Politicians must know more about necessity to stimulate expansion of IT and ought to create policy that strengthens positive trends in the given field.

IS are one of the main elements of the expansion of IT. They stimulate formation of educated society and e-government. IS require considerable investments into hardware, software, installation, management and training of staff and users. IS comprise a tangible part of organisations assets. Such assets must be responsibly planned, advisedly procured, efficiently used and properly managed. One of important management elements is evaluation. IS evaluation is complicated problem that has not universal and final solution at the given time. Absence of objective and universal IS evaluation methodology carries in elements of subjectivity into evaluation process and does not ensure procurement of the best possible IS.

Subject of the paper: management of investments into IT and IS.

The pending problems: assurance of efficient use of IT investments; search for universal and objective criteria for IS procurement evaluation.

The goals of this paper: evaluation of dynamics and trends of the investments into IT in Lithuania; formulation of generalised IS evaluation criteria and proposals for refinement of IS public procurement process.

Methods applied: systematic, comparative and logical analysis of available literature and statistical data.

Investments into Information Technologies in Lithuania

Statistical data of the last decade showed noticeable worldwide trend – investments into IT were falling down. Situation has
changed in recent time and investments begin to rise. Unfortunately, Europe invests as usually less than USA into IT. USA invested two times more than EU in the new millennium. USA and China employed investments and their benefits more efficiently. New phenomenon is China that became the greatest exporter of the products of IT. China outran Japan and EU in 2003 and USA in 2004 (OECD, 2004).

Situation of use of IT in Lithuania is not good. Computers were used only in 91.1% of manufacturing enterprises and in 84.6% of service companies in 2005. 92.9% of companies possess computers, but they are used mostly for banking operations, accounting, web pages, many of which are seldom updated and keep obsolete information. Computers are used more efficiently in the middle (from 50 to 250 employees) and large (more than 500 employees) companies. State investments into the processes of the development of information and knowledge society permanently grow, but they are still insufficient (Fig. 1).

A typical today’s global tendency is exceeding of computer software procurement against hardware procurement. It can be easily explained: the most important procurement result is the possibility to get process and disseminate information. More important are not technological means, but content residing in them. Timely access to actual information enables usage of worldwide information sources and ensures competitive advantage.

European Commission directs public procurement to be the main element of the strategy of the development of IT infrastructure and amendment of public services. The role of e-public procurement is emphasised now. Extent of public procurement of IT in Lithuania in the first
half of 2006 achieved 9% of total number of all contracts (4% in 2004), and it corresponds to 3% of total contract costs. The newest data on public procurement of IT in Lithuania are presented in Fig. 2, which shows stable increase of number of IT contracts. Software segment in IT constantly occupies approximately 70% from IT costs.

Rising of number and volume of IT public procurement operations boosts problems of improving this process and its evaluation criteria.

European Commission suggests using of public procurement and its standard procedures to stimulate demand of innovative goods and to raise culture of innovations. Market of innovative IT products and services is the expected result. Changes in the software industry, when subscribed services replace direct software sales, stimulate e-business and e-services.

**Related Works on IS Evaluation**

Evaluation of IS has become a separate research branch since the last decade of the twentieth century. It has been stimulated by rapid growth of number, influence and cost of IS in use. IS evaluation should help to carry necessary decisions and approve or deny initial hopes.

Complex IS is a sophisticated system, and it can be evaluated using different approaches and methodologies. The main problem is to define what is to be evaluated, how to evaluate, and when to evaluate. Cost-benefit analysis is among the most popular (Willcocks, 1996; Renkema and Berghout, 1999). Many authors (Farbey et al., 1999; Irani and Love, 2001) emphasize better managing of investment resources and enhancing systems performance. All those evaluation trends express economic and managerial points of view. Limitations of a given standpoint are revealed by “productivity paradox”. Such paradox is a phenomenon, when successful IS may sometimes poses negative economic return (Brynjolfsson and Hitt, 1996). J. Nandakumar (1996) showed that successful IS projects are necessary, but not sufficient for creation of business value. It shows necessity to use wider viewpoint of IS evaluation, including less tangible features as increased functionality, product quality, enhanced competitive ability, user satisfaction. S. Smithson and R. Hirschheim (1998) propose a general three-stage framework to capture the most significant aspects of the system. M. Nijland (2003) tries to improve standard evaluation methods and focuses on the critical perspective.

Some authors (Kannelis et al., 1998; Wilkin et al., 2001) tend to the idea of IS stakeholders’ evaluation, thus emphasising interpretive approach. Interpretive standpoint recognises IS to be more social system than technical. Success or failure of IS is determined not by technical aspects but by people problems (Avgerou, 1995; Nijland, 2003). Interpretive evaluation employs the concepts of evaluation content, context in which the evaluation takes place and the process by which an evaluation is performed. It broadens the scope of conventional evaluation methods. Critical theory (Lyytinen, 1992) expands interpretive approach including accounting and economic calculations. Critical accounting has many social aspects. The fundamental idea – there is no independent economic reality, but accounting is creating that reality (Power, Laughlin, 1992). The social and political properties of evaluation are difficult to include in the evaluation method, but they appear in the
process of applying the evaluation method.

Many problems of IS evaluation are caused by different treating of the concept information system. IS can be defined technically as a set of interrelated components that collect, retrieve, process, store and distribute data to support decision making, co-ordination, control, analysis, and visualisation in an organisation (Laudon and Laudon, 2001). Components of IS are hardware, software, data and people. Restricting evaluation on separate group of components, we cannot get whole picture of the system. Modern IS evaluation models include assessment of all components, their relationships and links. For instance, W. H. DeLone and E. R. McLeans (2003) success model emphasises three success factors: business quality, user satisfaction and IS work quality. Nevertheless, the model retains an element of subjectivity – different stakeholders may validly come to different conclusions about success of the same IS.

In the most cases we deal with evaluations of the systems to be developed and already implemented IS. Status of the system imposes strong differences into evaluation approach. Early evaluation of IS confirms or denies decision on the system development or acquisition. Evaluation of implemented IS shows its actual benefits and drawbacks, assesses degree of the initial decisions realisation.

Early evaluation of IS actually assesses decision to procure IS. Decision may be rational or political, or may include features of both types. Rational decisions use systematic and accurate data, decisions are logically based on the value maximisation upon given constraints (Walsham, 1993). Decisions become uncertain when there are no enough data to validate them. Such situation is quite possible at early stage. Moreover, rational decisions do not assess qualitative aspects, risk and social factors. Contrarily, political decisions are useful in the situations with limited information and time for decision making (Patton, 2002). They provide greater flexibility and facilitate decision-making. Political decisions do not use mathematical methods; they are based on bargaining among interests. It is difficult to treat political decisions as well founded, but they are inevitable in the situations when rational evaluation is impossible. Combinations of both described decisions types are most widely used.

Evaluation of implemented IS can be rational because all necessary quantitative data should be available. Evaluation can be expanded including social and organisational qualitative features (Fitzgerald, 1998). Nevertheless, existing diversity of evaluation goals and evaluators views does not allow to have unique standardised IS evaluation method. Conclusion of T. Dahlberg and J. Jarvinen (1997), that no approach yet provides a solution that is detailed enough in either a scientific or practical sense, remains valid until today. B. Farbey et al. (1999), F. Bannister and D. Remenyi (2000) noticed that IS evaluation tools, techniques and methodologies developed during the last two decades have little practical use. A. Brown (2005) marks two main factors that tend to work against their adoption:

- Heavy demand on staff resources and the requirement for special skills;
- Unresolved problems of change management if organisation is not capable to apply evaluation techniques.

It means that evaluation approach must be selected individually depending on actual IS, evaluation tasks and problem
domain. We advocate a composite evaluation model based on balanced entirety of criteria of difference types. Our model is intended to link the main strengths of different approaches. To simplify evaluation tasks, we propose to decompose IS acquisition process into separate stages and to evaluate them sequentially.

**IS Acquisition Process**

IS procurement is a part of a wider IS acquisition process. Only analysis of entire acquisition process can help us to clear up real objectives and goals of IS procurement. We see IS acquisition process as a set of the following stages:

- Analysis of the organisation goals and needs, and ability of their realisation using IS;
- Decisions on necessary acquisitions and formulation of business requirements for desirable IS;
- Development of the IS requirements specification for IS procurement;
- Planning and execution of the procurement, choosing of the best tender;
- Installation of purchases and subsequent IS operation;
- Evaluation of the procurement results.

Timely evaluation of the results of each stage lets control and improve the entire acquisition process and supplies additional data for final IS procurement evaluation.

Goals of the organisation are reflected in its strategic plans and are expressed in generalised manner. IS can stimulate achieving of such goals as increasing of profit, saving of material, financial and human resources, increasing of efficiency and productivity, improving of organisation management, operating conditions and competitive ability. Goals should have priorities, because immediate realization of all of them is seldom possible.

Decision on IS acquisition should be always based on organisation goals and results of the analysis of its needs. Sometimes decisions are politically grounded or caused by emerged situation. Feasibility study usually precedes formulation of business requirements for desirable IS. An evaluator of a given stage should ascertain on adequacy of decisions, results of analysis and economic substantiation.

A requirement specification is the main document that describes IS. It defines required technical parameters and sets limits of possible price. Requirement specification reflects business requirements in technical terms. Evaluation of the stage must approve or deny this. If the evaluator finds IS requirement specification does not fully conform to the organisation and business needs, it should be possible to use feedback and propose to correct the specification.

Procurement process includes few steps: preparing of bid documents, organising of bids, choosing of the best tender, setting-up and fulfilment of contract. When procurement is performed following the Law of the Republic of Lithuania on Public Procurement (2002), which is obligatory for state and local authorities or other legal persons, various additional bureaucratic constraints appear. Evaluation of the stage must assess quality of bid documents and conformance of them and of overall process to the Law on Public Procurement. The selected and procured IS must satisfy the requirement specification and be the best among available choices. Procurement process is the most responsible stage of the acquisition
process because of absence of a feedback in this stage. Evaluation cannot improve results of this stage.

It is impossible to evaluate procured IS immediately because all features of the system emerge only after some time of its operation. To evaluate operation stage, you must assess users and staff readiness and response, the system operation and its maintenance. There are very limited possibilities of a feedback in a given stage. You cannot change IS, but you can improve its maintenance or additionally train the users.

The final evaluation of the procurement will show, in what degree the procured IS conforms to the organisation needs and in what extent it stimulates realisation of stated primary goals, what are anticipated and unexpected social and organisational changes, what real benefits were obtained. At the same way, the evaluation can show what may be better accomplished in each acquisition stage.

Summarised evaluation tasks and viewpoints of separate IS acquisition stages are presented in Table 1 to emphasise diversity of viewpoints during IS procurement evaluation.

### IS Evaluation Process

Any evaluation is limited by goals, scope and resources. Evaluation, which claims to be universal, would probably require too much time, financial and human resources, and special research. Such IS evaluation can be treated as IS audit. There is no standard methodology of entire IS audit, only audit of IS hardware and software is described in detail (Weber, 1999). The objective of a given paper is to present practical IS evaluation method that is relatively simple and corresponds to economic, managerial, technical and social viewpoints.

We see any evaluation process consisting of several steps:
- determination of evaluation goals and tasks;
- defining of evaluation criteria;
- gathering of necessary information about the object;
- estimation of criteria values;
- comparison of criteria values with a standard;
- formulation of conclusions.

Evaluation goals determine the whole evaluation process. O. Vasilecas et al.

<table>
<thead>
<tr>
<th>Acquisition stage</th>
<th>Evaluation tasks</th>
<th>Viewpoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis of organisation needs</td>
<td>To make assurance on objectivity of needs and stated priorities</td>
<td>Social, economic</td>
</tr>
<tr>
<td>Formulation of business requirements</td>
<td>To define the level of fullness and sufficiency of business requirements and adequacy of them to organisation needs</td>
<td>Managerial, economic</td>
</tr>
<tr>
<td>Definition of technical requirements</td>
<td>To define the level of fullness of technical requirements and adequacy of them to business goals and financial possibilities of the organisation</td>
<td>Technical, economic</td>
</tr>
<tr>
<td>Procurement process</td>
<td>To assess quality of bidding documents, to define the level of adequacy of requirements and purchases; to make assurance on the best choice</td>
<td>Economic, technical, bureaucratic</td>
</tr>
<tr>
<td>IS implementation and operation</td>
<td>To assess outcomes and efficiency of purchases, and possibilities to enlarge it</td>
<td>Social, technical</td>
</tr>
<tr>
<td>Final evaluation</td>
<td>To assess social, organisational and managerial outcomes, economic efficiency of procured IS and the level of its adequacy to initial hopes.</td>
<td>Social, economic</td>
</tr>
</tbody>
</table>
(2006) showed that IS procurement goals can be used as the goals of final IS evaluation. The idea can be generalised: goals of separate step and its evaluation goals should be identical.

### Table 2

<table>
<thead>
<tr>
<th>Viewpoint</th>
<th>Generalised criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic</td>
<td>Cost, economic efficiency</td>
</tr>
<tr>
<td>Managerial</td>
<td>Increasing of management efficiency</td>
</tr>
<tr>
<td>Technical</td>
<td>Technical data of hardware and software</td>
</tr>
<tr>
<td>Social</td>
<td>Users satisfaction, organisational consequences</td>
</tr>
<tr>
<td>Bureaucratic</td>
<td>Formal adequacy to standards and laws</td>
</tr>
</tbody>
</table>

Evaluation criteria are related with evaluation goals. We support multi-perspective viewpoint of IS evaluation that leads to miscellaneous evaluation criteria. Table 2 presents data on generalised criteria depending on a viewpoint. Number of actual criteria can vary because it depends on evaluation scope.

Methodologies of assessment of distinct criteria corresponding to different viewpoints are known, they have been reviewed in the Related Works section. Some criteria are hard, other – soft defined. Few problems arise here:

- generalising of criteria sets,
- deriving of objective results from subjective criteria values,
- linkage of different viewpoints.

Conclusions of IS procurement evaluation should show an extent in which primary IS goals are achieved, what are positive and negative unexpected outcomes, what and how better results may be obtained. Evaluation of IS becomes critical when few systems are available for procurement. A trivial solution – to choose the system that has higher evaluation values is seldom applicable, because the first system may have better one group of evaluations whilst the second – the other.

To compare systems with different characteristics, a universal system quality function can be used. Quality of IS, which is evaluated using various generalised criteria of different importance that are located in separate groups, can be assessed using formula

\[
Q = \sum_{j=1}^{n} w_j \sum_{i=1}^{k_j} s_{ji} w_{ji},
\]

where \( w_j \) – weight of the group \( j \); \( s_{ji} \) – value of the \( i \)-th criterion in the group \( j \); \( w_{ji} \) – weight of the \( i \)-th criterion in the group \( j \); \( n \) – number of criteria groups; \( k_j \) – number of evaluated criteria in the group \( j \).

Formula (1) was used in the Standard Bidding Documents of the World Bank (2003) to assess different technical characteristics. We see possibility to expand quality scope including criteria of quite different types. System quality grows if any criterion value is increased. Such result is valid when all criteria are independent. Actually, many criteria are interrelated and improving of one of them may cause reducing of another. For instance, increasing of technical characteristics may cause system complexity and its maintenance problems, increasing of managerial efficiency may cause labour intensification and users’ dissatisfaction. The most conflicting criterion is cost. Cost is related with the most quality criteria, increasing of them usually leads to cost boost and decrease of the rest economic indicators. We treat IS economic requirements as specific system constraints, and the main of them is cost:
\[ C \leq C_{\text{max}}, \]  

(2)

where \( C \) – actual system cost, \( C_{\text{max}} \) – the highest acceptable cost.

To evaluate criteria of different types, we suggest using of a four-grade scale, which enables to assess qualitative and quantitative features of different metrics, with the following values:

0 – does no satisfy requirements;
1 – not full satisfy requirements;
2 – satisfy requirements;
3 – slightly exceed requirements;
4 – distinctly exceed requirements.

When few systems are compared, additional constraints to criteria values are usually applied

\[ s_j > 0 \]  

(3)

The best system has the highest value of a quality (1). The problem of calculating of an extreme value of the function \( Q \) with constraints (2) and (3) formally looks as a problem of non-linear mathematical programming. Nevertheless, we cannot apply such method because of unknown analytical relationships between evaluation criteria and digital criteria values. Number of possible IS choices is always limited, and quality function of each can be calculated.

IS procurement process can follow few ways. Public procurement process in Lithuania is obligatory for state and local authorities or other legal persons and follows the requirements of the Law on Public Procurement (2002). The Law imposes hard bureaucratic constraints on the procurement process. We see few negative features of such constraints:

- reduced number of possible choices,
- low price is emphasised against high quality,
- bidding process lacks flexibility,
- loss of time.

Following the Law, the process of IS public procurement occupies more than three months (56 days from invitation to tender till opening of tenders, tentative results are announced after 10-14 days, rank is notified during 10 days, appeals are examined 3 days, etc.). Such situation is very inconvenient for purchaser. Life cycle of hardware is short, and purchaser must pay more than market price already at the moment of contract signing. Overpay becomes even bigger when hardware is delivered (additional 2-3 months). Such situation should be improved. Principle of the lowest cost must be replaced by more efficient principle of price-quality ratio. It allows to procure more efficient IS of higher quality.

Procurement process that follows The World Bank Standard Bidding Documents (2003) is characterised by softer bureaucratic constraints. Price and technical merits are rated alike during IS evaluation.

Free trade should ensure the highest flexibility of IS procurement process. The process can use informal procedures, flexible constraint and requirement system. It is one of examples of competitive advantages of private institutions against public. Evaluating IS, the highest quality criteria should be applied. It enables selecting the system of the highest technological level.

Conclusions

Analysis of information technology investments in Lithuania showed their substantial growth during the last years. Ne-
vertheless, analogical rise of productivity and competitive ability is not observed. It forces solution of important problem – assurance of efficient use of given investments.

IS are complex sophisticated systems, including information technologies as one of their components. Acquisition of IS requires to use considerable part of budget funds assigned for information technologies. As the result, successful employment of IS can ensure efficient information technologies investment. Evaluation of IS procurement must show extent, in which investment goals are achieved. Evaluation becomes one of the main tools of investment management.

Analysis of different IS evaluation approaches and methodologies shows possibility to apply them to the evaluation of IS procurement. Evaluation approach must be selected individually depending on actual IS, evaluation tasks and problem domain. A composite evaluation model based on balanced entirety of criteria of different types, including economic, technical, social and managerial, is proposed. The model links the main strengths of different approaches. To simplify evaluation tasks, decomposition of full IS acquisition process and individual evaluation of its separate stages are proposed.

To evaluate IS objectively, quality function, which enables to use quantitative and qualitative criteria of different types with necessary accuracy, is proposed. Each criterion is supplied with weight reflecting importance of a given criterion. Quality function is totally dependent on the IS requirements, but there are no strictly defined methods for setting unique relationship between the requirements and parameters of the function. Uncertainties of setting of some parameters include the element of subjectivity into IS quality evaluation. It shows necessity of additional research in the given field.

Procurement process that follows the Law on Public Procurement of the Republic of Lithuania supports price minimisation, whereas World Bank process supports balanced criteria optimisation. Any public procurement process imposes bureaucratic constraints that hardly restrain procurement operations, waste time and limit possibilities to select the best choice. To increase efficiency of the public procurement in Lithuania, principle of the lowest cost must be replaced by more efficient principle of price-quality ratio. It should allow to procure more efficient IS of higher quality.

Free procurement process, which can be employed by private enterprises, has many advantages. The process can use informal procedures to ensure necessary flexibility, and evaluation methodology can be freely adjusted to the real situation.

References


INFORMACINIŲ SISTEMŲ PIRKIMO ĮVERTINIMO VADYBINIAI ASPEKTAI

S a n t r a u k a


Informacinių technologijų investicijų analizė Lietuvoje rodo esminių jų apimties augimą per pastaruosius metus, tačiau atitinka produktyvumo ir konkurencingumo augimo nepastebimą. Iškyla poreikis išspręsti svarbių uždavinių – užtikrinti minėtų investicijų efektyvų panaudojimą.

IS yra sudėtingos sistemos, kurių vienas komponentas yra informacinių technologijų. IS įsigijimui panaudojama žymi informacinių technologijų biudžeto dalis. Tik sėkmingas įsigytos IS naudojimas gali užtikrinti informacinių technologijų investicijų efektyvumą. Įvertinimas yra vienas iš pagrindinių investicijų panaudojimo užtikrinimų.

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Олегас ВАСИЛЕЦАС, Альгис САУЛИС, Наримантас – Казимерас ПАЛЮЛИС, Римгаудас-Станисловас ВАЙЧЮЛИС

АСПЕКТЫ УПРАВЛЕНИЯ В ОЦЕНКЕ ЗАКУПОК ИНФОРМАЦИОННЫХ СИСТЕМ

Резюме

В статье представлен анализ тенденций изменения структуры и объема инвестиций в информационные технологии, где доля информационных систем (ИС) является доминирующей. Рассмотрены различные методы оценки ИС с учетом всего процесса приобретения системы. Представлена оценка процесса публичных закупок ИС, предложены обобщенные критерии оценки.

Ключевые слова: инвестиции, оценка, информационные системы, публичные закупки.