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Methods and techniques for evaluating effectiveness of information technology implementation into business processes

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ABSTRACT

The article studies the methods of evaluating the effectiveness of the information technology implementation into an enterprise's business processes. The criteria of the effectiveness of IT solutions implementation are researched. The main characteristics and peculiarities of existing methods for evaluating the effectiveness of IT implementation are analyzed to determine the optimal one. A comprehensive methodology for evaluating the effectiveness of IT implementation is proposed. This methodology allows to accurately evaluate the effectiveness of business process implementation; to identify problems with help of the business process automation; to identify issues to be solved; to evaluate the expected results, and to justify the optimal strategy for management basing on IT solutions.

Keywords: business process, automation, information technology, effectiveness of IT implementation, methods of effectiveness evaluation, complex methods for evaluating the effectiveness of information technology implementation

1. INTRODUCTION

In today's competitive environment, it is impossible to do business without the introduction of information technology (IT). IT ensures the integration and communication of an enterprise with the external environment; allows to increase the speed and quality of services provided by an enterprise, and allows to consider all the needs of each client. IT implementation into an enterprise's management process can boost its competitiveness, can help an enterprise to capture and hold a large share of the market. Thus, informatization of business today is the most promising tool in the entrepreneurship development^{7,8}. Evaluation of automation level of processes in an enterprise enables a manager to forecast labor productivity, labor demand, possible profit increase and other indicators. It should be noted that the complexity of IT implementation depends on the size of an enterprise. The only correct approach to informatize an enterprise is the one, which uses modern methods for evaluating the effectiveness of IT solution implementation. Therefore, automation of business management and evaluating the effectiveness of IT solutions are becoming important for entrepreneurs.

The main stages and peculiarities of the introduction of IT to an enterprise are highlighted in the writings of such Ukrainian scholars as M. Armstrong¹, M. Voynarenko², I. Goncharuk³, V. Guzhva⁴, V. Zakharchenko⁵, S. Zelinsky⁶, M. Orlikovsky⁹, V. Ponomarenko¹⁰, O.Savenkov¹¹ and others. In the writings of these scholars, much attention is paid to the theoretical and applied aspects of the application of automated IT for successful management. At the same time, the problems of business process management and evaluating the effectiveness of the information technology implementation are insufficiently described and require further research.

The purpose of the article is to conduct an analytical review of the characteristics and features of existing criteria and methods for evaluating the effectiveness of IT implementation. These methods are meant to help a manager to choose optimal methodology that will allow him or her to develop an effective strategy for an enterprise. Methods of analysis and various IT based methods of evaluating the effectiveness are used in the article.

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2. RESULTS AND DISCUSSION

It should be noted that the modern enterprise is a complex dynamic system having a layered structure, which implements various production and management functions. In this regard, business executives begin to understand the importance and the need for an integrated approach to the automation of information processes in enterprises. A practical experience in automation of enterprises proves that the efficiency of automation, first of all, depends on how widely it covers units of an enterprise and business processes. The level and depth of automation depend on the budget of an enterprise and its IT strategy, which is a comprehensive plan for the development of the information infrastructure of an enterprise. IT strategy defines a set of actions for the development, maintenance and use of information resources, the principles of a common information environment between units of an enterprise⁴.

As is known, the performance management of an enterprise is a special kind of management that ensures effective operating of all business processes and describes the methodology, measurement, processes, methods, techniques, systems and software that are used for diagnosis (evaluation), analysis, control and the efficiency growth of activities of enterprises¹.

Ensuring the efficiency of management of business processes is one of the main tasks of any enterprise. In modern conditions, the implementation of this target is complicated due to the influence of many external and internal factors that hamper the growth of revenues and increase the expenses of an enterprise.

It is, therefore, necessary to use reliable methods and tools to counter these adverse factors. Taking into account the importance of efficiency in any enterprise, there is a need for clarification, systematization, and formulation of the main principles and methods of performance management of an enterprise.

The basis for its implementation should be an effective control system of IT implementation.

The purpose of introducing IT is to reduce the complexity of the processes, which use information resources and to increase their reliability and efficiency through the development of components of information security based on mathematical modeling discussed in¹².

The effectiveness of IT implementation is a degree to which objectives are achieved with help of the implemented IT system. The results of evaluation of IT implementation effectiveness should always be analyzed and then used to boost an enterprise's profit^{3,9}.

IT introduction can have direct, indirect and cumulative effects on an enterprise, and can have an effect on any part of it through economic, technical, social and other impacts^{2, 5}. Therefore, it is important to determine the effectiveness of an enterprise before implementing IT system in order to compare how well it worked out. It is better to take into account what kinds of impact IT implementation are influenced by in order to ensure the completeness and reliability of provided data further. After the data are obtained, they need to be compared with the industry average, with market leaders' indicators or desirable indicators. The current information system of an enterprise is evaluated too⁶.

The need for evaluation of automation processes in an enterprise depends on if there is a possibility to improve conditions and raise labor productivity, to make product quality better, to reduce work force requirements or any other possibility to keep old and gain new markets. The level and methods of automation depend on technical equipment of job places, gZand seriation of products^{6, 10, 11}.

Business development can only be achieved with the effective management of an enterprise. Today, information and results of its processing play a main role in management of an enterprise. In modern conditions of significant growth of information volume, processing of information can only be done with computer hardware and software products, and the creation of a unified information environment of an enterprise².

That is why the role of the organization, automation and computerization of managers' and professionals' labor is rising. In addition, the automation of IT processes requires a high level of knowledge and profound skills. Implementation of management functions requires a radical change of most of management techniques and technical means of information processing (personal computers).

The massive amount of data makes enterprises decentralize their functions, and this decentralization leads to distributed data processing, which requires personal computers to be used. In practice, this is achieved by the creation of automated workplaces (AWP), which take into account the specificity of labor and the specialization of the expert. Creating automated workplaces for specialists increases their performance, provides an opportunity to apply new management

methods, enables them to use a unified reliable information in the management of all units, and, hence, to increase productivity. An employee with an automated workplace tends to have professional knowledge in a specific area and to be computer literate. Automated workplaces are an important component of an enterprise's information system. Today, the fastest and cheapest way to organize an automated workplace in an enterprise is to connect automated workplaces into a local network and make employees work in a common information environment².

It is important that the effectiveness of AWP's comply with the cost of their construction and operation. The creation of automated workplaces in an enterprise is a good indicator of the high level of automation of an enterprise^{1, 3, 10}. The most effective way to reduce labor costs is to introduce IT into business processes. The level of Informatization of an enterprise can be evaluated according to the following (1), (2), (3) formulas⁹.

The ratio of AWP's to the number of employees in the company (*S*) (1):

$$S = \left(\sum_{i=1}^n p_i \right) / n, \quad (1)$$

where $p_i = (k_i/b_i) \cdot 100\%$, $i = 1, \dots, n$ is the number of units in an enterprise, k_i is the number of APW's in the i -th unit and b_i is the number of employees in the i -th unit.

The indicator describes the technical and professional readiness of units for the development of CALS-ERP technologies.

The ratio of AWP's connected to the local network of an enterprise (LNE) to the total number of AWP's in units (*L*) (2):

$$L = \left(\sum_{i=1}^n m_i \right) / n, \quad (2)$$

where $m_i = (k_i/g_i) \cdot 100\%$, g_i is the number of AWP's in the i -th unit connected to LNE.

The indicator reflects the readiness level to create a unified information environment in an enterprise.

The ratio of the number of automated structural units to the total number of units (*K*) (3):

$$K = (TPK/TP) \cdot 100\%, \quad (3)$$

where TPK is the number of computer-assisted units, TP is the total number of units.

The indicator shows the possibility of implementing end-to-end computer technology for certain types of work.

Thus, the calculation of the above-mentioned indicators will determine the level of automation, which is the basis for the effective carrying out of key business processes in an enterprise. Therefore, the progressive application of computer technology and information technology allows to increase productivity in various activities; to release staff from routine, to improve the quality and reliability of information. Along with this, the introduction of automation in business processes promotes the growth of competitiveness and increases the prestige of any company. A common information space and a high-quality database of the company allows to access necessary information quickly, and then a specialized software allows management to solve any functional problems.

So, effective information-analytical management of all units can be achieved with the help of automation and by the creation of a common interconnected system of information and tools for solving problems. The effect of the introduction of informatization is considered good when it improves the quality and effectiveness of management, boosts an enterprise's competitiveness and maximizes its profits.

Variety of methods and techniques¹⁰⁻¹⁹ are used to evaluate the impact of IT implementation^{2, 4, 10, 12}. Before a manager chooses the methods of evaluation of IT introduction, it is necessary to determine the criteria of evaluation. The most common criteria for evaluating the effectiveness of innovation and IT introduction are functional, resource criteria, time-saving criteria and the ratio of the costs of implementation to the estimated value of its results^{3, 6-9}. Each of them is described below.

Functional criteria are to characterize the degree of how the embedded technology helped to achieve the desired indicators of the information, namely:

- space-time characteristics of the implemented information process (data transfer speed, amount of memory to store information, etc.);
- characteristics of the reliability of the information process implemented (the probability of correct transmission or the probability of conversion of information, etc.);
- the parameters characterizing the degree of achievement of the desired result of information process, implemented with the help of this technology (the correctness of speech or image quality graphics information and others)^{3, 8}.

Resource criteria, which characterize the quantity and quality of different types of resources required for the implementation of the information technology. Resource criteria make it possible to compare different types of technologies. Besides, they provide an opportunity to evaluate the effect from the point of view of their social utility in terms of saving resources such as:

- material resources (instrumental and technological equipment that is required to successfully implement this technology);
- energy resources (the energy cost of the implementation of the information technology);
- human resources (number and level of staff training required to implement this technology);
- time resources (the amount of time required to implement the information process);
- information resources (data and knowledge required for the successful implementation of the information process)^{7, 9}.
- time-saving criteria are used for the comparative quantitative evaluation of time savings due to the implementation of information technology in comparison with the use of manual labor⁹.

The ratio of the costs of implementation to the estimated value of its results is needed to be analyzed when an enterprise is implementing data processing technology. Meeting the needs of users is considered as the main objective of IT implementation.

If the costs and results of the introduction are measured in the same units, then the effectiveness of the implementation (E) can be determined by the formula (4):

$$E = W - Z, \quad (4)$$

where W is the result from the use of IT and Z is the total cost for implementing IT.

Thus the total cost Z can be expressed as (5):

$$Z = Z_r + Z_e + Z_m, \quad (5)$$

where Z_r is the cost of development, debugging and implementation of the technology, the acquisition of additional equipment, staff training, etc.; Z_e is the operating costs associated with the chosen technology and Z_m are the costs associated with the modification and adaptation of data processing technology.

The study of evaluation of IT implementation showed that the above-mentioned criterion is a common approach to define efficiency⁶⁻⁸. Nevertheless, it is a common mistake to focus only on this indicator since IT implementation influences the profitability of an enterprise indirectly through improving the quality of business process management and enhancing the competence of employees and customer satisfaction. It is difficult to measure these effects in financial terms, and, therefore, this performance indicator cannot give accurate information regarding the effectiveness of IT implementation.

Besides, criteria-based determining the effectiveness of IT implementation includes investment, financial, qualitative and probabilistic analysis methods^{2, 3, 5-16}. Methods for evaluating the effectiveness of IT introduction into business processes are represented on Figure 1.

These methods need to be studied carefully to apply them. Investment analysis includes: Total Cost of Ownership (TCO), Activity Based Costing (ABC), Net Present Value (NPV), Return on Investment (ROI), Economic Value Added (EVA), Rapid Economic Justification (RAY), Total Economic Impact (TEI). They are designed to help management to

analyze the risks of IT implementation and to identify possible ways to improve performance, to reduce costs, to make an enterprise's activity less complex, time-consuming, and to improve the quality of delivery of services to clients^{3,5,10}.

Financial analysis techniques include the Internal Rate of Return (IRR), Accounting rate of return (ARR), Profitability Index (PI), Payback period (PP). They allow managers to compare the projects with different levels of funding; they consider risks, the value of future cash flows; they also have clear criteria for decision-making^{3,5,8,11}.

Among the most frequently used techniques of qualitative analysis include the Balanced Scorecard (BSC), System Life Cycle Analysis (SLCA), Portfolio Management (PM). These techniques allow to conduct a detailed monitoring of an enterprise's activities with help of IT introduction and to control the most important financial indicators of an enterprise^{3,5,6}.

Techniques of probabilistic analysis include Economic value sourced (EVS) and other. They provide a possibility to estimate the probability of the emergence of new risks and opportunities because of IT introduction^{3,5,8,9}.

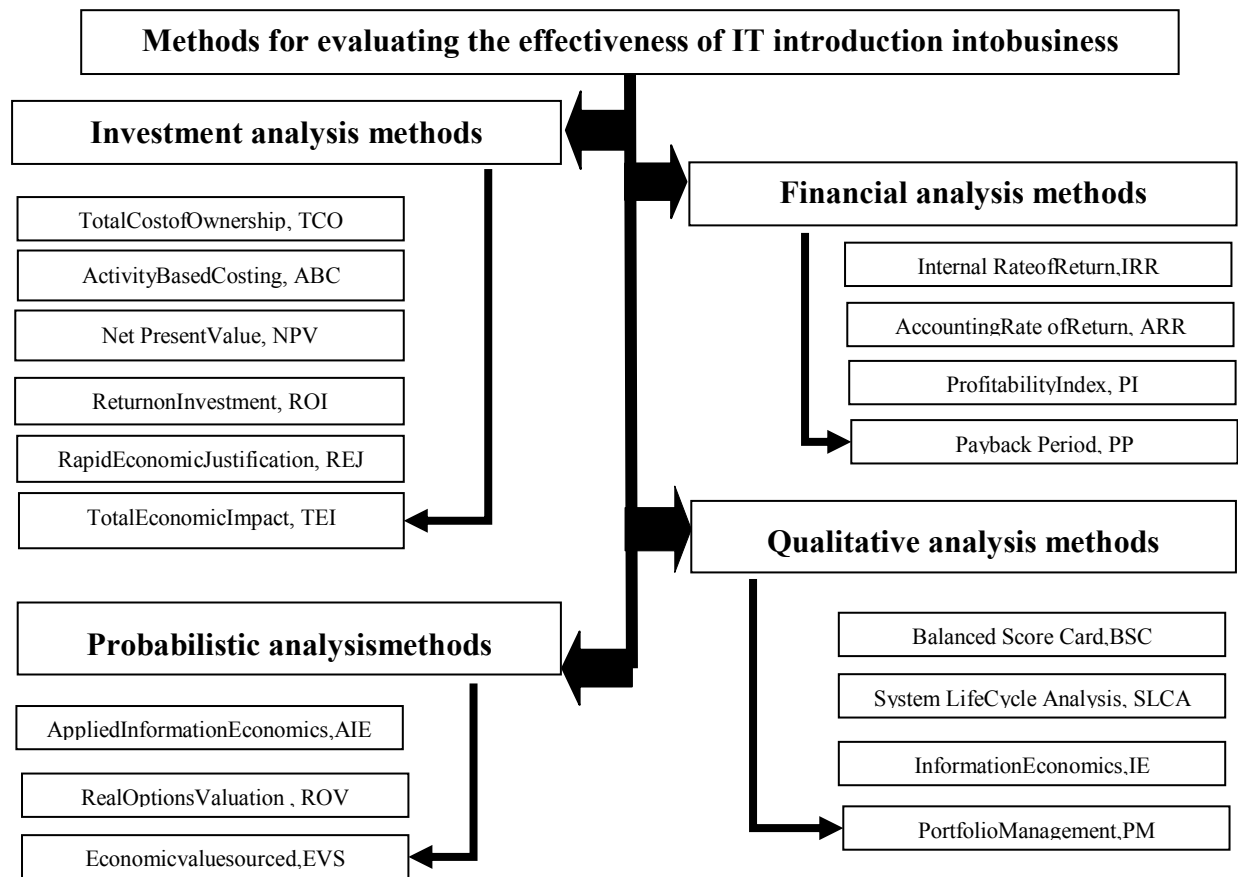


Figure 1. Methods for evaluating the effectiveness of IT introduction into business processes

Therefore, the peculiarities and characteristics of the above-mentioned techniques enable the selection of the most acceptable tools for determining the efficiency of IT introduction.

To enable a comprehensive evaluation of the effectiveness of IT implementation in an enterprise, the authors suggest a methodology that includes a well-defined sequence of actions:

1. Identification and evaluation of the current effectiveness of business processes. That can identify many problems, hence, give an idea what solutions are, and what to automate.
2. The rationale for the selection of IT solutions based on which it is possible to improve the efficiency of business processes. At this stage, a causal analysis can be used. It identifies bottlenecks in each of the business processes

analyzed, allowing a manager to choose the right IT solutions that make it possible to eliminate the found shortcomings and to achieve the best results.

3. Risk forecasting. At this stage, the risks that can take place are determined.
4. Evaluation of costs for implementation of IT solution. This step determines the amount of investment needed to be made to achieve an enterprise's goals. The cost evaluation consists of:
 - a. estimating the costs of IT implementation (involves identifying all capital and recurrent costs associated with implementation and use of information technology, which includes:
 - i. evaluation of direct costs (V_p) on implementation of it-solution (6):

$$V_p = V_{tz} + V_{ppz} + G_{tc} + V_{sz} + V_{pso} + V_u + V_i, \quad (6)$$

where V_{tz} is the acquisition of technical equipment; V_{ppz} is the acquisition and maintenance of software; V_{op} denotes staff wages; V_{sz} are the costs for organization of social events; V_{pso} denotes services of third-party organizations; V_u is the cost of IT management and V_i denotes other direct costs of implementation.

- ii. evaluation of indirect costs of IT implementation (V_h);
- iii. evaluation of the cost of IT maintaining (V_y). The annual cost of IT maintaining (7):

$$V_y = V_{opy} + V_{szy} + V_{psoe} + V_{iy}, \quad (7)$$

where V_{opy} denotes the cost of maintenance and improvement of IT; V_{szy} are the costs of social activities; V_{psoe} are the costs of outsourcing and V_{iy} are the other expenses for IT maintenance;

- iv. evaluation of possible losses from IT implementation (G), which includes losses from failures and downtime (scheduled or unscheduled), losses from the elimination of failures and so on. The level of possible losses is predicted basing on statistical data concerning the implementation of similar IT innovations or just data accumulated in an enterprise. Thus, the total expenditure for IT introduction (VIT) is determined with help of the following formula (8):

$$VIT = V_p + V_h + V_y + P \quad (8)$$

- b. determining whether the cost of IT implementation is reasonable with:
 - i. comparing the cost of IT implementation with the average cost of similar technology implementation in the field.
 - ii. calculating the economic efficiency of IT implementation.

5. Evaluation of the effectiveness of IT introduction. At this stage, evaluation of expected benefits from IT implementation is made with help of methods described above. The choice of method of effectiveness evaluation depends on the type of effect, which is provided by implemented information technology.

In general, this approach helps to determine the level of efficiency of the business processes and to identify areas, which need to be re-engineered to boost profit.

3. CONCLUSION

According to information stated above, it can be noted that the introduction of modern IT must be based on detailed pre-planning activities; analysis of key business processes in an enterprise; on problems and ways to deal with them; on criteria which are expected to help to achieve required results of the implementation; on existing and innovative methods and techniques for the integrated evaluation of the effectiveness of the IT introduction in an enterprise. This will help to ensure the efficiency, reliability, and quality of management's decision-making in any sphere, which directly or indirectly affects the level of profit, which, in turn, is the main source of financing for enterprise development and income growth of an enterprise's owners and employees. Therefore, management is a complex process, in which a manager uses tools and techniques to make a decision, which is aimed to increase the level of profits, to maximize the efficiency of an enterprise, and to optimize the use of resources.

Overall, the study showed that in modern conditions, the effective management is possible only with the full informatization of all spheres of financial and economic activities of an enterprise, and the proposed methodology is an efficient tool, which helps to make a reasonable choice of an optimum strategy.

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