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DEVELOPMENT OF A MATHEMATICAL MODEL FOR BUSINESS PROCESS AUTOMATION

Abstract: *The article discusses the main elements of creating an ideal mathematical model of the operating procedure of the budget department for IT enterprises. The main technical problems arising in the context of deteriorating business conditions and economic instability are analyzed from the point of view of strategy. The introduction of information technology and the creation of specialized programs and modules are the primary methods for resolving the issues associated with the automation of business processes. By using such systems in various functional divisions, it is possible to reduce the amount of human factor and unneeded paperwork while also making the information gathered at the organization clear, accessible, and organized. Business process management modeling, which is a numerical optimization synthesis of the structure, components, and parameters of a business process, is incredibly important yet is still in its infancy. The cost of an IT project is the primary concern of the developed principles of mathematical modeling of business process management. The baseline data for the generated model, as well as its structure and the findings obtained, can alter dramatically throughout the simulation depending on the nature and peculiarities of each specific project. The research under discussion is aimed at increasing competitiveness in the market and maximizing the overall strategy of the organization. When constructing a mathematical model, the author pays special attention to the methods of mathematical modeling of a business process based on the principles of queuing theory. The created model will allow budget departments of IT companies to evaluate and improve their activities.*

Key words: *IT company, intelligent systems, financial planning, IT technologies, mathematical model, business process automation.*

Introduction

The administration of business processes needs to be given extra consideration in order for the organization to be efficient. To achieve this, models and digital solutions are gathered, audits are performed, and their efficacy is assessed. Due to automation, it is possible to reduce the workload of employees aimed at supporting business – processes. It is possible to automate both one process and several processes, while creating a single information space in the enterprise. Employees of the enterprise, without whom it is impossible to produce any products, take direct participation in the creation, maintenance, control of all processes, but the degree of human participation in business processes can be reduced by automation. Automation, which exempts a person from direct involvement in industrial processes, is the application of technology means, procedures, and control systems [1].

Automation aims to boost labor productivity and efficiency, enhance product quality, and create better working circumstances for people. Automating company operations is a task that is getting more and more important. This is as a result of the analysis of business process effectiveness and the identification of the root causes of the detected inconsistencies. Most often, it turns out that the absence of automation and databases for systematizing acquired information is the primary issue facing contemporary businesses. Routine tasks that require a significant amount of manual entry, searching, and data analysis result in errors, wasted time, and generally lower employee engagement [2].

The introduction of information technology and the creation of specialized programs and modules are the primary methods for resolving the issues associated with the automation of business processes. By using such systems in various functional divisions, it is possible to reduce the amount of human factor and unneeded paperwork while also making the information gathered at the organization clear, accessible, and organized.

Key research findings

Tasks for automating business processes

The continual management of processes and their optimization constitute the primary criterion for the success of the process approach. Three categories of business processes are identified: 1) Main procedures. They act as the company's cornerstone. Processes give the consumer more value. Manufacturing, logistics, marketing and sales, procurement, etc. are a few examples. 2) Support techniques. They offer the primary processes' activity. For instance, bookkeeping, hiring, staffing, upkeep of the equipment, etc. 3) Control procedures. The management of the business is its primary duty. Consider financial planning, developing a strategy, documentation [3].

All corporate business operations are covered by automation. Both local tasks at the level of a single small business function and larger tasks encompassing an entire web of interconnected business processes can be solved using it. The automation of accounting, client accounting, and document management was the most prevalent since these processes are directly related to the processing of massive amounts of data. Three categories, which are shown in Figure 1, can be used to categorize business process automation procedures.

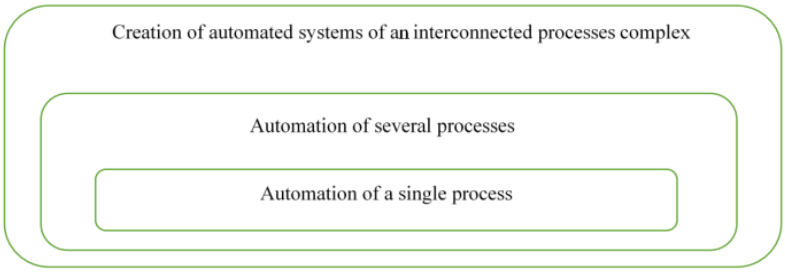

Figure 1 – Types of business process automation

1) Automation of the process. In this instance, one department resolves one or two specific tasks linked to streamlining work with individual papers. For instance, the creation of software modules that display graphs, provide tooltips, format spreadsheet cells based on the parameters entered, generate reports, archive files, instantly send emails, etc.

2) Automation of several processes. This kind of automation involves two or more processes, and it is accomplished through specially created programs. These programs typically include a database for gathering and storing data, forms for data entry and exchange, reports for analyzing this data, and databases for gathering and exchanging data. For order administration, procurement, internal audit documentation, statistical data processing, production planning, etc., businesses separately design client-server programs.

3) Automation that involves designing and putting in place specialized systems to handle a complex network of interconnected business activities. Such automation technologies enable us to fully automate all business activities, track the status of production in real time, and effectively manage the company for maximum profit [4].

Some heads of design institutes consider the business process of drawing up estimates as a time-consuming and complex process. Evaluation engineers involved in implementing this process are dealing with a huge amount of data that cannot always be processed quickly, and consequently, they make the best use of the application software products that ensure the success of this process. However, such software products are just an engineering tool, but the quality of the process is not always ideal. If we analyze these actions, collect modeling data and find optimal solutions, then all this together will serve as a powerful tool for rational management and implementation of this process

Materials and methods

Mathematical modeling and optimization are necessary for high-quality design of business processes. While business process modeling typically takes the shape of texts, tables, diagrams, and other tools (notations) to explain work processes and information, it is descriptive in nature. Business process modeling in this context is understood to be the control of processes, their documentation, and the associated paperwork, whereas the optimization of business processes, according to various ITcompany manuals, entails the implementation of specific actions aimed at their coordination and partial improvement. It is not possible to refer to the adoption of such

organizational activities for the management and operation of the business as optimization. All these steps do not provide the best management of specific business processes, according to a recent study. It is impossible to optimize and automate business processes using descriptive modeling using well-known designations like IDEF0, DFD, and BPMN. The business process should be mathematically modelled so that optimization can be done while the business process is being explicitly investigated and given in the form of a model. All the relevant criteria for the business process model's optimization will also be added. The scientific community does not pay much attention to mathematical modeling [5].

The major objective of any business process is to optimize the estimate documentation, which includes evaluating the amounts of resources and output (estimates, tariffs, and services) at each step of the process and across the whole business process (production, maintenance, service, distribution, etc.). A suitable optimization business process must be carried out under conditions of future uncertainty due to the uncertainty of prospective demand for the final product (because of which the business process is organized), uncertainty of future sales and purchase prices for production resources, uncertainty of investments and their effects, and more. Establishing criteria that reflect future uncertainty and probable business process outcomes is important in order to construct a mathematical model of business process optimization. Only in the future, both in terms of the financial outcomes and the end result of the entire procedure, should all these criteria be updated [6].

The evaluated business process's model structure and its mathematical interpretation

The researched business process' structural model takes into account every part of the work involved in this form of activity. The model is built on process links (each distinct operation) and has two input flows for resources, requirements, and other regulatory elements: *Z= {X;Y}.* Flow vector $X=\{x_1, x_2,\ldots,x_n\}$ at the input to the i-process link includes the flows of production factors or external requirements; flow vector $Y=\{y_1, y_2,\ldots,y_k\}$ includes products, services, and operations performed within the previous i-process links, which serve as input production resources within the given i-link. Within the model, such flows of resources are expressed as circles, process production links as rectangles, service links as rhombuses, influx of resources and/or products as arrows (Fig. 2a).

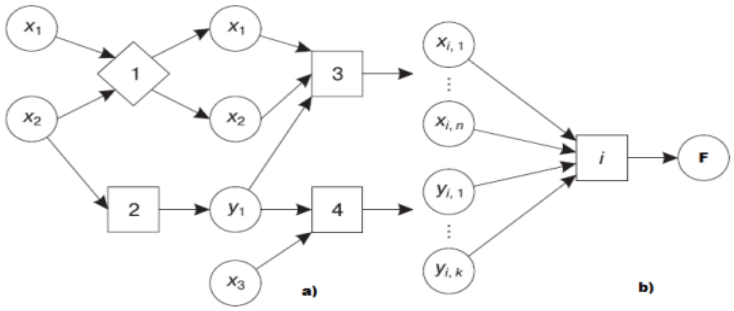

Figure 2 – (a) business process structural model (sample); (b) process link model

The production function (PF) may serve as the mathematical model of production activity on resource processing, which occurs within a production link at its input to the output product [7]. For process link i with X and Y resources at the input and one product made within the i-link at the output (Fig. 1b), the mathematical model represents a multiple-factor PF:

$$F_i = f_i\{(x_1, x_2,\ldots x_n; y_1, y_2,\ldots, y_k)\}. \quad (1)$$

Using the regressive econometric method and available statistical data pertinent to both the IT product process and the applicable technology in this link, a specific PF type is established for each link and operation (activity). Physical transformation of production factors getting into the input of a process link to the output product is simultaneously followed by a cost increase of the input flow by the costs of work performance in a link (further costs are understood as the so-called average costs or unit costs [8]. Considering that the resources coming to *i*-link in volumes x_1,

$x_2,\ldots x_n$ and $y_1, y_2,\ldots, y_k$ have costs (per unit volume) $p_1, p_2,\ldots,p_n$ and $q_1, q_2,\ldots,q_k$ respectively, it is possible to get the overall cost of resources incoming to i-process link:

$$\sum_{i=1}^{n} p_i x_i + \sum_{i=1}^{k} q_i y_i \quad (2)$$

In each *i*-link of a business process, the cost (2) of the input flow will be transformed into the cost at the output flow caused by expenses Δq_i incurred by production within the *i*-link. Then, the overall cost of the output flow of an *i*-link can be presented as follows

$$\sum_{i=1}^{n} p_i x_i + \sum_{i=1}^{k} q_i y_i + \Delta q F_i \quad (3)$$

When modeling a business process for further optimization, the best requirements for production inputs must be taken into account in order to get the desired result. Demand for production factors and their pricing are unpredictable and unknown in advance [9]. The actual source data will comprise aspects of the financial and economic situation, as well as the developed market circumstances required for price and cost estimate documentation $c_1, c_2,\ldots, c_i$ for production factors $x_1, x_2,\ldots x_n$ and sales prices c_i of the final product received at the output of final *i*-process link, known quantity of financial resources *j* assigned for the business process. In the assumption that the structure of a business process and the structure of the corresponding organizational units are chosen, the following optimization problem is solved: to define the optimal cost of the final product – cost estimate F_j at the output of the final *i*-link and optimal volumes of production factors $x_1, x_2,\ldots x_n$ maximizing the profit of the entire business process. The corresponding mathematical model is as follows:

$$c_i * F_i(x_1, x_2,\ldots x_i) - (c_1x_1 + c_2x_2 + \ldots + c_ix_i) \quad -> \quad max$$

To ensure optimization, the output of final product F_j shall be preliminary expressed through PF of all previous links of a business process and contain finite dependence on volumes of production factors $x_1, x_2,\ldots x_n$. This is achieved through the composition (inclusion of one into another) of PF of the previous links into PF of final link F_j $x_1, x_2,\ldots x_n$) in the sequence, which begins with PF of the last process link and ends with PF of the first link.

Conclusion

The optimization of the business process should be carried out as a system for the complete structural model of the process as a whole since this business process is meant to achieve a global goal that encompasses the release of the final product (cost estimate). Additionally, the owner of the business process controls variables that are used in the mathematical model's optimization, such as the output volume, selling price, and volume of factors purchased for the IT product. Economic theory and the process management framework are both included in this mathematical understanding of business process management. If specific technological connections are met, all values obtained will be applicable. It should be mentioned that when researching this topic, it is important to consider both the economic aspects of business process management and the overall efficiency of all process divisions.

Business process management modeling, which is a numerical optimization synthesis of the structure, components, and parameters of a business process, is incredibly important yet is still in its infancy. The cost of an IT project is the primary concern of the developed principles of mathematical modeling of business process management. The baseline data for the generated model, as well as its structure and the findings obtained, can alter dramatically throughout the simulation depending on the nature and peculiarities of each specific project.

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БИЗНЕС-ПРОЦЕСТІ АВТОМАТТАНДЫРУ ҮШІН МАТЕМАТИКАЛЫҚ МОДЕЛЬ ЖАСАУ

Мақалада АТ кәсіпорындары үшін бюджеттік бөлімнің жұмыс процедурасының идеалды математикалық моделін құрудың негізгі элементтері қарастырылады. Бизнес жағдайының нашарлауы және экономикалық тұрақсыздық жағдайында туындайтын негізгі техникалық проблемалар стратегия тұрғысынан талданады. Ақпараттық технологияларды енгізу және мамандандырылған бағдарламалар мен модульдерді құру бизнес-процестерді автоматтандыруға байланысты мәселелерді шешудің негізгі әдістері болып табылады. Мұндай жүйелерді әртүрлі функционалдық бірліктерде қолдану арқылы адам қателігі мен қажетсіз қағазбастылық көлемін азайтуға, сондай-ақ ұйымда жиналған ақпаратты түсінікті, қолжетімді және жүйеленген етуге болады. Бизнес-процестің құрылымын, құрамдас бөліктерін және параметрлерін сандық оңтайландыру синтезі болып табылатын бизнес-процестерді басқаруды модельдеу өте маңызды, бірақ әлі де бастапқы сатысында.

IT-жобаның құны бизнес-процестерді басқарудың математикалық модельдеу әзірленген принциптерінің негізгі міндеті болып табылады. Жасалған модель үшін кіріс деректері, сондай-ақ оның құрылымы және алынған нәтижелер әрбір нақты жобаның сипаты мен сипаттамаларына байланысты модельдеу процесі кезінде күрт өзгеруі мүмкін. Талқыланған зерттеу нарықтағы бәсекеге қабілеттілікті арттыруға және ұйымның жалпы стратегиясын барынша арттыруға бағытталған. Математикалық модельді құру кезінде автор жаппай қызмет көрсету теориясының принциптеріне негізделген бизнес-процесті математикалық модельдеу әдістеріне ерекше назар аударады. Құрылған модель АТ-компаниялардың бюджеттік бөлімшелеріне өз қызметін бағалауға және жетілдіруге мүмкіндік береді.

Түйін сөздер: *АТ компаниясы, интеллектуалды жүйелер, қаржылық жоспарлау, ат технологиялары, математикалық модель, бизнес-процестерді автоматтандыру.*

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РАЗРАБОТКА МАТЕМАТИЧЕСКОЙ МОДЕЛИ ДЛЯ АВТОМАТИЗАЦИИ БИЗНЕС-ПРОЦЕССА

В статье рассматриваются основные элементы создания идеальной математической модели процедуры работы бюджетного отдела для ИТ-предприятий. Основные технические проблемы, возникающие в условиях ухудшения условий ведения бизнеса и экономической нестабильности, анализируются с точки зрения стратегии. Внедрение информационных технологий и создание специализированных программ и модулей являются основными методами решения вопросов, связанных с автоматизацией бизнес-процессов. Используя такие системы в различных функциональных подразделениях, можно уменьшить количество человеческого фактора и ненужной бумажной работы, а также сделать информацию, собираемую в организации, понятной, доступной и систематизированной. Моделирование управления бизнес-процессами, представляющее собой численный оптимизационный синтез структуры, компонентов и параметров бизнес-процесса, невероятно важно, но все еще находится в зачаточном состоянии. Стоимость ИТ-проекта является первостепенной задачей разработанных принципов математического моделирования управления бизнес-процессами. Исходные данные для сгенерированной модели, а также ее структура и полученные результаты могут резко меняться в процессе моделирования в зависимости от характера и особенностей каждого конкретного проекта. Обсуждаемое исследование направлено на повышение конкурентоспособности на рынке и максимизацию общей стратегии организации. При построении математической модели автор уделяет особое внимание методам математического моделирования бизнес-процесса, основанным на принципах теории массового обслуживания. Созданная модель позволит бюджетным подразделениям ИТ-компаний оценивать и совершенствовать свою деятельность.

Ключевые слова: *ИТ-компания, интеллектуальные системы, финансовое планирование, ИТ-технологии, математическая модель, автоматизация бизнес-процессов.*

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