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STRATEGIC MODELING OF ENTERPRISE BUSINESS PROCESSES FOR SUCCESSFUL DIGITAL TRANSFORMATION

Elvira RUSTENOVA [1], Aizhan IBYZHANOVA [1] ✉, Nazym AKHMETZHANOVA [1], Gulnar TALAPBAYEVA [2], Zhanat YERNIYAZOVA [2], Aizhamal AIDARALIYEVA [1]

[1] *Faculty of Economics, Information Technologies and Professional Training, Zhangir Khan West-Kazakhstan Agrarian Technical University, Uralsk, Kazakhstan*
[2] *Institute of Economics and Law, Korkyt Ata Kyzylorda University, Kyzylorda, Kazakhstan*

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Abstract. *Purpose* – the purpose of this study is to develop a methodology for modelling business processes based on the principles of process management and the use of modern information technology in order to improve the efficiency and quality of the enterprise.

Research methodology – in this work we applied the methodology of business process analysis and optimisation based on the decomposition principle proposed by the SADT methodology.

Findings – the result of the study was the development of practical recommendations for enterprises seeking to improve the efficiency of their activities and adapt to rapidly changing market conditions. The proposed methodology of business process modeling allows organizations not only to standardize and optimize their processes, but also to respond flexibly to changes in the external environment and maintain competitiveness.

Research limitations – The study focuses primarily on SADT and IDEF0 methodologies, which may limit consideration of other potentially effective approaches to business process modeling. Future research may include a comparative analysis of different business process modeling methodologies to determine their relative effectiveness and applicability in different contexts.

Practical implications – overall, this study makes a significant contribution to the development of modern business process modeling methodology, providing practical tools and recommendations for organizations seeking to improve their performance and sustainability in a rapidly changing business environment.

Originality/Value – the novelty of this study lies in the development of an integrated methodology of business process modeling based on the principles of process management and modern information technologies. In contrast to earlier studies emphasizing individual aspects of process management or specific technologies, our study offers an integrated approach combining both managerial and technological elements.

Keywords: business process modeling, process management, information technology, enterprise efficiency, digitalization.

JEL Classification: M15, M21, L21.

✉Corresponding author. E-mail: *iaizhan02@gmail.com*

1. Introduction

With the rapid development of digital technologies and global digitalisation, strategic modelling of business processes is becoming a key factor in the successful transformation of companies. The relevance of this article is due to the need for organisations to adapt to rapidly changing market conditions that require the implementation of innovative digital solutions. Strategic modelling allows not only to optimise current processes, but also to predict possible changes, ensuring business sustainability and competitiveness.

The transition to process management and the use of modern information technologies (IT) are often referred to as the main factors of innovative economic development. Transition to process management at enterprises is carried out hesitantly, and the reasons for this are often the complexity of business processes, high modelling costs, and unobvious results of implementation. IT implementation, if we consider technological benefits, has a local effect and rarely leads to increased efficiency and productivity of the entire enterprise, while business benefits are achieved only when supported by effective organisational practices. For this to happen, the process models used must depict the organisational interactions of the participants, but analysts often omit this important detail. The high failure rate in the creation of enterprise IT is attributed to the lack of detail in the modelling phase and the many changes in the development phase. The business process models used usually provide only the most general idea of the sequence of work, omitting organisational practices and other important details. This suggests that the limited economic effect of IT implementation during the transition to process management is due to insufficient attention to the detailed business process models that form the basis of development.

The problems associated with the transition to process management and automation of business processes are caused by the lack of our knowledge about the models with the help of which we describe the activities of an enterprise. Today there is no unambiguous opinion about the composition and properties of executable business process models, there are no requirements to them, so that models often turn out to be inadequate to the purpose of their creation.

Thus, there is an objective need to develop a new methodology that will allow to better combine IT with organisational practices, reduce the gap between business needs and their IT implementation, improve the efficiency and quality of labour, reduce the costs of creating and maintaining computer systems. All this will help to move enterprises to an intensive development path, which determines the relevance of the research topic.

The purpose of this study is to develop a methodology for modelling business processes based on the principles of process management and the use of modern information technology in order to improve the efficiency and quality of the enterprise.

Objectives of the study:

1. Research of factors of increase of efficiency and quality of work of the enterprise as a result of transition to process management.
2. Process description of enterprise business process modelling.
3. Development of a methodology for modelling business processes at the enterprise.
4. Development of a functional model of key business processes of the enterprise using IDEF0 methodology to analyse their structure, interrelations and identify points of optimization.

2. Literature review and problem statement

In the context of modern technological progress, digitalisation of enterprises is becoming an integral component of the development strategy. Digitalisation, introduction of new technologies and data processing methods have a significant impact on the structure and dynamics of business processes.

Business process models are an important tool for managing and optimising a company's operations. They provide a structured approach to analysing and improving processes, helping to increase efficiency, reduce costs and improve the quality of products or services. The use of business process models enables companies to adapt to change and remain competitive in a rapidly changing business environment.

The role of innovation in the business processes of enterprises is essential to improve the efficiency and competitiveness of companies, in a rapidly changing external environment caused by globalisation, technological breakthroughs and changing consumer preferences, traditional approaches to doing business are often insufficient.

Business model innovations are mainly concerned with transforming the way companies create value (Andreassen et al., 2018; Tykkyläinen & Ritala, 2021; Waska et al., 2021).

These innovations are aimed at increasing customer perceived value and improving the competitiveness of the company (Vatankhah et al., 2023, Ittner & Larcker, 1997).

Scholars have extensively investigated the components of business model innovation, proposing various models such as the three-element model (Amit & Zott, 2001), four-element model (Johnson et al., 2008), five-element model (Timmers, 1998), six-element model (Chesbrough & Rosenbloom, 2002) and nine-element model (Osterwalder et al., 2005).

Previous studies have reached a consensus that business model innovation contributes to corporate value creation by changing elements such as value proposition, key processes, core resources and transaction methods (Sjödin et al., 2020). Building on this theoretical framework, we will delve into the journey of business model innovation by focusing on four elements: value proposition, core processes, core resources and transaction methods.

At the same time, business model innovation is a complex process that is influenced by various factors, including the external environment and internal dynamics of the firm. Existing studies examine business model innovation from these two perspectives. On the external side, factors such as national strategic changes (Klein et al., 2021), institutional changes (Heider et al., 2021), industry competition (Xiaoli, 2011), customer demands (Sun et al., 2021), market orientation (Randhawa et al., 2021; Ye et al., 2023), and technological advances (Essen et al., 2023; Trischler & Li-Ying, 2023; Chasing et al., 2020).

With business consolidation and growing complexity, enterprise management is becoming more complex and requires the active adoption of digital technologies centred on the implementation of a process-oriented approach.

Digital transformation involves rethinking business processes using advanced digital solutions, where the creation of new, more flexible and efficient management models capable of adapting to rapidly changing conditions is considered.

In this regard, the revision of traditional management techniques becomes scientifically relevant in the context of rapid technological development and changes in the economic environment (Ochara et al., 2018, Alexopoulos et al., 2022).

Business processes are at the heart of modern organisations and are constantly evolving to meet changing business requirements (Appelbaum et al., 2017; Popova & Sharpanskykh, 2010).

Their execution is often supported by advanced business process management systems that collect and make available large amounts of data to analyse and improve processes (Reijers & Liman Mansar, 2005). The availability of this data pushes the need for business

process design and improvement to become "evidence-based". Evidence-based business process management is typically realised through a set of metrics that capture relevant aspects of business processes and their associated process management lifecycle stages (Song & van der Aalst, 2008).

Although several frameworks defining indicators for business process evaluation have been proposed in the literature (Hammer & Champy, 1993; Pinheiro de Lima et al., 2012; Terziovski et al., 2003; van der Aalst et al., 2007) the authors argue that they suffer from the following two limitations: (1) they assume that the data to calculate the indicators are available, or in other words, they do not specify what type of data should be collected to calculate the indicators and whether this is possible, and (2) they focus only on the evaluation of process performance, i.e., they do not provide data for analysing and making decisions related to the effective implementation of other specific life stages.

Modern development of business process reengineering methods largely depends on the integration of financial capability and efficiency indicators as key factors in rethinking business activities. The authors in (Al-edenat & Alhawamdeh, 2022) emphasise the importance of individual business intelligence and intelligence competencies for process efficiency. They propose a mediated and moderated model that emphasises the role of human capital in improving process efficiency, which is an important aspect of reengineering. Similarly, study (Fetais et al., 2022) conduct a comprehensive analysis of business process reengineering implementation measures. Their study highlights the importance of strategic and systematic approaches to reengineering, focusing on how organisations can effectively adapt to change. A different vision is held by the authors (Panchenko et al., 2022) who explore a methodical approach to planning in management systems for sustainable economic development. They emphasise the need to integrate innovation and production activities in companies, which is in line with the broader goals of reengineering. In the context of management accounting, they consider the impact of business intelligence and enterprise systems on business development (Amit & Zott, 2001). In general, the state innovation policy is aimed at creating favourable conditions for the implementation of innovation processes that allow enterprises not only to adapt to the new conditions created by innovation policy, but also to effectively use the opportunities provided (Ibyzhanova et al., 2023; Muftigaliyeva et al., 2016).

The technological aspect of business process re-engineering is covered in (Sungau & Msanjila, 2012), where it is highlighted that IT can facilitate significant changes in business processes to improve the overall performance of an organisation. The authors of (Lazarević et al., 2020), present a model for improving business performance using the example of a postal company. This study is important for understanding how business process reengineering can be applied in practice to improve performance in the service sector, which can be extrapolated to the engineering industry.

Investigating the relationship between business process reengineering and operational efficiency of national commercial banks is important to understand how reengineering efforts directly affect the financial and operational aspects of large and complex organisations (Xiaoli, 2011).

The authors (Ringim et al., 2012) discuss the moderating effect of IT capabilities on the relationship between business process reengineering factors and organisational performance

in banks. This study provides a detailed understanding of how technology interacts with reengineering efforts to influence performance outcomes. Researchers (Mohammad & Elaheh, 2014) examine the impact of business process reengineering factors on organizational agility using the path of analysis in the context of ports and organisations. This study is particularly important for understanding the flexibility aspect of business process reengineering, which is critical for engineering companies operating in dynamic markets.

The papers investigate the use of data processing and process mining techniques to identify redundancy in business processes. This approach is key to identifying inefficiencies and optimising processes through reengineering (Trabelsi et al., 2023) focus on foreign economic activity management and financial security assessment of engineering enterprises respectively. These studies provide a comprehensive view of the external and internal factors affecting reengineering, especially in the context of financial sustainability and crisis management (Sylkin et al., 2019).

Functional modelling of systems and processes requires a structured and visual way of describing their functions and interrelationships IDEF0 is used. This method helps organisations to analyse and improve their processes in detail, identify weaknesses and optimise resources. The use of IDEF0 allows the inputs and outputs of processes, the mechanisms used and the controlling elements to be clearly defined, which contributes to a better understanding of the system as a whole. It is particularly useful in complex systems design, project management and business process re-engineering as it helps to standardise and document process requirements and improvements.

Business process reengineering is the radical rethinking and redesign of key business processes to achieve significant improvements in critical metrics such as cost, quality, service and speed. In this context, there is a need for tools that can provide a systematic and clear approach to process analysis and modelling. One of the most effective tools for this purpose is IDEF0. This functional modelling method enables processes to be structured and visualised, their functions and relationships to be identified, and inputs, outputs, mechanisms and control actions to be defined. Using IDEF0 in business process re-engineering helps not only to standardise and document current processes, but also to identify opportunities for their optimisation and improvement, which contributes to more effective management and implementation of changes.

The papers (Frobisher, 2021; Simonyan et al., 2023), described an innovation model based on the IDEFØ modelling approach, identified the benefits of its application to guide innovation in the electric vehicle market and identified the interconnectedness of the antecedents that support the use of digital platforms to enhance resilience in manufacturing supply chains. The findings contribute to the knowledge of resilience modelling and dynamic resilience capabilities.

Earlier studies have discussed how process orientation has affected the management performance of companies. The use of process measurement and process improvement techniques as well as the use of core processes have been investigated. The literature has reported improved organisational performance due to process orientation (Harrington, 1997; Johnson et al., 2008), but other studies have shown that process orientation cannot meet all the high expectations placed on it (Reuter, 1998).

In an article based on a survey of 90 Swedish organisations active with process orientation the perceived effects of process orientation were discussed (Frobisher, 2021).

A thorough understanding of process flows and their interdependencies plays a key role in accurately modelling an organization's business processes and manufacturing operations (Aguilar-Savén, 2004). This highlights the growing importance of selecting appropriate modelling techniques, especially for process visualisation and analysis within business management. Researchers (Aguilar-Savén, 2004; Durugbo et al., 2010; Recker et al., 2009) have developed a classification of business process modelling techniques, evaluating their applicability and effectiveness. Among the proposed approaches are flowcharts, data flow diagrams, Gantt charts, IDEF, role activity diagrams, role interaction diagrams, coloured Petri nets, object-oriented languages, workflows, visualisations, business process model labels (BPMN) and others.

However, conducting a comprehensive evaluation of all available modelling techniques to account for every variable in complex manufacturing processes spanning several decades is extremely challenging. In this study, the IDEF0 method (IEEE, 1998; Morgan & Stilewell, 1983), which has powerful functionality to integrate digital platforms and enhance system resilience, was chosen for business process analysis and visualisation.

The IDEF0 standard provides an effective tool for modelling large-scale and complex systems characterised by multiple interactions and integrations. It was developed in the 1970s as part of the US Air Force's Integrated Computer Aided Manufacturing (ICAM) programme, becoming part of defence research. The method was originally introduced as Structured Analysis and Design Thinking (SADT) (Ross, 1977), which established itself in a wide range of fields from technical to social and biological due to its ability to deal with multi-level internal and external complexity. It was subsequently renamed IDEF0 (Morgan & Stilewell, 1983) and has since been widely adopted, being actively used for business process modelling in various industries (Collier et al., 2022; Tserng et al., 2021).

3. Data and methodology

The main object of research in this paper is the business processes of the enterprise, focusing on the transition to process management using business process management systems.

The main hypothesis of the study is the assumption that effective modelling of business processes based on the methodology of process management and the use of modern information technologies can increase productivity, optimise resource use and improve the quality of enterprise performance.

In this work we applied the methodology of business process analysis and optimisation based on the decomposition principle proposed by the SADT methodology. This method allows structuring and detailing business processes at different levels of their description.

IDEF0 notation: IDEF0 notation was used to create functional models of business processes. This notation allows to display the structure and functions of the system, as well as the flows of information and material objects, which provides a more complete understanding of the processes.

The processes were decomposed into smaller parts based on the intermediate states of the control object. This made it possible to describe the course of work execution in more detail and determine the interrelationships between them.

The models were designed in MS Visio vector-graphic editor system.

4. Results of development of business process models at the enterprise

Gailbraith linked the labour productivity of an enterprise with its ability to process internal information flows (Galbraith & Lavin, 1970). He argues that in order to achieve an increase in labour productivity it is necessary to strive to reduce the internal information flows that connect the employees of the organisation, and to increase the ability of these employees to process these flows. Gailbraith showed that the better formalised a production task is, the less time is spent on its execution, resulting in an increase in labour productivity. We use this approach to identify the factors of increasing labour productivity from the perspective of information management (Galbraith & Lavin, 1970).

Functional management is still the dominant enterprise management system. However, it has long been recognised that it generates many difficulties. Functional structures often have a rather narrow view and little interest in what does not directly concern them. In addition, it is an undeniable fact that destructive competition between functional structures is encouraged with more vigour than competition with external competitors. Perhaps the classic example of this is the perennial conflict between the marketing and sales staff on the one hand and the production department on the other.

The fundamental basis for management today is the process approach, which implies the existence of a system of business processes performed in the organisation and further work with them. Scheer (2016), the creator of the ARIS methodology, notes: "There is a close relationship between the hierarchical structure of an organisation and the structure of processes. Generally speaking, the business process for the enterprise represents a continuous series of tasks, the decision of which is carried out with the purpose of creation of an output (result). The starting point and the final product of a business process is the output, the demand for which is represented by corporate or external "consumers" (Scheer, 2016). That is, the process approach allows the entire organisation to be oriented towards the achievement of a result that has value for the consumer. It is this circumstance that makes the process model of management the most relevant.

Transition to process management allows to calculate as accurately as possible the enterprise's need for required labour resources, localise process bottlenecks, and calculate the safety margin that the existing process has with the existing staff schedule in relation to possible changes in the incoming workload. This reduces the need for labour resource reservation. Business processes consist of a sequence of well formalised simple tasks, so that the logic of execution of each can be easily understood by each employee. A business process links performers from different departments, bypassing their direct supervisors. This eliminates redundant information flows up and down the staff hierarchy. In order to reduce redundant information flows along the management hierarchy, it is necessary to provide a set of conditions under which an employee can pass a production task directly to his/her co-worker, along the process, bypassing coordination with his/her immediate superior. The "virtual" channel linking the allies in the execution of a common production task will be called a business process. Thus, standardisation of work processes allows to reduce the need for direct control and increase the rate of controllability. However, only those tasks that fulfil clearly defined requirements can be moved in this way. And if a task does not meet the established

standards, it will be transferred in the usual way, including all escalations and delegations. With this way of doing things, the manager does not lose control levers, because he is sure that he will be promptly and timely informed about all situations when the process deviates from the norm, for example, falls behind schedule.

The first step in managing business processes is to describe, model and regulate them.

Description is the basic element, as the basis for analysis is the existing business process. Thus, it is necessary to obtain a scheme (model) of the analysed business process "as is". It is important to describe the existing process at the level of performers as accurately as possible, this will allow to analyse its "bottlenecks" more accurately. However, using only analysis it is impossible to improve the activity and to increase the efficiency of the management system, so the next step is to create an effectively planned model "as it should be". That is, a model that allows you to avoid bottlenecks found during the analysis in the original business process and, no less importantly, without significantly worsening its other characteristics or sub-processes. It is worth noting that optimisation decisions are not unambiguous, so improvement of one parameter can provoke deterioration of other parameters. Thus we can conclude that optimisation is the search for solutions that will have the greatest effect in this particular case, this particular company, taking into account its capabilities, features and existing constraints at the time of optimisation. It is advisable to analyse the accumulated experience of own and other companies.

Thus, it is necessary to obtain models of "how it should be", and it is necessary to cover the maximum number of processes, as this will directly affect the effectiveness of improvement of the original business process. However, the models themselves are not able to improve the efficiency of the business process and company management. In fact, new models change the rules of personnel work, and with the help of regulation it is necessary to communicate these rules to employees as effectively as possible. Thus, regulations and the introduction of new work rules based on them are the significant result of a business process optimisation project

As part of this work, a model of the process network of the management company was built using IDEF0 methodology, describing the main and auxiliary processes of the enterprise

The activities of any organisation are primarily aimed at creating products or providing services of real value to its external environment. The main process is aimed at achieving the main goal of the company, and in the course of its fulfilment a product or service of value to the consumer is created.

Management processes are a set of individual activities aimed at maintaining the functioning and development of the organisational system in order to achieve its goals. These processes do not create a result valuable to the customer, but without them it is impossible for the normal existence and development of the enterprise.

Finally, the organisation must purchase the products and goods needed for its core business, hire staff, and carry out business operations. Supporting processes do not create the value of the product offered by the enterprise. They provide resources for all of the organization's activities and ensure the operation of the core and supporting processes.

Figure 1 shows the context diagram of the enterprise management process, made in accordance with the universal functional diagrams of the enterprise, on the basis of which the inputs, outputs, control and mechanisms of the process are defined.

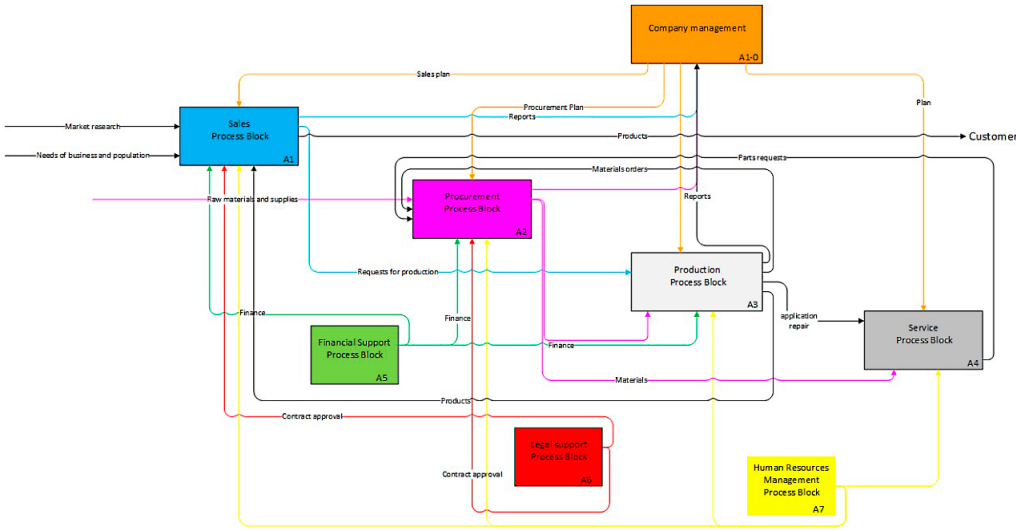

Figure 1. Context diagram of the enterprise management process (source: developed by the authors)

This IDEF0 model covers the main business processes of enterprise management: resource planning, production, sales and marketing, technical and technical service, financial and legal support. Each function is detailed with inputs, outputs, mechanisms and control factors, which allows to get a clear picture of the structure and interaction of business processes in the enterprise.

Sales process block, A1: A sub-process involving market research and analysing the needs of the business and the public. This sub-process generates the sales plan, which is the input to the purchasing and production blocks, providing the enterprise with data on the required quantities of raw materials and supplies.

Procurement process block, A2: involves planning and organising the supply of required materials and raw materials. The main function of this block is to provide production with materials according to the sales plan and production requests.

Production process block, A3: The process that converts materials into finished products. Controlled by inputs from the sales and purchasing blocks. The output of the process produces reports and products ready for further distribution through the service block.

Service process block, A4: provides after-sales service, including repair requests. This process focuses on maintaining product quality and customer satisfaction.

Financial support process block, A5: provides financial resources for all enterprise processes. The financial block plays a liaison role, providing funding and contract approval throughout the value chain.

Legal support process block, A6: Provides legal support for contracts and other formal aspects of the process, ensuring that all operations comply with legal requirements.

Human resources management process block, A7: Responsible for recruiting and managing the human resources required to perform the tasks in each of the business processes.

Process notation (Basic Flowchart in Microsoft Visio) is used to represent the algorithm of process execution, which allows to specify cause-and-effect relations and time sequence of actions. It also supports decomposition into lower-level processes. Process notation is used for modelling individual processes of the company, as well as at the lower level of the business process model created in IDEF0 notation.

Each of the upper level business processes is decomposed into a number of lower level processes. Intermediate states of the control object are used as a criterion for their separation.

Figure 2 shows the decomposition of the management process to the next level on the example of the procurement process. This decomposition describes the key stages of the procurement process and the main sub-processes that ensure the fulfilment of tasks on planning, organisation and implementation of procurement of materials and raw materials for the company.

Formation of procurement plan, A21: this sub-process includes the collection of requests for spare parts and raw materials, as well as the calculation of the required quantities based on requests from the production department. The output is a procurement plan, which becomes the basis for sourcing.

Search and selection of supplier, A22: In this phase, the market is analysed and suppliers that meet the company's requirements are selected. As a result, the optimal supplier is selected, which allows the company to proceed to the contracting stage.

Conclusion of supply contracts, A23: This involves negotiating and signing contracts with suppliers. This stage provides a formal basis for the fulfilment of supply obligations and the transfer of purchased materials to production.

Purchase of materials, A24: Implementation of the process of purchasing materials on the basis of concluded contracts. At this stage, the materials are received into the warehouse and

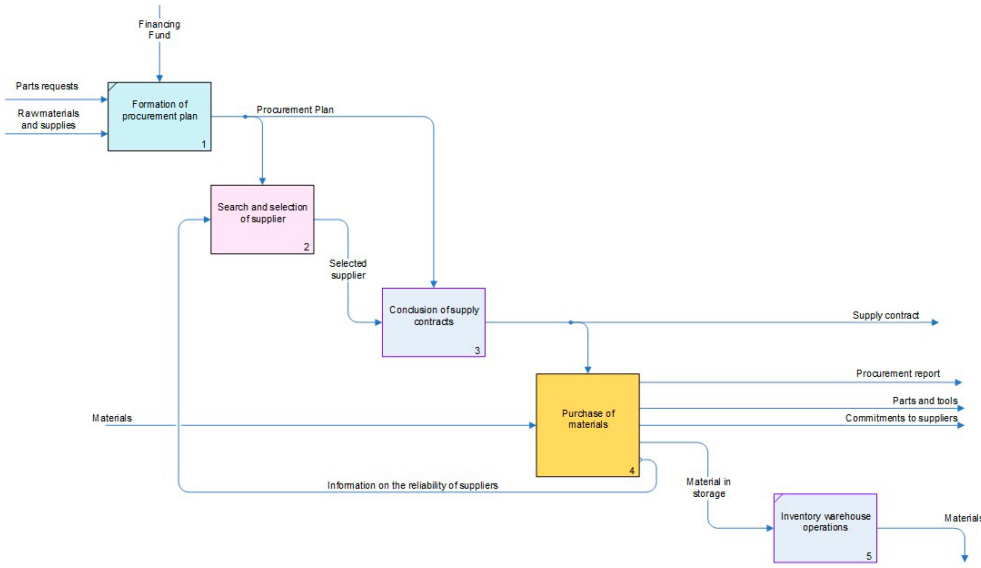

Figure 2. Diagram of the second level of the "Procurement" process (source: developed by the authors)

are ready for further use in production processes. The output of this process is a purchase report and a record of the materials delivered.

Inventory warehouse operations, A25: involves receiving and storing incoming materials and organising warehouse operations to maintain the availability of required stock. This process ensures that materials are ready for transfer to production processes.

Thus, the process 'A2 – Procurement' is structured into stages, each of which plays an important role in providing the enterprise with the necessary resources, as well as helps to optimise procurement costs and improve interaction with suppliers.

At present, knowledge representation models in business modelling systems of production systems are increasingly being adapted to descriptions that take into account both hierarchy and the possibility of convenient object-oriented representation of complex problem situations as an obligatory element. This determines the prospect of building business models on the basis of the situational approach, the defining principle of which is the formation of not so much a model of the object itself as a model of management tasks of this object. In this case, the model of this or that management task is represented in the form of a set of situations reflecting the states of the process of solving the management task, and a set of paths of transition of states from one to another, which correspond to these or those stages of solving the task.

Within the framework of the situational approach, the model of a management task is represented as a set of situations reflecting the states of the process of solving the task, and a set of transition paths between these states, which correspond to different stages of realisation of the management task.

Formally, the model of the management task (M) can be represented as follows:

$$M = \left\{ S_i,\ U_i, E_{ij}, I \right\},\ i = 1,\ldots,N.$$

- S_i – i-th situation (initial, intermediate or final);
- U_i – set of computational procedures performed when the model transitions to the i-th situation and related to the adjustment of model parameters;
- E_{ij} – set of signals initiating the model transition from the situation S_i to the situation S_j;
- I – information base of the rules of generation U_i and transition signals E_{ij}.
- Each situation (S_i) is characterised by a set of attributes (atr_{i1}, atr_{i2},...,atr_{in} } reflecting the current state of the control task. Formally, it can be represented as follows:

$$S = \left\{ S_i \left(atr_{i1}, atr_{i2}, \ldots atr_{in} \right) \right\},\ i = 1,\ \ldots,\ N.$$

- $S_i(atr_{i1}, atr_{i2},\ldots, atr_{in})$ – i-th situation;
- atr_{ij} – value of the j-th indicator for the i-th situation ($j = 1,\ \ldots,\ n$);
- N – total number of situations;
- n – number of indicators.

The methodology of business process modelling developed by the authors was tested at enterprises of various industries, which allowed obtaining valuable practical results. Enterprises with a high degree of supply chain complexity and significant dependence on external factors were selected as research objects. The methodology was applied through the

construction of business process models using IDEF0 and situational networks approaches, which provided the possibility of detailed analysis and optimisation of key operations.

At one of the enterprises engaged in the production of dairy products, modelling of the processes of raw material procurement and distribution allowed to identify bottlenecks in the logistics chain. This resulted in a 12% reduction in delivery time and lower transport costs. In a manufacturing company focused on battery production, the use of IDEF0 methodology for modelling the production cycle ensured optimisation of the equipment schedule, which reduced downtime by 9%. In an agricultural company specialising in meat processing, the use of situational networks improved the accuracy of forecasting resource requirements and reduced excess inventory by 17%.

Approbation of the methodology included the construction of basic models of the current state of the processes, implementation of experimental changes and evaluation of the results obtained in real conditions. The models were optimised iteratively, with subsequent refinement based on the analysis of the efficiency of the implemented improvements. The application of the proposed approach demonstrated its versatility and ability to adapt to the specific conditions of various industries, confirming the possibility of achieving significant improvements in productivity and cost reduction.

5. Conclusions

The research developed and tested a methodology of business process modelling aimed at improving the efficiency and sustainability of enterprises in the context of digital transformation. The methodology is based on the use of modern approaches such as IDEF0, IDEF3 and situation networks, which allowed for detailed analysis and optimisation of key processes.

The results of approbation confirmed the universality of the proposed approach and its ability to adapt to the peculiarities of enterprises in various industries. Application of the methodology in practice allowed to identify and eliminate bottlenecks, improve the accuracy of forecasting resource requirements, reduce costs and optimise production processes. Implementation of the models at dairy, manufacturing and agricultural enterprises showed a significant reduction in time and costs for key operations, as well as improved resource management.

The results obtained show the high efficiency of the proposed methodology in conditions of increasing complexity of production and logistics chains. This opens up prospects for its further application and development, including integration into digital platforms and automated management systems. The developed approach contributes to the achievement of sustainable growth and competitiveness of enterprises, which makes it a significant tool for strategic management in the modern economy.

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Author contributions

Elvira Rustenova and Aizhan Ibyzhanova conceptualized the study and were responsible for the design and development of the research framework. Aizhan Ibyzhanova and Nazym Akhmetzhanova managed data curation, while Elvira Rustenova performed the formal analysis. Aizhamal Aidaraliyeva secured funding for the research. Elvira Rustenova carried out the investigation. Project administration was handled by Aizhamal Aidaraliyeva. Aizhan Ibyzhanova developed the software used in the study. Aizhamal Aidaraliyeva supervised the overall project. Resources were provided by Elvira Rustenova and Nazym Akhmetzhanova. Aizhan Ibyzhanova also ensured the validation of the results. Gulnar Talapbayeva and Zhanat Yerniyazova. Gulnar Talapbayeva and Zhanat Yerniyazova participated in the editing of the article, in the development of the mathematical model.

Disclosure statement

The authors declare that they have no competing financial, professional, or personal interests from other parties.

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