

Strategic management of the enterprise's business model based on innovative technologies of data processing

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Abstract

The process of strategic management of the enterprise's business model based on innovative data processing technologies is to apply effective tools and measures to ensure their sustainable spread in the market. The main problem that was solved in the course of the study was the need to generalize the theoretical foundations, as well as to develop scientific and methodological recommendations for clarifying the content and significance of strategic management of the enterprise's business model based on innovative data processing technologies. The paper establishes that advanced data processing technologies allow enterprises to improve customer interaction, anticipate their requirements and improve the overall quality of service. By applying sophisticated analysis methods, enterprises can achieve more accurate market segmentation and more successful product promotion. It is determined that by introducing innovative technologies, enterprises can adapt more quickly to changes in the market and make more accurate and informed decisions. It is substantiated that the use of innovative data processing technologies in the management of the enterprise's business model provides a number of strategic advantages that increase the competitiveness and efficiency of business, namely in such aspects as: forecasting accuracy; operational efficiency; flexibility and scalability; personalization of products and services; increased speed of decision-making; resource optimization; risk management. The algorithm for the phased introduction of modern digital data processing technologies into the system of strategic management of the enterprise's business model is proposed. This allows for the gradual integration of digital technologies into strategic management, ensuring the effective and systematic implementation of innovations in the enterprise.

Keywords

strategic management, development strategy, business model, business process, innovative technologies, data processing, digitalization, digital business transformation

1. Introduction

In the era of rapid technological progress and global business integration, the introduction of innovative data processing technologies is crucial for creating a successful business model in the enterprise. Data are one of the most valuable resources, and data analysis provides important information that forms the basis for making rational strategic decisions. To use the modern technologies such as Big Data (BD), artificial intelligence (AI), machine learning (ML), and cloud computing, businesses can quickly and accurately process huge amounts of information efficiently. This allows them to adapt to market fluctuations, discover untapped avenues for business expansion, and optimize their internal operations [1].

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Advanced data technologies allow businesses to improve customer experience, anticipate customer demands, and increase the overall quality of service. By applying sophisticated analysis methods, businesses can achieve more accurate market segmentation and more successful product promotion. Similarly, these technologies minimize the risks of making wrong management decisions by relying on comprehensive data and accurate forecasts.

The implementation of the latest technologies in data processing also leads to economies of scale, increased productivity, and reduced costs. This allows businesses to stay ahead of the competition in a rapidly changing marketplace. As a result, the adoption of advanced technologies is crucial for the sustainable growth of modern businesses and their ability to overcome future obstacles.

In today's constantly evolving business environment, innovative technologies and globalization are changing industries, forcing enterprises to find new ways to maintain their market position. Strategic management integration involves long-term planning that takes into account both external and internal factors, identifies competitive advantages and defines the main areas of growth. Nevertheless, in the era of information overload and huge amounts of data, traditional strategic management methods are not enough to meet the requirements of modern business.

The combination of strategic management and data processing technologies allows enterprises to effectively solve problems in real time, as well as to actively identify potential obstacles and prepare for them. Therefore, the automation of business processes has a positive impact on the performance of the enterprise and increases the need for their evaluation in terms of various areas of activity (procurement, finance, personnel, sales, marketing) [2]. In addition, it helps to optimize internal operations, reduce costs and increase efficiency, which is especially important for the sustainable development of the enterprise.

Thus, the study of strategic management of the enterprise's business model based on innovative data processing technologies will allow for the formation of more sustainable and competitive business models for the development of enterprises in the future.

2. State-of-the-art and the statement of the problem

The fragmentation and unsystematic nature of scientific research in the field of innovative data processing technologies in the system of strategic management of the business model of enterprises is becoming an increasingly urgent problem. Most studies focus on individual elements of innovative technologies or management procedures, neglecting their interaction. The absence of a structured approach limits the potential for implementing the latest technologies in practical business models. In addition, the gap between theoretical achievements and practical business requirements hinders informed decision-making.

The scientific paper [3] investigated the impact of Big Data on business productivity, focusing on its integration into strategic management and decision-making. The author investigated how artificial intelligence and big data analytics change business management and modeling processes. The paper [4] studied the use of analytics and innovative technologies to improve the efficiency of strategic management and influence business decision-making.

The scientific paper [5] focuses on the role of big data and machine learning technologies in transforming business models and improving strategic management.

The paper [6] investigated digital transformation and cloud computing, namely their impact on the strategic management of enterprises, with a focus on innovative data processing technologies. The authors of paper [7] studied the impact of data analytics and machine learning on business and management decision-making, developing new approaches to modeling business processes. Thus, these scientists are working at the intersection of management and technology, exploring how innovative approaches to data processing can improve strategic planning and business modeling.

The paper [8] studied the issues of strategic management of the enterprise's innovative development. The authors of paper [9] studied the strategic management of innovation of business processes of the enterprise in competitive markets. The authors propose a model for creating and

implementing strategic management of business process innovation by innovative development of enterprises, which focuses it on effective functioning based on the introduction of new technologies in production and management activities in the implementation of a set of business processes.

The scientific paper [10] studied modern directions of improving the strategic management of the enterprise in the context of digitalization of the economy. The authors identify tools for the digital transformation of enterprise's business models and propose measures to improve the strategic management of the enterprise, including analyzing the impact of digital technologies on business models, developing a methodology for strategic planning in conditions of instability, using artificial intelligence in strategic planning, and assessing the risks of digital transformation.

The authors of paper [11] emphasize that identifying and implementing the principles of creating a modern innovative business model, defining its components and their role is very important for companies to make timely strategic decisions that can achieve a competitive advantage, which is very important for their development and efficiency. The paper [12] deals with the problem to determine the role of innovative technologies in the enterprise management system. The expediency of using innovative technologies in enterprise management is substantiated and their impact on enterprise development is identified. The scientific paper [13] proposes the algorithm for implementing the process of digital transformation of the enterprise, which is adaptive and allows to realize the transition to a digital enterprise, which is also associated with cultural changes and the transition to "digital thinking".

This ambiguity of approaches requires further in-depth research to create a balanced and sound methodology. As a result, the study of this issue is key to the development of effective strategies for managing the enterprise's business model based on innovative data processing technologies. Integration of advanced digital technologies into the strategic management structure of business models is a crucial element in achieving success in today's market. In modern fast-paced business world, enterprises are constantly adapting to external changes, such as increased competition, changing consumer demands, and rapid technological advances. The use of innovative technologies and information systems also helps to reduce the company's costs for spare parts and materials through more accurate accounting and forecasting of needs, which is important in planning the company's activities and is a prerequisite for ensuring its sustainable operation and development in the market [14]. These technologies not only improve the accuracy of forecasting and analyzing market trends but also optimize internal business operations, reduce costs, and increase overall efficiency.

By incorporating innovative technologies into their strategic management approach, businesses can adapt to market changes more quickly and make more accurate and informed decisions. With the development of the Industry 4.0 concept, which is spreading to all industries and areas of activity, the primary task for enterprises is to use advanced information technologies, including those aimed at reducing uncertainty [15, 16]. This increases the competitiveness of the enterprise and opens up new ways for growth and progress.

The purpose of the study is to analyze the theoretical foundations and develop scientific and methodological recommendations for clarifying the content and significance of strategic management of the enterprise's business model based on innovative data processing technologies.

3. Materials and methods

In the process of scientific research on the strategic management of the enterprise's business model using innovative data processing technologies, it is recommended to use a number of methods and techniques. The use of system analysis makes it possible to study the links between the components of the business model and technological advances, assessing how technologies affect strategic choices. In addition, the modeling method allows to create and evaluate several business development scenarios using data analysis, market forecasting, and consumer behavior analysis. An important methodological approach is economic and mathematical modeling, which allows to

quantify the effectiveness of technology implementation and its impact on business processes. The expert evaluation method allows taking into account the opinion of experts on the suitability of certain technologies in strategic management.

In addition, it is crucial to use statistical methods to analyze big data to gain insight into consumer behavior and market trends. Correlation and regression analysis allows to identify the factors that most significantly affect the success of a business model. It is also important to use machine learning to automate decision-making processes and improve management functions. Using the benchmarking method, it is possible to evaluate the business model of the enterprise in comparison with the best industry practices providing identification of specific management areas for improvement. Modern business structures and industrial organizations make significant profits by using innovations in their business processes to increase the productivity of their tasks [17]. The use of innovative data processing technologies in the management of the enterprise's business model provides a number of strategic advantages that increase the competitiveness and efficiency of the business (Table 1).

Table 1

Strategic advantages of applying innovative data processing technologies in managing an enterprise's business model

Strategic advantage	Description
Forecasting accuracy	Innovative data processing technologies, such as BD analytics and AI, enable accurate forecasting of market trends and changes in demand
Operational efficiency	Automating processes using AI and ML reduces costs and increases business productivity
Flexibility and scalability	Cloud technologies and real-time analytics allow to adapt business model to market changes and scale operations as demand grows
Personalization of products and services	Data analytics technologies help create personalized offers for customers, increasing customer satisfaction and loyalty
Increased speed of decision-making	Real-time analytics and intelligent systems allow managers to make informed decisions, which reduces the time to react to changes
Optimization of resources	Innovative technologies allow to optimize the use of financial, human, and material resources, which increases the enterprise's efficiency
Risk management	Data processing technologies allow to predict and manage the risks, minimizing the impact of negative factors on the business model

These advantages allow enterprises to become more competitive, adaptive and efficient in dynamic markets. There is a clear identification of specific digital data processing technologies, which is crucial for the effective implementation of innovations in the strategic business modeling process in the enterprise. In today's business environment, where information flows quickly, appropriate technologies can significantly improve the efficiency of management and decision-making processes. The use of digital tools in management allows to find an individual approach to each client, which increases customer satisfaction and loyalty. This approach helps to increase sales and reduce customer losses [18]. It also prevents overinvestment in technologies that may not be relevant or useful in a particular business setting. A systematic approach to technology selection makes the business model more adaptable to market changes and less susceptible to disruptions [19].

The development of scientific and technological progress in recent years indicates irreversible changes in society, the emergence of concepts such as Industry 4.0, which defines a key contribution to the digitalization era, and Industry 5.0, which unlocks industrial potential, promoting stable, sustainable, regenerative and cyclical economic behavior of enterprises. To effectively manage these changes, enterprises must use innovative solutions based on new digital technologies [20]. An assessment of the possibilities of using modern digital data processing

technologies at certain stages of the strategic management of the enterprise's business model is presented in Table 2.

Table 2

Possibilities of using modern digital data processing technologies at certain stages of the strategic management of the enterprise's business model

Process stage	Characteristics of the stage	Description and example of digital data processing technologies
1. Setting strategic goals	Identification of key areas of enterprise development based on market analysis and internal capabilities	Using big data analytics to analyze market trends and the competitive environment. For example, analytical platforms such as Google BigQuery help identify promising market segments and trends
2. Conducting the analysis	Assessment of the company's strengths and weaknesses, as well as external opportunities and threats	Big data technologies can be used to analyze the external environment and internal performance in more depth. Tools such as Power BI allow you to visualize and analyze data to identify strategic factors
3. Strategy development	Formulating a strategy based on defined goals and analysis of the current market situation	ML and AI can be used to model different development scenarios, e.g. platforms such as Amazon SageMaker help to develop optimal strategies through modeling and forecasting
4. Decision-making	Selecting specific areas of action and tools to achieve strategic goals	AI and recommender system algorithms can help to choose the best course of action. For example, IBM Watson provides recommendations for management decisions based on data analysis
5. Implementation of the strategy	Implementation of the chosen strategy in the business processes and operational activities of the enterprise	Cloud technologies, such as Microsoft Azure, allow you to implement and scale solutions in real time, providing flexibility and adaptability of business processes
6. Evaluation and control of results	Measuring the effectiveness of the implemented strategy and making adjustments if necessary	Business data analytics tools such as Tableau or Qlik help to track key performance indicators (KPIs) and compare actual results with expected ones. This allows you to quickly respond to deviations and adjust your strategy

Thus, it can be argued that modern digital technologies can be integrated at every stage of strategic management, ensuring greater efficiency and flexibility of the enterprise's business model. The algorithm for the phased introduction of modern digital data processing technologies into the strategic management system of the enterprise's business model can be divided into several key stages, as shown in Figure 1 and Figure 2. The algorithm presented in Figure 1 and Figure 2 allows for the gradual integration of digital technologies into strategic management, ensuring the effective and systematic implementation of innovations at the enterprise.

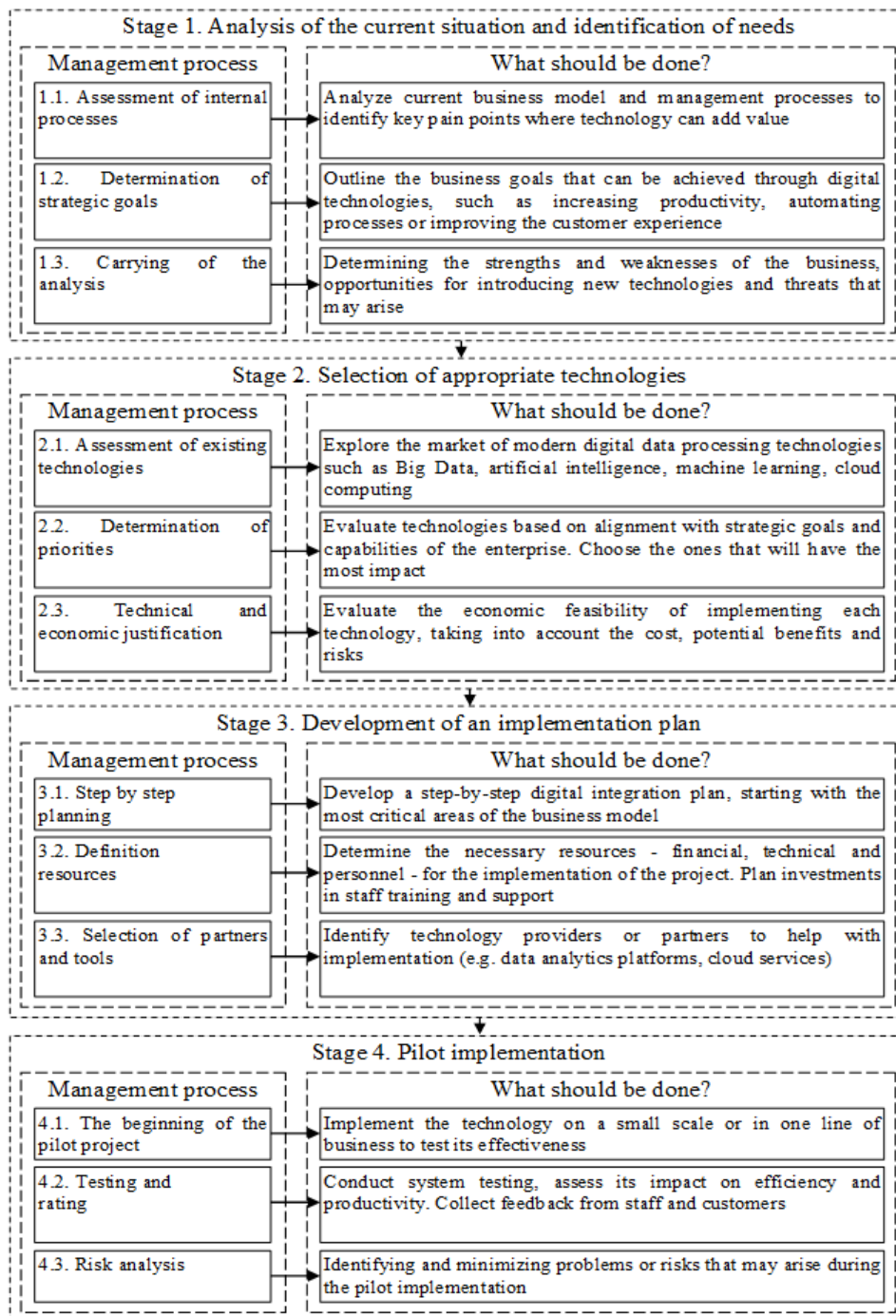


Figure 1: Algorithm for the phased introduction of modern digital data processing technologies into the strategic management system of the enterprise's business model (stages 1 – 4).

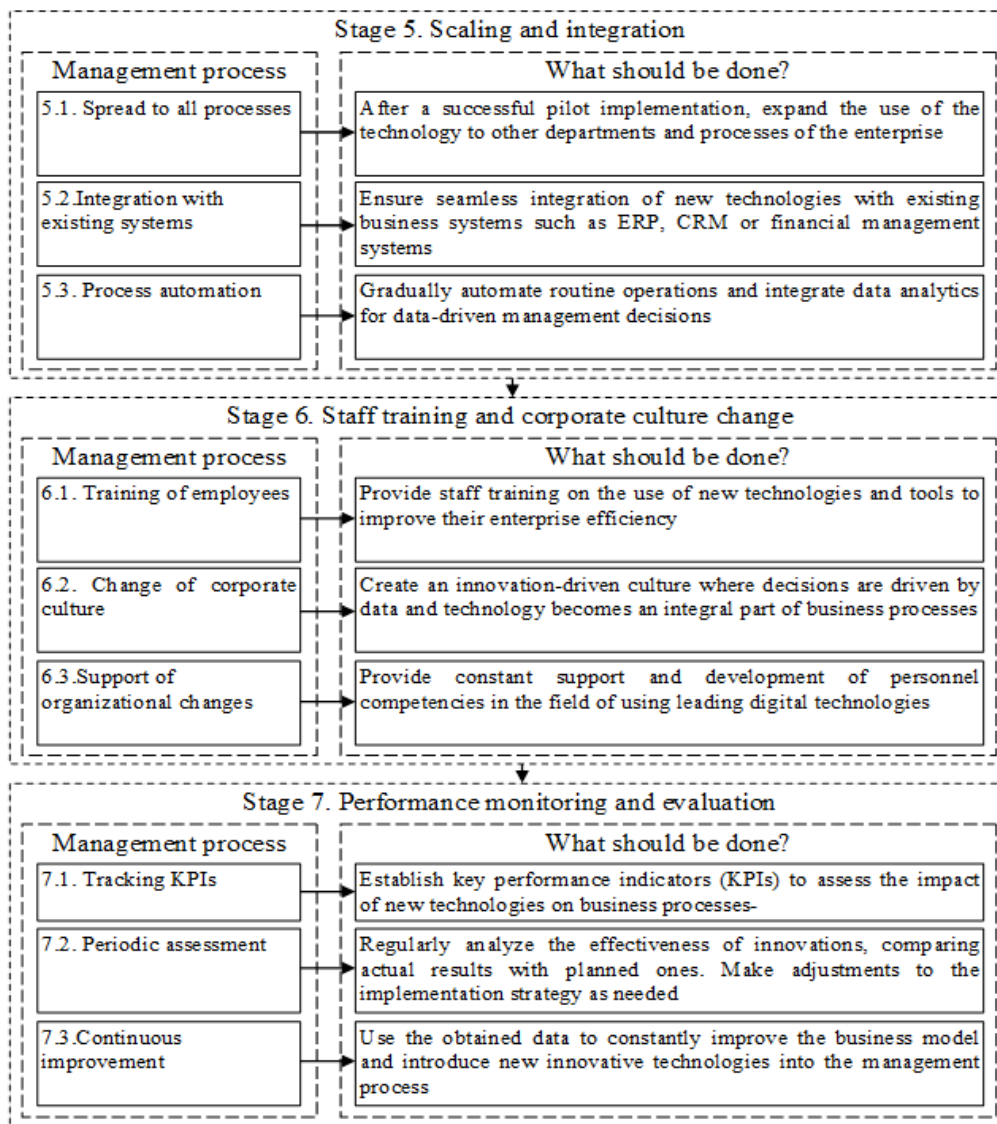


Figure 2: Algorithm for the phased introduction of modern digital data processing technologies into the strategic management system of the enterprise's business model (stages 5 – 7).

Evaluating the effectiveness of implementing modern digital data processing technologies in the business model is crucial to achieving success in strategic management of the enterprise. Without a consistent assessment of the results of implementing new technologies, it becomes difficult to determine their impact on strategic goals and improve management procedures. By conducting a thorough evaluation, potential problems can be identified and strategies can be changed to fully utilize the benefits of implementing new ideas. In addition, it ensures that resources are used efficiently and guarantees their effectiveness. Only by conducting a thorough assessment can sustainable development and increased competitiveness of the enterprise in the business environment be achieved.

4. Results and discussions

The study was analyzed the effectiveness of the introduction of modern digital data processing technologies into the strategic management system of the enterprise's business model for three enterprises: PE TRANS LOGISTICS, PJSC DHL INTERNATIONAL UKRAINE, and LLC MERSK UKRAINE LTD based on data characterizing their activities during 2020-2023 years [21, 22, 23]. To evaluate and predict the effectiveness of the introduction of modern digital data processing

technologies identified the factors on which this introduction had the most significant positive impact. The results of statistical data processing and correlation analysis are shown in Table 3.

Table 3

Determining the degree of influence of the introduction of modern digital data processing technologies on various indicators of enterprise performance

Indicator	Private enterprise TRANS LOGISTIC		Enterprise PJSC DHL INTERNATIONAL UKRAINE		LLC MERSK UKRAINE LTD	
	<i>r</i>	<i>p_{val}</i>	<i>r</i>	<i>p_{val}</i>	<i>r</i>	<i>p_{val}</i>
	Assessment of the current state of the enterprise (x_1)	0.93	0.98	0.89	0.96	0.85
Selecting optimal resource management strategies (x_2)	0.87	0.96	0.79	0.92	0.85	0.95
Risk assessment (x_3)	0.74	0.89	0.76	0.90	0.80	0.92
Selection of optimal risk for the management strategies (x_4)	0.72	0.88	0.73	0.89	0.72	0.88
Predicting consumer behavior (x_5)	0.91	0.97	0.93	0.98	0.92	0.97
Selection of optimal market strategies (x_6)	0.88	0.95	0.90	0.96	0.91	0.97

The following notations are used in Table 3: p_{val} is probability with which the hypothesis of a statistically significant relationship is accepted; r is Pearson's correlation coefficient.

The correlation coefficient was calculated according to the equation:

$$r = \frac{1}{N} \sum_{k=1}^N u_i v_i - \bar{u} \bar{v}, \quad (1)$$

where u_i and v_i are sets of statistical data characterizing the company's activities, \bar{u} and \bar{v} are the mathematical expectations of the respective data sets, N is the volume of observation.

Thus, it can be concluded that for the six identified key indicators, the factor of introducing modern digital data processing technologies into the strategic management system of the enterprise's business model had a significant direct impact on improving their efficiency. At the same time, this relationship was most significant with the factors: x_1 is assessment of the current state of the enterprise, x_2 is selection of optimal resource management strategies, x_5 is forecasting consumer behavior, x_6 is selection of optimal market strategies. The significant relationship can be observed for the factors: x_3 is risk assessment and x_4 is selection of optimal risk management strategies, but for them, also the hypothesis of a statistically significant impact is confirmed with a fairly high level of reliability (not less than 0.88).

Using the special statistical package Statgraphics factor loadings for each indicator based on the data characterizing the activities of the three enterprises was calculated. Thus, the latent factors that influence the main indicators of the enterprise's activity are determined by the following equation:

$$F(x_1, x_2, x_3, x_4, x_5, x_6) = 0,3457x_1 + 0,2897x_2 + 0,1235x_3 + 0,2098x_4 + 0,1702x_5 + 0,2987x_6. \quad (2)$$

After normalization, we obtain the distribution of normalized factor loads that is shown in Figure 3.

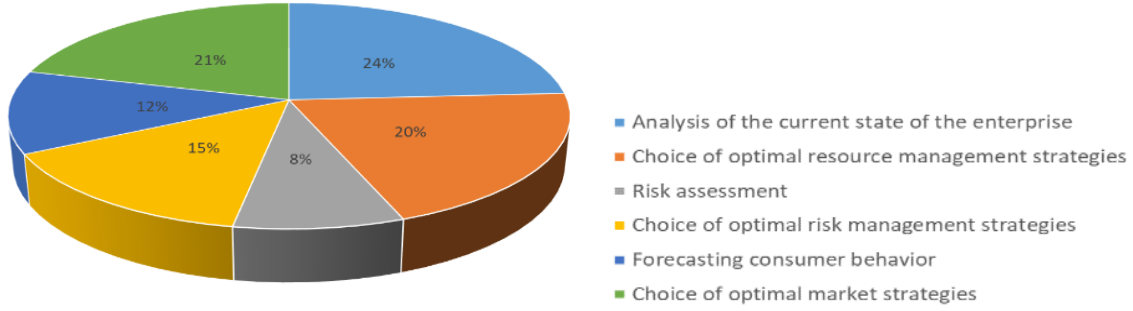


Figure 3: Distribution of the impact of factor loads on the activities of enterprises

The largest factor load in this sequence is the indicator of assessing the current state of the enterprise (24%), followed by the indicators of choosing optimal market strategies (21%) and choosing optimal resource management strategies (20%). Therefore, the introduction of modern digital data processing technologies into the strategic management system has the greatest impact on the efficiency of the processes of assessing the current state of the enterprise and choosing management strategies, while it has a lesser but still quite significant impact on risk assessment and management and forecasting consumer behavior.

We can conclude that it is advisable to group certain factors, namely: group of evaluation and forecasting factors $\{x_1, x_3, x_5\}$ and group of strategic management factors $\{x_2, x_4, x_6\}$.

For each group, based on the data obtained for the studied enterprises, the main numerical characteristics of the distribution of the digitalization efficiency indicator were estimated: $I_1 = F_1(x_1, x_3, x_5)$ is integral normalized indicator of digitalization efficiency in relation to the factors of evaluation and forecasting and $I_2 = F_2(x_2, x_4, x_6)$ is integral normalized indicator of digitalization efficiency in relation to strategic management factors.

The methods of relative normalization of factor loadings and linear combination of factors were used to determine the integral indicators:

$$I_1 = \sum_{i \in \{1,3,5\}} \frac{\lambda_i}{\sum_{i \in \{1,3,5\}} \lambda_i} x_i, \quad I_2 = \sum_{i \in \{2,4,6\}} \frac{\lambda_i}{\sum_{i \in \{2,4,6\}} \lambda_i} x_i, \quad (3)$$

where $\lambda_i \in \{0,24; 0,20; 0,08; 0,15; 0,12; 0,21\}$ is the set of factor loads.

Figure 4 shows the distribution of the values of the evaluation factors that affect each enterprise depending on the effectiveness of digitalization (I_1) and the integral indicator of digitalization efficiency (I_2).

For a more detailed presentation of the impact of each of the factors ($x_1 - x_6$) on the business model of the enterprise with regard to digital technologies, an integrated assessment was conducted for each of the enterprises (Figure 5).

Based on the calculation of mathematical expectations and standard deviations, the interval was determined in which the expected values of integral indicators with a given level of significance. The lower and upper limits were determined using equation: $\bar{I} \pm F^{-1}(0.5\gamma)\sigma/\sqrt{n}$, where \bar{I} is the average value of the integral indicator, σ is the standard deviation, n is sample size, γ is significance level, $F(x) = (\sqrt{2\pi})^{-1} \int_{-\infty}^x e^{-\frac{t^2}{2}} dt$ is the Laplace integral function. Thus, for both integral indicators, three ranges of possible values were established, corresponding to high, sufficient and low levels of efficiency of the digitalization process.

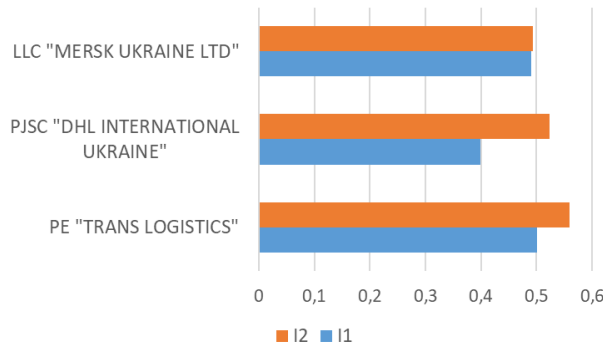


Figure 4: Distribution of values of evaluation factors.

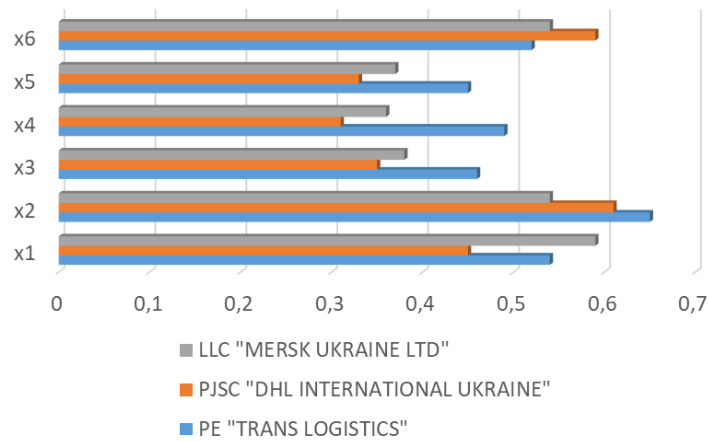


Figure 5: Values of integral indicators of factor groups ($x_1 - x_6$).

Since each enterprise can be characterized by a pair of values (I_1, I_2) , it is possible to determine the area in which it falls. The distribution of intervals and the definition of areas are shown in Table 4.

Table 4

Determination of the intervals of change in the values of integral indicators of groups of factors of efficiency indicators of digital technologies

$I_1 \backslash I_2$	I_2	High	Sufficient	Low
		$0.63 \leq I_2 \leq 1$	$0.43 \leq I_2 < 0.63$	$0 \leq I_2 < 0.43$
High	$0.63 \leq I_1 \leq 1$	I	II	III
Sufficient	$0.29 \leq I_1 < 0.63$	II	III	IV
Low	$0 \leq I_1 < 0.29$	III	IV	V

Depending on the values of the integral indicators was identified five categories to which the enterprise may belong depending on the level of digitalization. Category I characterized by the highest level of efficiency of digital technology implementation, which has a positive impact on all groups of factors: assessment and forecasting and strategic management. Category II characterized by a fairly high level of digitalization efficiency for both groups of factors, with one of them prevailing. Category III has a sufficient level of efficiency for both groups of factors or compensates for the low level of one of the groups at the expense of the other. Category IV corresponds to an insufficient level of digitalization efficiency with a possible slight advantage of one of the groups of factors. Category V corresponds to a low level of efficiency for all groups of factors. The following values of integral indicators were determined for the studied enterprises: a) PE TRANS LOGISTICS has (0.50; 0.61), which corresponds to category II, which means that this enterprise has a high

efficiency of the group of strategic management factors and a sufficient group of evaluation and forecasting factors; b) PJSC DHL INTERNATIONAL UKRAINE has (0.39; 0.52), which corresponds to category III, which means that this enterprise has sufficient performance indicators for both groups of factors; c) the similar result for LLC MERSK UKRAINE LTD, which is characterized by indicators (0.48; 0.49).

The analysis made it possible to identify the main factors that have a significant relationship with the effectiveness of the implementation of modern digital data processing technologies in the enterprise. The significance of the relationship was confirmed with a high level of reliability. For all the identified factors, the factor loadings were calculated, as well as grouping and a method for calculating integral indicators was proposed. For the introduced integral indicators, the boundaries of confidence intervals and ranges of values corresponding to different levels of efficiency of digital technologies implementation were determined. Based on the calculations, a matrix has been built that allows classifying enterprises into five categories.

5 Conclusions

The results of the study of the process of strategic management of the enterprise's business model using innovative data processing technologies emphasize the significant potential of these technologies in improving the efficiency and competitiveness of enterprises. By using modern digital technologies, enterprises can obtain more accurate forecasts of market trends and consumer behavior, which allows them to make informed strategic choices. Assessing the current state and choosing the right technologies are key elements for successful implementation, as they help minimize costs and reduce risks.

The study showed that the integration of digital technologies into business processes can increase productivity, adapt to changes faster and improve resource management. Customizing products and services with the help of the most advanced analytical tools increases customer satisfaction and promotes customer loyalty. At the same time, the study emphasized the importance of regular monitoring and evaluation of the implementation process to verify the correctness of decisions and adapt to any unforeseen circumstances. The importance of staff training and cultural transformation within the organization is crucial for the effective implementation of new technologies. Advanced data processing technologies play a crucial role in the sustainable development of the business model, opening up new growth paths and increasing the efficiency of business processes. Further research should focus on identifying new technological trends and their potential for strategic management needs, as well as on modifying existing methods to adapt to the rapidly evolving business environment. In general, the study emphasizes the importance and indispensability of using modern digital technologies to achieve strategic goals and ensure the competitive advantage of the enterprise in the market.

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