

*A study was conducted on modeling business processes at an enterprise under the conditions of modern digital technologies, which could make it possible to determine the level of digitization at the enterprise in general, minimize costs, optimize work, and enable business processes automation. The main and most important business processes at an enterprise require simulation on basic digital technologies. As part of the research, the main business processes at an enterprise under the conditions of digital technologies were formed, which make it possible to determine the level of efficiency of the enterprise from the implemented digital technologies and the ways that the enterprise should implement to improve it.*

*It has been established that digitalization has a positive effect on a country's GDP level, the level of employment, and the growth of the population's well-being.*

*A methodical approach to the formation of the company's strategy based on the modeling of business processes, taking into account digital technologies, has been devised. This approach, unlike existing ones, makes it possible to determine the necessary level of digitization and identify the scope of implementation of the implementation of digital technologies at the enterprise. This makes it possible to assess digitization at an enterprise and determine the most important business processes for its operation.*

*Practical implementation of the proposed methodology was carried out for four transport industry enterprises. The most important business processes for enterprises have been determined. According to the results of the study, it was found that digital modeling and optimization of business processes has the greatest impact, which is (3.00) and shows the level of effectiveness of the implementation of digital technologies, as well as their orientation to the search for appropriate sources of financial resources*

**Keywords:** digital technologies, enterprise business processes, modeling of business processes, level of digitization

# DEVISING APPROACHES TO MODELING ENTERPRISE BUSINESS PROCESSES UNDER CONDITIONS OF MODERN DIGITAL TECHNOLOGIES

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## 1. Introduction

Under modern economic conditions, the role of competition in the market is increasing, which affects the sustainable development of enterprises and encourages them to look for ways that contribute to the growth of the efficiency of their existence. It is business processes that are a key tool of enterprise management, which ensures the achievement of goals and increases the level of their competitiveness. Business processes of enterprises under modern conditions are prone to the development of digitalization (digital technologies). Businesses that can implement digital technologies and can adapt to the changes that are taking place have a great opportunity for their existence in the context of digital transformation. The external environment pushes enterprises to implement digital technologies and determines a significant restructuring of business processes using new digital technologies. Rethinking the current structure, fundamental change of all organizational and management

processes makes it possible to achieve key results of economic efficiency. Namely, in the creation of new formats in working with partners, optimization of costs, adaptation of services, improvement of product quality according to consumer requests. Business processes are an important part of enterprise management, especially in the context of Industry 4.0, digital technologies, which leads to an increase in the welfare of the population, additional GDP growth, and the creation of a favorable innovation climate. Modeling is an effective tool for managing business processes in the context of digital technologies. The relevance, breadth, and versatility of business process modeling depends on the size of the enterprise: the larger it is, the more detailed the business processes are modeled. Thus, the development of new methods and approaches to modeling business processes of an enterprise under the conditions of digital technologies will make it possible to eliminate the shortcomings of existing approaches to business process management. It will also contribute to the fulfillment of the company's strategic tasks and goals.

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## 2. Literature review and problem statement

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In work [1] it was determined that digital technologies in the activities of enterprises would help use their capabilities more effectively under the influence of the internal and external environment and ensure effective functioning regardless of the influence of adverse factors. However, until this issue is resolved, there is no comprehensive direction on a systematic approach to modeling the enterprise's business processes.

In paper [2], it is proposed to define digitalization as one of the main digital technologies during the transformation and optimization of business processes, which helps increase productivity and improve communication interaction with consumers. However, issues related to achieving effective functioning of the enterprise and ensuring its effectiveness, which becomes possible only on the basis of coordinated and agreed actions of the management in accordance with its development strategy, remained unresolved. Within this framework, it is expedient to provide modeling of business processes depending on changes in the external environment, as well as the formation of rational processes based on digital technologies of their development.

In work [3] digitalization was formed as a way of doing business, based on replacing physical (analog) systems of data collection, processing, analysis, storage, and transmission with digital technologies. This contributes to the transformation of organizational principles of work, the formation of a new business culture taking into account new digital technological opportunities. However, there is no definition of the amount of investments in the implementation of digital technologies, as well as a definition of the effectiveness of the results obtained. That is why it is of particular importance for enterprises to constantly monitor the dynamics of the performance indicators of the enterprise under the influence of the use of digital technologies.

In work [4] it is determined that digitalization involves the standardization of business processes and is associated with cost reduction and operational excellence. However, the work does not define the mechanism and the maximum possibilities of enterprises regarding the financing of digital technologies.

The authors of work [5] determined that for the successful implementation of digital technologies in the enterprise, the management must take into account various problems: technological innovations, customer behavior and requirements, the level of readiness of the staff for digital technologies. It should be noted that the level of functioning of enterprises is significantly influenced by orientation to consumer requirements and formation of supply in accordance with demand. That is why, in work [6] applied aspects of consumer behavior management are formed because no enterprise can achieve success if it ignores consumer requests. Most enterprises focus their activities on specific consumer groups in order to more efficiently, qualitatively, and fully satisfy their needs. However, the cited work does not take into account methodical approaches to the management of business processes of the enterprise depending on the requests of consumers.

In [7] it is stated that the success of the enterprise is not measured by many years of successful activity, the availability of main assets, but by the ability to change and adapt its business to new conditions. And it is digital technologies that contribute to adaptation to modern business challenges. On the basis of the above, it can be argued that it is expedient to direct the enterprise's activities to the use of digital

technologies, which allows for more efficient organization of one's own activities. This involves improving the organizational structure and existing business processes, as well as ensuring the most advantageous positions on the market in relations with foreign partners.

The use of digital technologies allows the enterprise to conduct centralized control at all stages of the life cycle of the manufactured product (or provided services). Namely: digital design and modeling, digital manufacturing, digital supply chain, logistics and digital adaptation for the consumer after its delivery. The result is a qualitatively different level of the enterprise's work, the characteristics of which are the formation of quality management system processes, the transition from descriptive analysis to automated, the creation of an integrated business process management model. That is why, in work [8], the possibilities and necessity of implementing digital technologies at enterprises are determined, but the work does not take into account the evaluation of the efficiency of the enterprise from the implementation of digital technologies.

Work [9] states that digital technologies provide positive trends in enterprise management. Investigating the issue of the implementation of information and communication technologies in the business process management system, the author of the work recognizes that the automation of business processes helps increase the efficiency of performing daily routine functions. The main goal is the systematization and unification of specific business processes, in particular, placing an order, sending an order, calling customers, etc. However, what approaches will allow the enterprise to successfully implement, use, and further develop digital technologies is not covered.

In work [10] it is stated that digitization in enterprise management represents transformed approaches in managing all aspects of enterprise activity, which is expressed in the implementation of the latest methods and approaches in the management of all spheres of enterprise activity. Implementation of innovative technologies in management and the latest business models implemented by reorientation in the information and virtual space for qualitatively new changes in the implementation of their functions. On the basis of the above, it can be argued that ensuring the digital transformation of the enterprise, which combines various methods and management tools at the enterprise, is becoming important.

However, measures and ways to model business processes of the enterprise under the conditions of modern digital technologies have been neglected. This will make it possible to form sustainable long-term competitive advantages and increase the level of competitiveness of the enterprise, which indicates the expediency of conducting research on the use of digital technologies. On the basis of the above, it is possible to determine the strengths and weaknesses of the enterprise, as well as financial opportunities to achieve the desired goal.

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## 3. The aim and objectives of the study

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The purpose of our study is to devise theoretical approaches to modeling business processes of the enterprise, taking into account the use of modern digital technologies at the enterprise. This will provide an opportunity to promote the stimulation and optimization of the enterprise's activities, as well as its constant modernization of the technological state on the basis of digitalization.

To achieve the goal, the following tasks were set:

- to propose an algorithm for evaluating the process of modeling business processes of an enterprise under the conditions of modern digital technologies;
- to form the main directions and factors of influence on the efficiency of business processes of enterprises under the conditions of digitalization;
- to develop an enterprise strategy based on the modeling of the enterprise’s business processes, taking into account digital technologies.

#### 4. The study materials and methods

The object of this study is the process of modeling business processes of the enterprise under the conditions of modern digital technologies. The research hypothesis was that the modeling of business processes of enterprises directly determines the need to use the principles of digitization. In particular, digital technologies, which will contribute to the increase of the company’s profitability, effective functioning on the market and will make it possible to obtain sustainable competitive advantages in the strategic period. Depending on the directions of research, such methods were used as: theoretical; analytical; statistical, expert, comparative-descriptive, system-structural. As well as grouping and graphic methods – when developing and justifying the introduction of digital technologies by enterprises. A set of general scientific and special methods of cognition were used, these methods were used during the modeling of business processes, which is used to identify the parameters of external and internal determinants of influence on the activities of enterprises.

Based on the substantiation of the theoretical provisions and the provision of practical recommendations, an analysis of the possibility of their application in the practice of enterprises was performed.

#### 5. Results of investigating the modeling of business processes of an enterprise under the conditions of modern digital technologies

##### 5.1. Algorithm for evaluating the process of modeling an enterprise’s business processes under the conditions of modern digital technologies

The use of modern digital technologies provides unlimited opportunities for improving the business processes of enterprises, automating production, and modernizing the technical equipment of the enterprise with the use of special systems, which in turn significantly simplifies the methods of enterprise management. In modern market relations, the

problem of the most effective modeling of the enterprise’s business processes is gaining particular relevance. The introduction of new information systems and technologies, as well as the use of digital tools, contributes to the effective resolution of the company’s goals and objectives.

The use of innovative technologies and processes, development, and implementation of innovative types of products allows the enterprise to occupy a leading position on the market. This will provide products with a high degree of scientific content and novelty, thereby making them competitive on the world market [11].

The digital transformation of the enterprise is characterized by the speed of information processing and flexibility in making operational decisions, which at the same time requires large-scale organizational transformations. Therefore, it is important and expedient to highlight structural modules or components of digital transformation. Each of them is an independent functional component, and all of them together are a foundation that creates a basis for the development, planning, design, deployment, and operation of digital technologies (Fig. 1).

The basic components are the actual digital development and the components of the digitalization of the enterprise, which include databases, business processes, digital technologies that make it possible to quickly redesign the business processes of the enterprise under changes in the external and internal environment that occur permanently.

Each building block of digital development plays a role in building a digital enterprise. Their decomposition and determination of a specific contribution to digital development allow the enterprise to more reasonably assess its capabilities and readiness for such transformations.

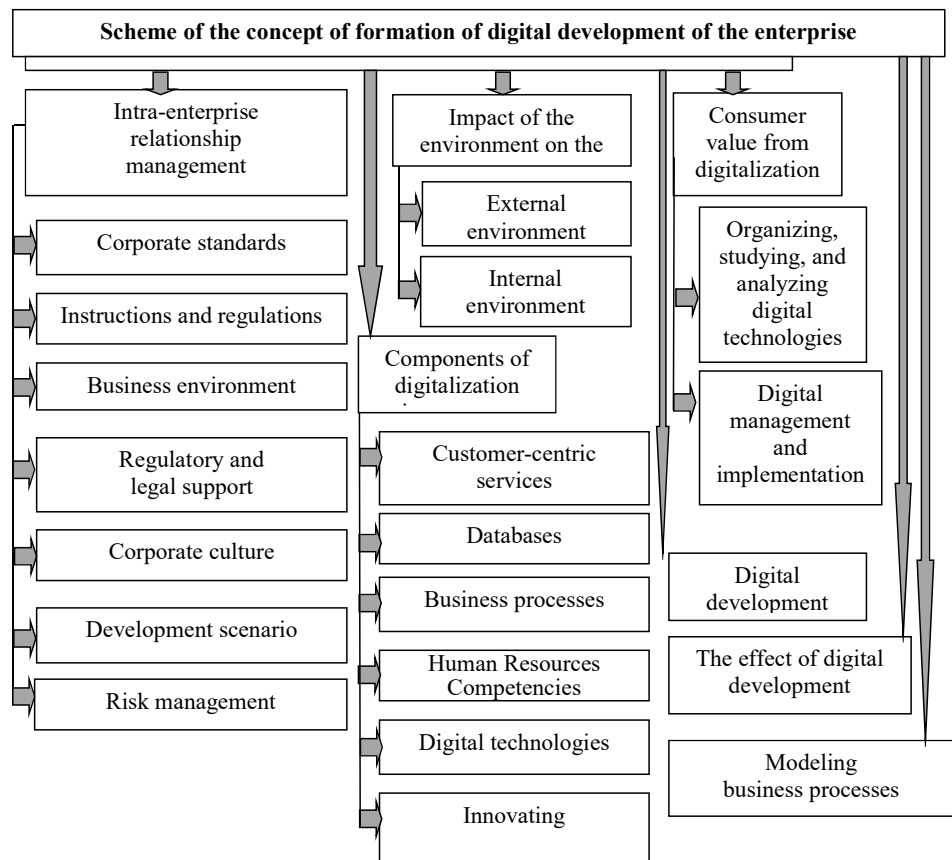


Fig. 1. Scheme of the concept of formation of the digital development of an enterprise

Digitization of the enterprise contributes to the emergence of new innovative solutions in the business environment, ensuring regulatory and legal support, intellectualization, automation, and analysis of databases, which encourages the enterprise to adapt to new conditions and provide client-oriented services [12].

In order for the enterprise to make effective management decisions, it is necessary to correctly analyze databases and manage relationships within the enterprise [13]. As mentioned earlier, the efficiency of digital technologies gives the enterprise the opportunity to model business processes.

Modeling the enterprise's business processes under conditions of digitalization involves the use of conceptual foundations, which consist of four stages. Namely: assessing the need for business process modeling, building an effective business process model, designing the end result from business process modeling, and evaluating effectiveness in the context of digitalization. All these stages are carried out with the active use of modern tools, factor analysis, performance indicators:

Stage 1 – research/assessment of the need for business process modeling. At this stage, the main and auxiliary business processes are analyzed, the strengths and weaknesses of their application at the enterprise are determined, as well as the threats that determine the need to model a certain business process at the enterprise.

Stage 2 – building an effective business process model. This stage involves factor analysis and definition of tools to achieve the goal.

In connection with the fact that the business processes of the enterprise are considered in terms of digitalization, the factor analysis should also be conducted taking into account:

- customer orientation;
- digital technologies;
- cost minimization.

Such digital technologies as: cloud data storage, Big Data, mobile devices, and applications, blockchain and others are gaining relevance.

Stage 3 – design of the final result from modeling business processes. After replacing any elements of the business process, it is necessary to check the effectiveness, whether the goal is being achieved.

Stage 4 – assessment of the efficiency of the enterprise's business processes under conditions of digitalization. This may include the following list of works: selection of indicators, their calculation, as well as summarization of results and assessment of the impact of digitalization on business processes.

Before making a management decision on the digital transformation of business processes, it is necessary to carefully analyze the current business processes of the enterprise. To understand the problems and opportunities to solve them, and only then to choose methods and measures of digitalization of existing business processes, or the development of fundamentally new ones based on digital technologies and platforms [14].

The business processes of the enterprise under the conditions of digital technologies should be evaluated from the point of view of their effectiveness/feasibility and modeling. The algorithm for assessing the effectiveness of modeling the business processes of the enterprise under the conditions of digital technologies, which represents a block diagram with certain options for the implementation of stages and decisions, takes the form shown in Fig. 2.

The proposed algorithm for assessing the effectiveness of business process modeling can be divided into several stages based on the results of the evaluation of indicators, which provide for intermediate control of the results with the necessary adjustment of business processes. If at the initial stage the business process is unprofitable, then the evaluation of the effectiveness of the use of labor resources is irrelevant, as well as the evaluation of the degree of participation of financial assets in the business process together with the current assets of the enterprise.

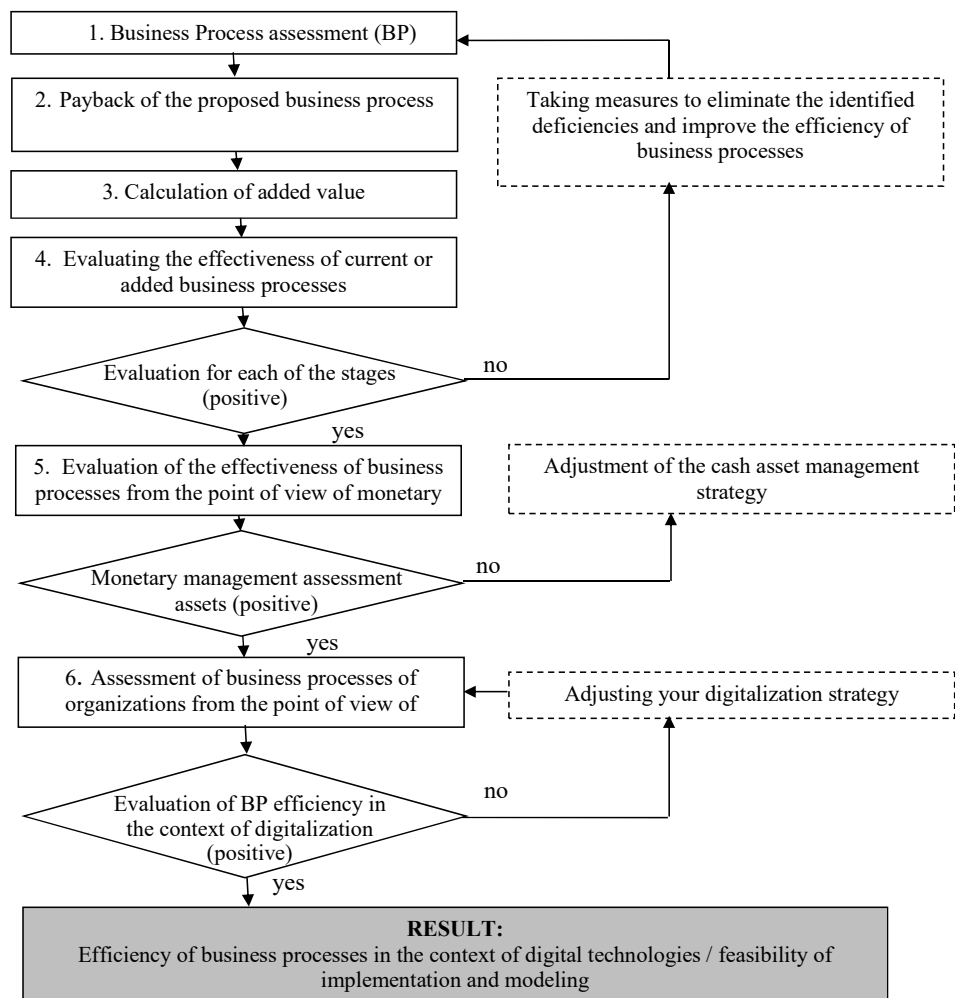


Fig. 2. Algorithm for evaluating the process of modeling business processes of an enterprise under the conditions of digital technologies

Modeling the business processes of the enterprise under the conditions of digital technologies is connected with the factors and methods of their improvement, with the active use of modern tools of practical importance.

**5.2. Directions and factors of influence on the efficiency of business processes of enterprises under conditions of digitalization**

Increasing the efficiency of an enterprise’s business processes under conditions of digitalization is influenced by various factors that have a traditional and modern development format.

The traditional factors of increasing the efficiency of the enterprise’s business processes under the conditions of digitalization include business reputation, sales diversification, consumer behavior, market competition, industry development trends, personnel competence, availability of necessary resources, organizational structure, service. The role of business reputation in the formation of financial and economic indicators of the company’s activity, ensuring market stability, competitiveness, and even the efficiency of the company’s business processes is being strengthened. Diversification of sales helps increase the efficiency of the process of selling goods (services). This manifests itself as the implementation of new types or names of products (services), as the structuring of fixed assets, the reduction of risks under the conditions of the implementation of basic business processes.

Under modern conditions of digitalization, the following factors influence consumer behavior:

- the image or brand of the company;
- reviews about products (services), reposts.

The efficiency of the enterprise’s business processes should be defined as the totality of the results of commodity circulation with general economic benefits. This entails the active functioning and positioning of the enterprise in the market niche, taking into account material and non-material costs [15].

Modern factors affecting the efficiency of business processes of an enterprise under conditions of digitalization include information technologies, digital transformation, automation of processes, customer experience, innovations in business processes, digitalization strategies.

Information technologies make it possible to rationally manage all types of enterprise resources (software, ERP concepts). ERP business planning information systems make it possible to efficiently and effectively plan all commercial activities of the enterprise.

The main opportunities for the development of the enterprise from the introduction of digitalization principles are multifaceted, among which it is possible to note:

- attraction of new target groups of customers;
- improvement of economic indicators of the enterprise;
- increasing the company’s competitiveness (timely changes in the structure and digitization of internal processes lead to an active improvement of the company’s position on the market);
- improving the quality of work with enterprise partners;

- improvement of the innovative sector of enterprise development;
- speeding up and increasing the efficiency of individual business processes.

Digitization of business processes is an important step in increasing the efficiency and competitiveness of enterprises in the modern world. Digital technologies allow enterprises to automate and optimize processes, reduce production time, improve the quality of products or services, and ensure more efficient use of resources [16].

Undoubtedly, digital technologies are an integral part of enterprise development and affect most domains of economic activity, in particular, economic, social and innovation. If countries continue to develop and use digital technologies, they will become even more competitive, and their GDP levels will continue to increase at an even faster rate. After all, digitization fundamentally changes the specifics of the functioning of enterprises and sectors of the economy, leading to their mobility, optimization, automation of processes, reduction of the workforce and minimization of costs. In order to determine which sectors of the economy have the largest share in the formation of Ukraine’s GDP and need the implementation of digital technologies, we present the structure of Ukraine’s GDP by types of economic activity for 2021 (Fig. 3).

Fig. 3 shows which industries form Ukraine’s GDP the most and require the implementation of digital technologies, in order to ensure high GDP indicators of Ukraine in the future.

The economy of the most developed countries of the world is at the stage of transition to a new technological system based on the penetration of the digital economy into all domains of activity without exception. These trends are accompanied by a restructuring, a break in the existing ways of conducting economic activity. The current stage of the economic development of Ukraine involves the transition to the sustainable development of the country as a whole and its regions, the use of modern conditions of the post-industrial society and the construction of a creative economy. The share of the digital economy in Ukraine’s GDP is 65 %. In today’s business environment, 95 % of all enterprises have reoriented their business models and goals under the influence of digital technologies. Those who did not manage to do it in time remained outsiders or completely disappeared from the market [18].

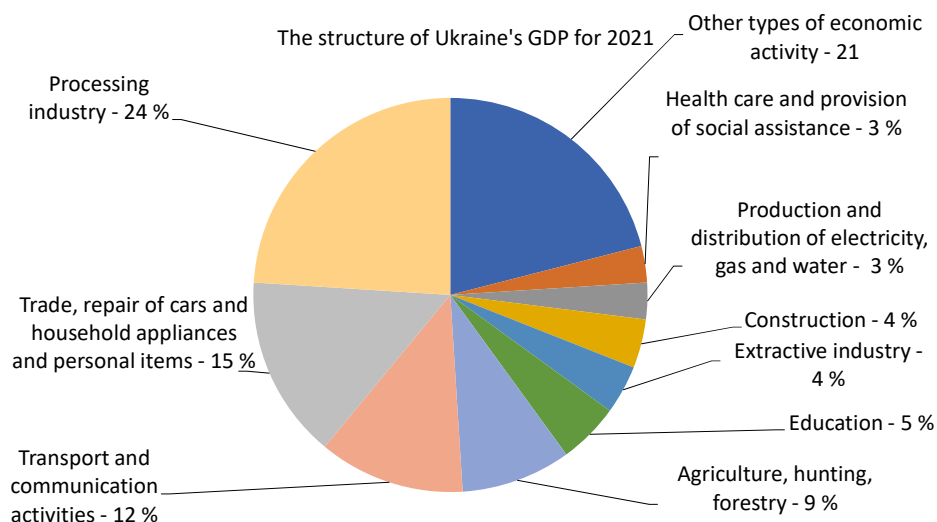


Fig. 3. Structure of Ukraine’s GDP by types of economic activity for 2021 [17]

Fig. 4 shows the main types of digital technologies that go through a number of stages from the past to the present, and to the near future.

It is also appropriate to highlight trends in the development of technologies within the framework of Industry 4.0, which increasingly actualizes the problem of creating prerequisites for preserving economic security when using high-tech processes [19]. Adaptation of enterprises to the parameters of the new neo technological society within the framework of Industry 4.0 reduces threats and prompts radical changes in the field of personalization and personal service.

Digitization enables enterprises to:

- optimize business processes;
- create new products (services) thanks to the Internet of Things technology, virtual reality, cloud services, artificial intelligence, etc.;
- reduce costs (automation of processes takes place, manual work is replaced by “smart” management);
- makes it possible to offer completely new business solutions (new service models, smart technologies, mobile applications, individual approach to the buyer, etc.).

Digitization of production forms scenarios for the development of industries, and also offers comprehensive solutions for optimizing energy consumption, which makes it possible to significantly reduce energy consumption and improve environmental indicators of industries. Also increase the industry’s competitive advantage by increasing waste reduction using digital technologies. Businesses that invest in digital technologies can stand out from their competitors, which will lead to increased market share and increased profits [20]. For the development of the economy of the country and the enterprise,

it is necessary to increase the pace of unique and advanced technologies, to attract financial resources for the development of innovations. At the same time, the introduction of innovations in the enterprise must be permanent. In addition, during the development and commercialization of new products, it is necessary to focus on the needs of the market, investors, and the needs of buyers of goods and services [21].

According to the statistics of the study of digitization in the economy of Ukraine, it can be said that the level of implementation of digital technologies is growing every year, and according to forecasts, it will reach USD 16.0 billion by 2030 (Table 1).

Singapore, the USA, Hong Kong, South Korea, Taiwan, Germany, Estonia, Israel, the UAE, the Czech Republic, Malaysia, Lithuania, and Qatar are among the world’s leading countries with a high level of digitalization and a strong pace of development in this area. The highest level of implementation of digitalization is in Singapore – 68 %, USA – 67 %, Hong Kong – 65 %, South Korea – 64 %, Taiwan – 64 %. According to The IMD World Digital Competitiveness Ranking, developed by the Swiss Business School of the International Institute for Management Development, the highest level of development of the digital economy among EU countries was observed in Finland, Sweden, the Netherlands, and Denmark. Their level was from 68 % to 70 % of world GDP [22].

The data above allow us to conclude that the digital economy tools and methods are being quite actively implemented in most countries and industries. At the same time, mobility is ensured, the speed of decision-making increases, and the variability of business processes increases depending on the client’s needs. High economic indicators of the country are also ensured, which in turn lead to the well-being of the population.

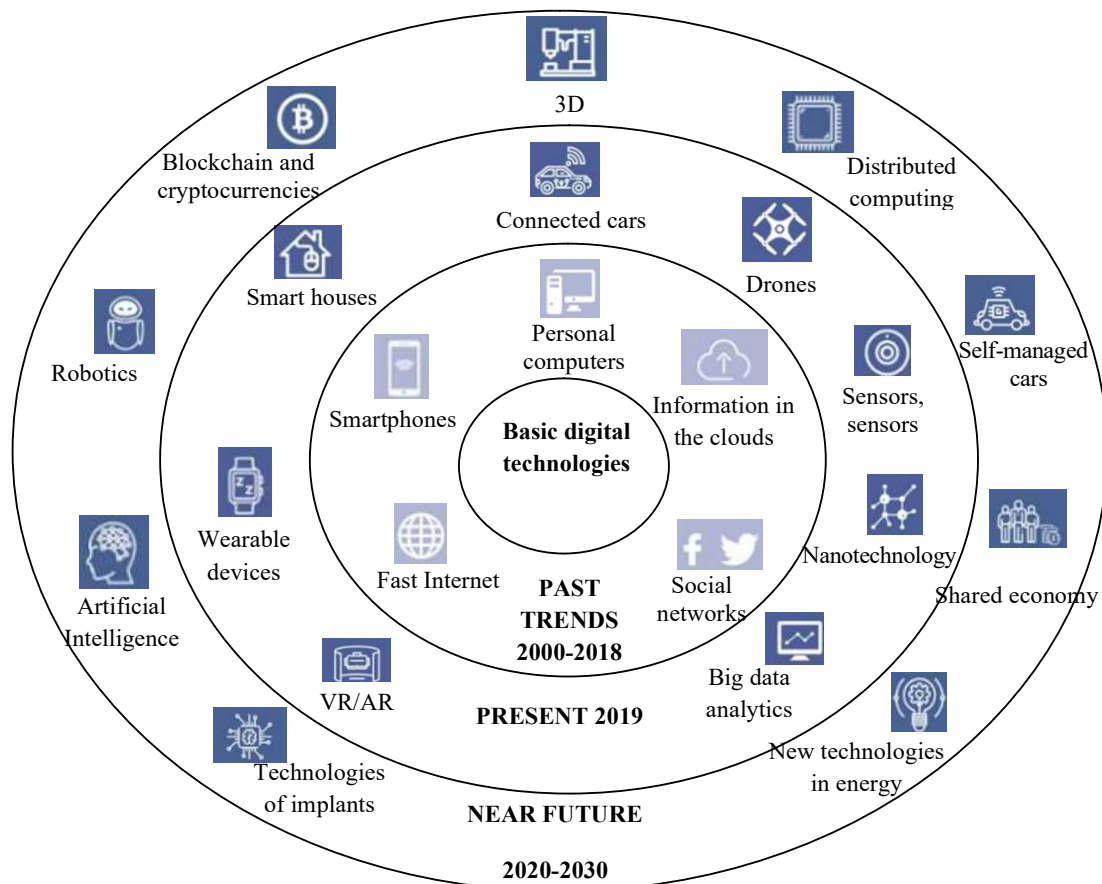


Fig. 4. The main types of implementations of digital technologies

Table 1

Digitalization of the Ukrainian economy

Indicator	2021	2022	2023	2024	Forecast 2025	Forecast 2026	Forecast 2027	Forecast 2028	Forecast 2029	Forecast 2030
Domestic market (consumption of digital technologies), billion dollars	2.0	2.5	3.0	4.5	6.0	8.0	10.0	12.0	14.0	16.0
Impact on GDP, % growth	+0.5	+1.0	+2.0	+3.5	+4.5	+6.0	+7.5	+9.0	+11.0	+14.0
The share of the digital economy in the total GDP, %	3 %	5 %	8 %	11 %	15 %	20 %	28 %	40 %	52 %	65 %

Note: summarized based on [17]

5.3. Enterprise strategy based on the modeling of enterprise business processes taking into account digital technologies

Rapid changes in economic and business conditions are caused by the need for enterprises to achieve a stable position in the market, which leads to the inevitable development and implementation of long-term target programs or development strategies.

The dominance of the global trend of digitalization and the acceleration of the processes of digital modernization of business lead to a radical transformation of the principles of organizing the innovative activities of enterprises. Global trends in the development of innovative activity indicate total digitalization, which leads to a transition from mass standardized production to the development of individual products and services, deepening of global innovations, partnerships and cooperation based on digital technologies [23].

The strategy of digital technologies is aimed at creating opportunities for full use of the company’s capabilities and new technologies to form a synergistic effect from their interaction [24].

The implementation of the business process modeling strategy taking into account digital technologies should include the stages of analyzing the internal environment of the enterprise, the level of resources, the formation of a predictive development model, the development of a concept and practical recommendations for evaluating the effectiveness of the proposed measures.

A method of forming the company’s strategy based on modeling business processes taking into account digital technologies is proposed, which involves determining the level of digitalization at the company and analyzing business processes.

It is proposed to evaluate the current level of digitization at the enterprise by the method of expert evaluations, taking into account the scoring of each of the indicators. They reflect the level of digitization in the enterprise as a whole and affect the level of each of the business processes. The digitization level indicator (ID) of each of the key business processes is determined by formula (1):

$$ID_{Bj} = \frac{\sum P_i}{n_i}, \tag{1}$$

where  $B$  are key business processes of the enterprise;

$j$  – serial number of the business process;

ID – level of digitization of key business processes  $B$  with serial number  $j$ ;

$i$  – serial number of the question;

$P_i$  is the score obtained for the answer to the survey question with serial number  $i$ ;

$\sum P_i$  – sum of  $P_i$  points;

$n_i$  is the number of questions with serial number  $i$ .

Based on the value of the  $ID_{Bj}$  indicator, the level of digitization of each of the key business processes of the enterprise is determined (Table 2).

Table 2

Levels of digitalization of key business processes

Summary value $ID_{Bj}$	The level of digitization
0	Haphazard
1	Initial
2	Coordinated
3	Operating
4	Optimized

Then the level of digitization of the enterprise as a whole is determined (2):

$$ID_E = \frac{\sum ID_{Bj}}{n_i}, \tag{2}$$

where  $ID_E$  is the general level of digitalization of the enterprise;

$\sum ID_{Bj}$  – the sum of the digitization levels of each of the key business processes  $B$  with serial number  $j$ ;

$n_i$  is the number of key business processes  $B$  with serial number  $j$ .

Based on the obtained value, the general level of digitization is determined (Table 3).

Table 3

The general level of digitalization of the enterprise

Overall value $ID_E$	The level of digitization
0	Haphazard
1	Initial
2	Coordinated
3	Operating
4	Optimized

The unsystematic level implies the application of digital technologies and solutions not on a regular basis but on an unplanned basis. In the organizational structure of the enterprise, there is a low level of interest, understanding and confidence in the need for technological modernization.

At the initial level for the enterprise, there is a formed general approach to the implementation of various digital technologies. The effectiveness of work from digital technologies was determined in order to ensure the efficiency of the enterprise in general. A clear understanding of the dimensions of the effectiveness of the use of digital technologies, systems, and solutions in one’s activity is determined.

At the coordinated level, top management and other levels of the organizational structure are actively involved

in the process of introducing digital technologies into all aspects of the company’s activities. Managers and employees have the necessary competencies to ensure effective work with digital technologies. The enterprise forms and accumulates intellectual capital, best practices and acquired experience.

At the operational level, the implementation of digital technologies is compared with the strategic goals and objectives of the enterprise. The results of the work of digital technologies are synchronized with the results of other systems and are closely integrated into the business processes of the enterprise. A wide range of digital technologies and systems have already been implemented in the production process and other areas of the enterprise.

At the highest, optimized, level, the enterprise ensures the use of know-how, best practices, technological and production systems for new ones in its activities. Financial, temporal, qualitative and quantitative results from the implementation and use of digital technologies and solutions are evaluated and described.

The results of the assessment of the current level of digitalization can also be used to model the process of implementing digital technologies, predict their effectiveness, and justify the choice of optimal solutions for managing the digitalization of business processes.

As independent variables of the model, we consider the value  $X_j = ID_{B_j}$ , where  $ID_{B_j}$  is the digitization indicator of the  $j$ -th business process. According to the proposed methodology  $ID_{B_j}$  are determined on the basis of expert evaluations and acquire values from the interval  $[0, 4]$ . As well as the variables characterizing the possibility of implementing individual digital tools:

$$CI_m = \begin{cases} 1, & \text{provided that} \\ & \text{the } m\text{-th digital tool is implemented,} \\ 0, & \text{provided that} \\ & \text{the } m\text{-th digital tool is abandoned,} \end{cases}$$

where  $CI_m$  is the index of implementation of a digital business process tool.

As parameters of the model, we shall consider the following indicators:

– indicators characterizing the presence or absence of certain digital tools: digital management systems, cloud services, CRM, ERP, SCM, etc. At the same time,  $k$  is the number of key digital tools:

$$NI_k = \begin{cases} 1, & \text{provided that} \\ & \text{the } k\text{-th digital tool is available,} \\ 0, & \text{provided that} \\ & \text{the } k\text{-th digital tool is absence,} \end{cases}$$

where  $NI_k$  is the index of the available digital tool of business processes;

– indicators of the level of digital competence of personnel (3):

$$DC = \frac{\sum_{i=1}^N DC_i}{100 \cdot N}, \tag{3}$$

where  $DC_i$  is the assessment of the level of digital competence of the  $i$ -th employee on a 100-point scale,  $N$  is the num-

ber of employees,  $DC$  is the normalized indicator of digital competence of the staff.  $DC_i$  should be determined through testing, interviews, external evaluation, etc.;

– indicators of readiness for the implementation of digital technologies in the business process. This indicator is considered as a function, which for the  $j$ -th business process depends on the two groups of parameters defined above and the corresponding independent variables (4):

$$RD_j = f_j(DC(j), NI_k(j), IB_j); \tag{4}$$

– volumes of data generated and used in business processes:  $Data_j$  – average volume of data used by the  $j$ -th business process per unit of time;

– level of data analytics:  $AD_j$  – level of data analytics required for the  $j$ -th business process.

Taking into account the study of the primary business processes and the use of digital resources in analytics can be considered at 6 levels, namely:

1. Descriptive analytics: analysis and description of data to understand its main characteristics, display of basic statistical parameters, such as average values, medians, ranges, etc.

2. Diagnostic analytics: identifying patterns in data that can explain certain phenomena or trends, cluster analysis: grouping events or objects based on similar characteristics.

3. Predictive analytics: forecasting trends, using models to predict future values or events.

4. Behavioral analytics: analyzing interactions, observing, and studying how users interact with a product or service, audience segmentation: dividing users into groups with similar characteristics to better understand their needs.

5. Strategic analytics: business intelligence (BI): use of interactive tools to obtain data and create reports, key performance indicators (KPI): definition and measurement of key indicators that indicate success in achieving strategic goals.

6. Decision analytics: using data to support informed decision-making, experimentation, and A/B testing: running tests to determine the effectiveness of different strategies or product options.

Since each subsequent level of data analysis includes previous ones, we define the value of  $AD_j$  as a cumulative value that corresponds to the highest level of analysis required for the  $j$ -th business process:

$$AD_j = \begin{cases} 1, & \text{descriptive analytics,} \\ 2, & \text{diagnostic analytics,} \\ 3, & \text{predictive analytics,} \\ 4, & \text{behavioral analytics,} \\ 5, & \text{strategic analytics,} \\ 6, & \text{decision analytics;} \end{cases}$$

– time spent on implementing the  $m$ -th digital tool into the  $j$ -th business process –  $t_{mj}$ . Accordingly,  $t_{mj}^0$  – limitations on time resources;

– resource costs (monetary) for the implementation of the  $m$ -th digital tool in the  $j$ -th business process –  $R_{mj}$ . Accordingly,  $R_{mj}^0$  are limitations on resources.

Also, two dependent variables are considered in the model:  $Y = F(X_j, CI_m, NI_k, DC, RD_j, AD_j)$  – overall assessment of the effectiveness of digitalization of business processes and  $\sigma = G(X_j, CI_m, NI_k, DC, RD_j, AD_j)$  – general risk assessment.

To choose optimal strategies for increasing the level of digitalization, we suggest using three types of models.



*The maximum efficiency model.* This model assumes the maximization of the objective function of the following form (5):

$$Y = F(X_j, CI_m, NI_k, DC, RD_j, AD_j) \rightarrow \max, \quad (5)$$

provided that the independent variables satisfy the following constraint system (6):

$$\begin{cases} G(X_j, CI_m, NI_k, DC, RD_j, AD_j) \leq \sigma_0, \\ CI_m(j) \cdot t_{mj} - \sum_{m_1 \neq m_2} t_{m_1 m_2 j} \leq t_{mj}^0, \\ CI_m(j) \cdot R_{mj} - \sum_{m_1 \neq m_2} R_{m_1 m_2 j} \leq R_{mj}^0. \end{cases} \quad (6)$$

Inequality (6) in the system of constraints determines the condition that ensures that the measure of process risks will not exceed the given value  $\sigma_0$ . The inequality takes into account limitations on the use of time resources, the values  $t_{m_1 m_2 j}$  determine the time during which two different digital tools  $m_1$  and  $m_2$  can be implemented in the  $j$ -th business process simultaneously. That is, the inequality ensures optimal use of the time resource. Similarly, the inequality sets limits on material (monetary) resources, taking into account the possibility of simultaneous use of the same resource for the implementation or improvement of several different means of digitization.

*Minimum risk model.* This model assumes the minimization of the objective function of the following form (7):

$$Y = G(X_j, CI_m, NI_k, DC, RD_j, AD_j) \rightarrow \min, \quad (7)$$

provided that the independent variables satisfy the following constraint system (8):

$$\begin{cases} F(X_j, CI_m, NI_k, DC, RD_j, AD_j) \geq Y_0, \\ CI_m(j) \cdot t_{mj} - \sum_{m_1 \neq m_2} t_{m_1 m_2 j} \leq t_{mj}^0, \\ CI_m(j) \cdot R_{mj} - \sum_{m_1 \neq m_2} R_{m_1 m_2 j} \leq R_{mj}^0. \end{cases} \quad (8)$$

In this model, the process risk measure is used as the objective function. Inequality (8) determines the lower limit on the expected value of efficiency, that is, the resulting efficiency of the process must not be less than the expected value  $Y_0$ .

*The optimal ratio model.*

This model assumes the maximization of the objective function of the following form (9):

$$Y = \frac{F(X_j, CI_m, NI_k, DC, RD_j, AD_j)}{G(X_j, CI_m, NI_k, DC, RD_j, AD_j)} \rightarrow \max, \quad (9)$$

provided that the independent variables satisfy the following constraint system (10):

$$\begin{cases} CI_m(j) \cdot t_{mj} - \sum_{m_1 \neq m_2} t_{m_1 m_2 j} \leq t_{mj}^0, \\ CI_m(j) \cdot R_{mj} - \sum_{m_1 \neq m_2} R_{m_1 m_2 j} \leq R_{mj}^0. \end{cases} \quad (10)$$

This model makes it possible to determine such values of independent variables at which the ratio between expected efficiency and risk will be optimal.

Optimal solutions for all three models can be found using nonlinear optimization methods.

To confirm the effectiveness of the proposed methodology, calculations were performed for 4 enterprises in the transport industry (Table 4).

The results of our research showed that enterprise 1 has an advantage in the aspects of “synergy of digital data in the production process”, “intellectual property management”. As well as for “corporate information management”, “digital modeling and optimization of business processes”, “adaptive production and rapid prototyping”. At the same time, enterprise 3, despite the fact that it has the first level of digitalization, overtakes all other enterprises according to the indicator of “energy efficiency and environmental friendliness”. The business process with the least development is “digital logistics management”.

Verification of the methodology for assessing the effectiveness of the implementation of digital technologies at the enterprise and forming a business process modeling strategy showed that:

- enterprise 1 has a very low level of digitization;
- enterprise 2 has an insufficient level of digitization;
- enterprise 3 has a very low level of digitization;
- enterprise 4 has a very low level of digitization.

Three out of four enterprises have a very low level of implementation of digital technologies and modeling of business processes. These results can be used to carry out a number of modernization measures and attract financial resources for their implementation.

Table 4

Assessment of the level of digitalization of enterprises

No. of entry	Business processes	Enterprise			
		Enterprise 1	Enterprise 2	Enterprise 3	Enterprise 4
1	Corporate information management	3.33 (3)	3.00 (3)	0 (0)	0,33 (0)
2	Digital modeling and optimization of business processes	3.00 (3)	2.33 (2)	3.00 (3)	1,33 (1)
3	Synergy of digital data in the production process	3.00 (3)	33 (2)	1.33 (1)	1,00 (1)
4	Management of intellectual property	3.00 (3)	1.00 (1)	0 (0)	1,00 (1)
5	Adaptive manufacturing and rapid prototyping	2.66 (3)	0 (0)	0 (0)	0,33 (0)
6	Energy efficiency and environmental friendliness	2.33 (2)	2.33 (2)	2.66 (3)	1,66 (2)
7	Automated workplaces and data collection from production facilities	2.33 (2)	1.33 (1)	0 (0)	0,66 (1)
8	Production system	3.00 (3)	2.66 (3)	1.00 (1)	1,33 (1)
9	Digital logistics management	0.66 (1)	1.00 (1)	0 (0)	0 (0)
10	Technology transfer	2.00 (2)	2.00 (2)	1.00 (1)	1,00 (1)
11	Effective project management	2.33 (2)	3.33 (3)	0 (0)	2,00 (2)
Overall level of digitalization		2,66 (3)	1,93 (2)	0,97 (1)	0,87 (1)

**6. Discussion of results of modeling business processes of an enterprise under the conditions of modern digital technologies**

There is a large number of scientific opinions and approaches regarding the essence and use of digital technologies in enterprises, which have been proposed by modern researchers [1–10].

All of them are complex and contain a considerable number of components for calculation, others – on the contrary, few. In contrast to existing views and approaches, this paper proposes an algorithm for evaluating the process of modeling business processes of an enterprise under the conditions of digital technologies (Fig. 1). This algorithm makes it possible to establish qualitative and quantitative characteristics that determine the degree of efficiency of business processes under the conditions of digital technologies and the expediency of its modeling.

In order to ensure the effective functioning of enterprises, a methodology for assessing the level of digitalization of business processes and the general level of digitalization of the enterprise has been devised. Our authentic procedure makes it possible to identify the scope of implementation of the implementation of digital technologies at the enterprise and modeling of its business processes. The study of determining the assessment of digitalization at the enterprise allowed us to determine the most important business processes for its functioning, the entire procedure for calculating the stages of the methodology is given in Tables 2–4. The results of the study of the level of digitalization in all four enterprises indicate that the level of “digital modeling and optimization of business processes” has the greatest influence, a detailed analysis is given in Table 4. It is possible to draw a conclusion about the effectiveness of the introduction of digital technologies and modeling of business processes at the enterprise, which should encourage them to search for appropriate sources of financial resources.

In the future, it is advisable to study the interaction of all existing business processes of the enterprise and their possible modeling to improve the activity of its functional areas, develop appropriate strategies, and implement available opportunities to ensure sustainable competitive advantages.

However, in our research on the modeling of business processes of the enterprise under the conditions of modern digital technologies, the impact of digitalization is determined, but the impact of innovations and the level of innovation potential are not investigated. This, accordingly, outlines the scope of further research in the direction of applying the proposed methods and practical recommendations for enterprises.

The drawback of the study is that the effectiveness of the proposed recommendations is confirmed by the expediency and practicality of their implementation in the activities of enterprises that have a certain level of funding for the use of digital technologies. However, it should be noted that in the modern realities of military aggression of the Russian Federation against Ukraine, there are certain limitations in obtaining statistical information, therefore it is not possible to predict the number and real volume of digital technologies at transport industry enterprises. This model and our research results could be used as a key tool for the implementation of digitalization of enterprises in the post-war period and the period of development of the industry.

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## 7. Conclusions

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1. An algorithm for evaluating the process of modeling the enterprise’s business processes under the conditions of modern digital technologies has been proposed, which will allow determining the level of digitalization in the enterprise in general, as well as ways to increase it. The main prerequisites and factors of influence on the development of digital technologies by enterprises were determined, and an algorithm for evaluating the modeling of enterprise business processes under the conditions of digital technologies is proposed. It

takes into account the principles and reasons that lead to the modeling of business processes, as well as measures to eliminate identified shortcomings and increase the efficiency of business processes. This algorithm differs from others because it makes it possible to rationally use time when evaluating each business process between the results of the application of digital technologies and the costs of their achievement.

2. The main directions and factors of influence on the efficiency of business processes of enterprises under the conditions of digitalization were studied. It has been established that digitalization has a positive effect on the country’s GDP level, the level of employment and the growth of the population’s well-being. Based on statistical data, it was established that digital technologies have a significant impact on GDP growth, increasing their percentage from the overall level. The presented forecast of digitalization in the economy of Ukraine is 65 %, which makes it possible to assert the fairly active implementation of digital technologies in most sectors of the economy. It can be argued that the level of implementation of digital technologies in Ukraine will grow every year, and according to forecasts, in 2030 it will reach USD 16.0 billion. On a global scale, a high level of digitization is characteristic of Singapore – 68 %, the USA – 67 %, Hong Kong – 65 %, South Korea – 64 %, and Taiwan – 64 %. At the same time, it provides mobility, increasing the speed of decision-making and increasing the variability of business processes, which encourages their effective modeling.

3. A methodology to form an enterprise strategy based on modeling business processes considering digital technologies has been proposed, which involves determining the level of digitization at the enterprise and analyzing business processes. The methodology is a point assessment for each of the indicators, using the method of expert assessments. An assessment of the level of digitalization was carried out for four enterprises in the transport industry, and it was also determined which of the business processes have the highest level of digitalization. Verification of the proposed methodology for transport enterprises made it possible to conclude that three out of four enterprises have a very low level of implementation of digital technologies and modeling of business processes, and only one has an insufficient level of digitalization.

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### Conflicts of interest

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The authors declare that they have no conflicts of interest in relation to the current study, including financial, personal, authorship, or any other, that could affect the study and the results reported in this paper.

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### Data availability

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All data are available in the main text of the manuscript.

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### Use of artificial intelligence

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The authors confirm that they did not use artificial intelligence technologies when creating the current work.

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