Abstract. The article discusses the issue of digital transformation of the management system of a manufacturing company in terms of sustainable development of the Russian economy. A reasoned and objective approach to this problem based on the patterns of development of socio-economic systems and systematization of methodological aspects for building digital business management systems made it possible to develop effective strategic tools in order to increase the efficiency of production and management activities of an enterprise. The authors present statistical data on the use of digital technologies by the industrial enterprises in 2022 and analyze the features of digital changes in the management system of manufacturing companies. As a result, the main stages of the development and adaptation of the digital transformation strategy of a modern production facility are drawn up, which consist of developing the digital transformation concept and the process of conversion into a digital enterprise.

1 Introduction

Currently, issues of digitalization of the economy and management in terms of sustainable development are a priority at the level of the state, region and individual industrial enterprise [1,2]. In 2017, a special federal program "Digital Economy of the Russian Federation" was launched, promoting the transition to a new technological paradigm of Industry 4.0 based on the introduction of innovative technologies and methods for optimizing production and management activities through the continuous improvement of business processes occurring in an industrial enterprise. According to experts, the mechanism of digitalization of the Russian economy is set in motion, however, it will reach its peak by 2025 [3,4].

The main types of scholarly publications on the issues of digital transformation of industrial enterprises include the following:
- publications of the general theoretical profile (which prove that digital transformation of business processes of an industrial enterprise is essential for the successful operation and sustainable development of the economy) [4, 5];
- publications discussing the positive experience of digitalization of business management and its results [6, 7, 8];
- publications by foreign authors studying digital management technologies based on the functioning of cyber-physical systems [9, 10, 11]. At present, there is a lag between the
theoretical aspects of management and the practice of introducing digital technologies into the enterprise management system in terms of sustainable economic development, which shows the relevance of developing an algorithm for implementing the strategy of such transformation.

Several factors serve as prerequisites for the digital transformation of industrial enterprises: increased number of competitors and profitability of their businesses; reduction in the efficiency of traditional methods of product promotion; routine operations requiring automation or a combination of robotic and living labor; decision-making based on experience and authority, and not by assessing relevant digitized data in real time; the information technologies used not meeting the requirements of the competitive environment, etc.

2 Materials and methods

shortage of specialists and teams with “digital mindset” and competencies; the lack of

3 Results

- the need of companies to develop programs to ensure energy saving, energy efficiency, the use of waste-free and resource-saving technologies,
- integrating different digital areas in one technological solution based on combining and diversifying various areas of the enterprise’s activities [5],
- mandatory compliance with environmental requirements for industrial safety of companies in the context of emerging “green economy” principles,
- active participation of enterprises in digital technology initiatives to develop cross-sectoral, interregional, and international global digital space [13],
- engaging business partners in digitalization processes at all stages of the product life cycle for optimizing the supply chain and creating added value of products,
adoption of the positive experience gained by industrial enterprises in the area of complex
digital transformation of production business processes (as a result of which digital
platforms, digital factories, smart fields have been developed), and its further expansion
in the future.

At the same time, small and medium-sized enterprises experience a great shortage of
funds to purchase equipment and ensure existing production capacity at the required digital
level. Thus, there is a need to establish integrated structures that will contribute to combining
the potential of companies that is underused for production purposes.

There are issues that hinder digital transformation of the industrial enterprise management
system. Managers most often mention the following barriers: limited funds, lack of long-
term vision of the nature of digital changes and lack of the strategy developed, low “readiness” of
the enterprise’s business processes for digital transformation, lack of regulations in the field
of development and use of digital strategies, low and long-term return on investment, low
literacy rates of staff and the need to attract external professionals in information and
communication technologies [2, 3, 4].

According to the study of more than 1,100 large and medium-sized manufacturing
enterprises in the Russian Federation in 2019, the following trends in their digital activity
were identified: the growth of technologies aimed at electronic exchange; digital
supply chain management; use of various types of digital media and portable devices; use of broadband
Internet access for business purposes; electronic invoicing, etc. [14]. Business executives
note the development of robotic production, the use of end-to-end automation and integration
of business processes into a single information system and building digital workplaces. At
the same time, there is poor development of standard strategic solutions based on taking into
account the specifics of the production and technological base of industrial enterprises, which
would allow them to engage in digitalization and make a breakthrough in the long run.

Managers highlight the following most expected results of digitalization: improved quality
of work with clients, increased productivity, optimized production, and logistics processes.

Key digital technologies which are currently being actively introduced in manufacturing
companies include: big data, Industrial Internet of Things, robots, digital twins, artificial
intelligence, blockchain, cloud technologies, etc. [6, 15].

The analysis of digital technologies used by industrial enterprises in 2022 indicates that
cloud services and technologies for collecting, processing and analyzing big data are
becoming the most important for these companies (Fig. 1). These tools provide
comprehensive capabilities for digitalizing business processes, transforming management
practices, improving the efficiency of production activities, and increasing innovation
capacity [16].

According to the study conducted by AO “SPG” (Strategy Partners) in 2023, which covers
more than 230 Russian companies of different size of operation, level of integration in the
chain and specialization in the construction, the most popular technologies among
development and construction companies include electronic document management, cloud
technologies, dynamic pricing, and digital design systems [17]. Companies which deal only
with residential real estate are much more likely to use big data technology for market
analysis. It should be noted that the larger the enterprise, the more noticeable is the
penetration of certain technologies into its processes.

According to the executives, the top priority stages of a development project for digital transformation in the next 2-3 years
include project management, marketing and sales. Most companies identified the following as priority functions for digitalization of the construction business: building financial model, project management and procurement, sales process, supervision of construction works. At the same time, executives highlight the following most significant limitations for the construction business digitalization: lack of qualified personnel, limited funds, and no guaranteed effect. The share of companies experiencing the financial benefit from digital (2024), E3S Web of Conferences 531, 01006 (2024) UESF-2024
technologies has increased significantly compared to 2019, but many enterprises cannot yet accurately measure it.

Fig. 1. Digital technologies used by industrial companies in 2022, percentage of the total number of enterprises

The logic of digital transformation requires defining digital strategy as a corporate and competitive strategy [6,18]. Digital transformation of production enterprises is a complex, expensive and continuous process that requires a systematic approach and takes a long time. According to experts, the period for developing and implementing the strategy can be 5-7 years. The effectiveness of digital transformation strategy implementation largely depends on efficiently identified problems and risks (cybernetic, informational, organizational, etc.).
operational), which account for up to 80% of the outcome during the preparatory phase when developing a conceptual design for introducing innovative changes, taking into account organizational and technological aspects of the manufacturing enterprise operation.

The key objectives of digital transformation of a manufacturing enterprise encompass achieving economic development, including financial performance; optimization of production and management costs in order to increase the turnover of manufactured products; creation of a fundamentally new value proposition on the market; increased labor productivity and improved quality of customer service.

Enterprise management needs to monitor the cost-effectiveness of digital transformations and indicators of digital culture improvement, since if management’s initial focus is on introducing “buzz” digital technologies without fully assessing potential risks and organizational changes, then such an approach can lead to failure. According to experts, the success rate of companies implementing digital transformations is less than 30%.

The driving force behind the digital transformation of production enterprises include:

- level of digital culture of staff (knowledge and skills in applying digital technologies, digital thinking, level of development of digital communication channels, making management decisions "in one click" upon receipt and analysis of digitized information, adherence to ethical principles of virtual communication, ensuring information security),
- effective innovative and regular management, based on the readiness of the company's management for changes associated with the introduction of digital transformations, since they may counter to the solution of short-term problems of the enterprise and require significant funds in terms of limited budget or lead to a conflict between the current tasks of the enterprise and its strategic objectives [18],
- high-quality systematization of background information about the enterprise and its external environment in order to identify competitive advantages which facilitate the survival and adaptation of the company in the digital economy,
- standardization of business processes, content and format of information exchange, allowing quick management decisions to be made in "real time" and turning digital data into a source of positive cash flow,
- customer-oriented management, since the client becomes part of the digital value chain; the concept of a "client-centric" business management model arises when, in the process of developing new products, a company builds a business model focusing on the customer's needs and assessing the value of each client for the company [8, 15],
- comprehensive coordination within a corporate community, aimed at resolving the conflict when integrating humanitarian and technical knowledge in the management system of a production enterprise. This alignment of the enterprise's overall corporate strategy with new digital technologies strengthens the connection between digital innovations and other functional areas of the business.

It should be noted that digital optimization consists in targeted implementation of technologies and improvement of existing products. In the process of digital transformation, new business models, products and services are created [6, 8, 18]. The authors suggest the stages of developing an algorithm for the digital transformation strategy of a contemporary manufacturing enterprise, which consist of drawing up the concept of digital transformation and the process of conversion into a digital enterprise (Fig. 2).

An essential aspect, the neglect of which can lead to significant losses for an industrial enterprise, is the wrong choice of narrowly targeted pilot projects for the company's digital transformation at the initial stage of strategy implementation without understanding the depth of changes (which is based on the competitive environment analysis and subsequently developed transformation strategy) and the scale of digital transformation (management’s
Global vision of development paths and setting clear objectives for the enterprise digital transformation in terms of sustainable economic development

Comprehensive diagnostics of the enterprise operation system, taking into account key direct and indirect factors of external environment, carried out by a team of experts

Collection, systematization and digitization of the initial data bank: on the level of digitalization of the enterprise’s production and management business processes, the choice of methods and assessment of the digital maturity score and the level of information security, compliance with the requirements of sustainable development of the enterprise, preliminary assessment of additional resources and costs

Identification of bottlenecks in order to update the enterprise business model (markets, raw materials, technologies, preferences of the target audience, customer-oriented management) regarding the following elements: staffing and improving the digital competencies of personnel; justification of the choice of innovative digital technologies that have already penetrated the business environment and proved to be effective; assessment of information, operational, organizational and cyber risks

Justification of the new concept of digital transformation based on the study of existing concepts and selection of top priority areas for digital changes in the enterprise

Designing the environment to create value in the value chain of industrial products, as the significance of the supply chain is reduced and the transition to an ecosystem is made as a new way of doing business

Checking the compatibility of planned digital changes with traditional management methods, assessing compliance with the objectives of stakeholders

Preparation and approval of a long-term initial action plan: testing pilot projects (or programs) and evaluating their effects: summarizing the results and demonstrating their value to the enterprise

Development of digital twins based on cooperation with industry leaders, universities and startups; selection of solutions and suppliers; justification for creating a new digital platform or using an already functioning ecosystem

Assessing the dynamics of results, re-analyzing factors of internal and external environment; making adjustments based on identified digital competitive advantages; analyzing and adjusting the action plan

Clear regulation of the organizational structure of the enterprise and management functions in order to boost engagement of staff and build digital culture of the enterprise

Exploring the issues of scaling the digital transformation of the enterprise to create a single digital space based on horizontal and vertical integration

Carrying out incremental changes aimed at improving (optimizing and digitalizing) business processes, including withdrawing from ineffective business processes in the production and management activities of the enterprise

Monitoring and analysis of transformation results at the level of individual processes and production sites, disseminating the experience to the structural units of the enterprise, standardization of business processes, setting the information exchange format, continuous efforts to improve the digital culture of personnel
1. A strategy of gradual digital transformation based on "lean" transformation of the enterprise or "small victories" in the case when it is impossible or not economically feasible to upgrade the business model in a short period. Applicable to organizations operating in sustainable industries. Such strategy should best comply with the features of the development of production technologies.

2. A strategy of radical transformation, providing for the rapid and simultaneous introduction of digital innovations based on the development of completely new business models, products, production and management methods. Applicable to companies which depend on the Internet and possess an adequate level of digital skills of personnel.

4 Discussion

In the future, the effective digital transformation creates a strategic opportunity for industrial companies to develop global digital integration based on solving future technological and organizational problems in order to share the assets with other companies in a single digital space on the terms of collaboration. Such digital transformation helps "blur the boundaries" between industries and make it possible to launch a digital product on the market at the optimal price, that best meets the real needs of customers (customer-oriented cooperation).

In terms of management, the final substage of this algorithm (monitoring and analysis of transformation results) is especially important, which is performed continuously during the operation of an industrial enterprise in terms of changes in the digital economy within the context of its sustainable development. In this regard, let us consider in more detail the qualitative and quantitative indicators (metrics) for evaluating the effectiveness of the digital transformation strategy implementation in a modern industrial enterprise:

1. Methods, tools and infrastructure of the digital enterprise. Developing a data storage center for storing and processing digital data based on cloud technologies, providing a digital twin of the enterprise on all kinds of digital devices.

2. Business processes and products. Monitoring and continuous optimization of processes in order to update them based on the use of well-known practices of the process approach and leading trends in innovative digital technologies in terms of sustainable development.

3. Data. Ensuring the completeness and security of information, as well as constant access to digital data for making managerial decisions in real time.

4. Business models. Currently, most businesses are experiencing a shift from a traditional to a digital business model. The digital model requires constant updating due to changes in the competitive environment. In the future, the massive use of digital business models becomes the link between innovative technologies and new market opportunities. The criterion for the need to update the business model can be the willingness of customers to use more advanced ways of doing business, if they help significantly reduce time, increase speed and offer the best price for the product.

5. Staffing and digital competencies. Attracting digital talents and advanced training of employees who can learn quickly in today's changing environment. In most cases, the difficulty of transformation is explained by the lack of digital talents in the company.

6. Interaction and digital culture. The readiness of employees for transparent and open virtual communication along with the development of methods and tools for managing digital changes in the company.
5 Conclusion

The most important outcome of digital transformation is the synergistic effect in the process of gradual adaptation of production and management systems to new technological innovations based on the implementation of operational, organizational and cultural transformations of both the enterprise itself and the industry as a whole.

At the same time, the priority driving force behind the implementation of a digital transformation strategy to achieve this effect is the level of digital culture, which unites people, business processes, technologies, and contributes to maintaining competitive advantages, increasing overall production efficiency, and improving the quality of life of the population at large.

References


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