

Digital Transformation of Engineering Enterprise as a Method of Achieving Sustainable Development

Vladislav B. Mironenkov¹^a, Alla V. Surina¹^b, Sergey G. Redko¹^c and Tatiana A. Its¹^d

¹*Peter the Great Saint-Petersburg Polytechnic University, Saint-Petersburg, Russian Federation*

vladislavmiro@mail.ru, a.surina2010@yandex.ru, redko_sg@spbstu.ru, its_ta@spbstu.ru

Keywords: Sustainable development, Simulation modeling, Digital transformation, System dynamics.

Abstract: Today, businesses are forced to look for effective methods of managing the transformation process, make decisions in conditions of uncertainty and within a limited time frame, respond to risks, developing new business models, introducing programs of sustainable development and digital transformation. The article considers influence of digital transformation on dynamics of development of engineering company of processing industry, as well as on sustainability of its development. The company is one of the Russian leaders in providing engineering solutions for industrial enterprises. During the study the activity of the company and its competitors was analyzed, the main problems arising in the process of digital transformation of its activity were identified. As a result, simulation models were proposed to evaluate the dynamics of the company's development "as it is" and "to be" considering the digital transformation of the business process of sales of high-tech products. The proposed system-dynamic models allow to assess the prospect of conducting digital business transformation and sustainability of the obtained result. The models were verified using data from 2018-2022 and assessed the sustainability and future prospects of the company.


1 INTRODUCTION


Due to the high level of uncertainty and structural changes in the Russian economy, the priority task of enterprise management is to ensure accuracy, efficiency and flexibility of decision-making and management methods. In a rapidly changing world, the methods and speed of decision making play a particular role (Popova M., 2020), (Tukkel I., 2020), (Mironenkov V., 2023). The study (Tukkel I., 2020) notes that in Russia the digital economy is becoming an everyday part of economic and political life, as well as the basis for the development of society. According to international agencies, Russia is witnessing a steady increase in the use of information technologies in business and everyday life.


As noted in the studies (HSE, 2020), (Shvedov L., 2021), (HSE, 2022), (Junge A., 2019), such an important production factor as low production costs is beginning to become less important to ensure the competitiveness of companies in the global market. The development of the volume of intangible


components that form part of the final value of goods and the widespread access to digital technologies on a global scale are changing the understanding of the production and distribution of wealth. Signs of this phenomenon include a sharp decline in the prices of robotic and other high-tech solutions, as well as rapid access to foreign markets through e-commerce platforms.

Engineering companies in the Russian Federation are involved in the digital transformation process to varying degrees. In this industry, digital transformation is mainly focused on the internal optimization of companies and does not affect the external environment. Manufacturing processes are one of the components in which the transformation process takes place. The most indicative is the process of sales of manufactured products. It also requires complex transformation. The final value of the enterprise's goods and services depends on the effectiveness of this process, as it is a supporting process that encompasses all business processes of the company and fully encompasses the value chain.

^a <https://orcid.org/0009-0002-2281-5633>

^b <https://orcid.org/0000-0002-7477-9040>

^c <https://orcid.org/0000-0002-4343-4154>

^d <https://orcid.org/0000-0002-4121-3171>

This process determines the sustainability of a company because it encompasses both internal processes and external processes.

Many scientists are working on the relationship between digital transformation and sustainable development. According to studies (Beltrami M. et al., 2021), (Hajishirzi R. et al., 2022), (Martínez-Peláez R. et al., 2023), (Gomez-Trujillo et al., 2022), (Hanelt A. et al., 2021), digital transformation not only contributes to sustainable development in all its aspects - economic, social and environmental, but is also one of the key tools to achieve sustainability.

In a study conducted at Cambridge University (Chandola V., 2015), it is noted that digital transformation has a significant effect on improving the quality of customer service, improving operational processes, has a significant impact on supply chains and speed of information processing. As a result of the analysis of multiple studies, the authors concluded that digital transformation is a strategic factor in ensuring the sustainability of organizational development.

Based on the analysis of the literature, the authors conducted their own research on the relationship between digital transformation and sustainable development, and developed simulation models of "as is" and "to be" assessment of the dynamics of company development, which allowed to determine the level of impact of complex transformation. The company on which the model verification was performed is one of the leaders in the sphere of providing engineering solutions for industrial enterprises in the Russian Federation. The company operates in most regions of the country and has already implemented more than 1000 of its engineering solutions.

Thus, the purpose of the article is to assess the dynamics of engineering companies development on the basis of building a model of business process of sales of high-tech product in the current conditions - building a model "as is", as well as building a model "to be" taking into account the digital transformation and ESG (environmental, social and corporate) factors to assess the effect of comprehensive transformation and further management decisions based on the analysis.

To achieve it, the following tasks were set and solved:

- development of an "as is" model for assessing the dynamics of company development, showing the business process of sales of a high-tech product under current conditions;
- Exploring the relationship between digital transformation and sustainable development;
- development of the model «to be» assessment of the dynamics of company

development, taking into account the digital transformation and ESG factors;

- Verification of models on 2018-2022 data and comparison of forecast results.

2 RESEARCH METHODOLOGY

In order to assess the dynamics of company development, the article applies the methods of system dynamics. The simulation system-dynamic model allows to study the behavior of the system under certain conditions, with the change and addition of new factors that are set by the researcher. Based on the studied system behavior, as a result of comparison of the initial and projected state, managerial decisions are made.

Computer modeling today offers a set of methodological approaches and developed technological tools used to prepare and make decisions of economic, organizational, and social or technical nature (Lychkina N., 2022).

System dynamic models are commonly used in strategic analysis and long-term planning. The most common systems dynamic software products are High Performance Systems' Vensim, Powersim's Powersim, and Ventana Systems' IThink. IThink is a fairly simple tool, yet it supports graphical flowchart creation, built-in logical operators, database connectivity, reporting, and more. (Technical Documentation, 2003).

3 RESEARCH RESULTS

3.1 The "as is" model

The decision to develop a model «as is» of dynamics of engineering companies of manufacturing industry was taken to see the dynamics of development, without making significant changes in business processes.

Engineering companies operating in the industry have been analyzed. Based on the obtained data, the key business process that unites all the companies was selected. This is the sales business process. Average statistical data obtained from the analysis of statistical data, organizational and managerial, accounting reporting of engineering companies since 2018 are used for the development of the «as is» model.

The activity of the companies is aimed at profit from the results of activity, which entails the sale of

products/services. Development is assessed by examining the dynamics of revenue and company value. Therefore, the following indicators were chosen for forecasting the dynamics of engineering companies' development:

- Revenue;
- Profit;
- The company's value.

The developed "as is" model (Figure 1) describes the dynamics of changes in revenues, profits and value of companies under the conditions when the development of companies is carried out without significant changes.

The model consists of three related parts: product distribution, product portfolio, and the financial part (forecasting revenue and company value).

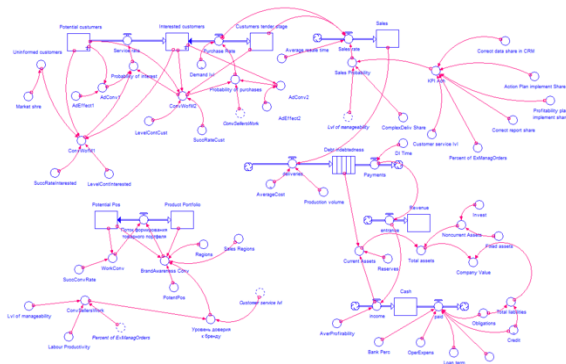


Figure 1: An "as-is" model of the sales business process of engineering companies.

The first part (Figure 2) shows the stages of the sales cycle - the sales funnel, taking into account the influence of external factors and product distribution. This part contains an adapted Bass model that describes the process of distribution of a new product, assuming that the growth of the number of consumers of goods occurs in two channels:

- Advertising effect;
- Interpersonal communication effect (word-of-mouth radio).

In the adapted model, in addition to the channels proposed by Bass, the conversion from the work of sellers, changes in demand in the market are taken into account. An additional stage, interested buyers, has been added to reflect the stages of product distribution in more detail. After the client was brought to the tender stage, the tender must be held and win, to reflect this stage added a flow «rate of sales» and stock «Sales», respectively, with influencing factors.

Thus, this part covers such spheres of company activities as: sales (from external communications to

internal interaction, complexity of deliveries), marketing.

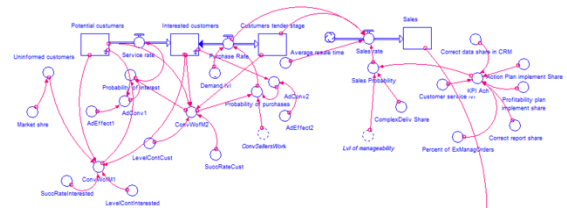


Figure 2: Product distribution.

The second part of the model focuses on the company's product portfolio (Figure 3). The product portfolio has the ability to expand and shrink, it depends on both suppliers and company performance.

This part allows to take into account the breadth of the company's assortment, and also takes into account the work of the sales department, the company as a whole, the external environment, by assessing the level of trust for the brand, the number of regions that company covers.

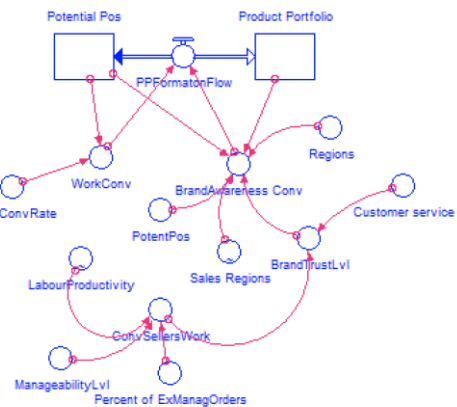


Figure 3: Product portfolio.

The third part (Figure 4) includes the financial block, where the company's development is forecasted by estimating the revenue, profit and value of the company. Revenues are estimated on an accrual basis, therefore, in order to assess the revenue dynamics, it is required to build tables calculating annual revenues. The cost approach is used to estimate the value of the company. It is considered to be the most objective and is used universally in reporting, as well as in assessing the value of companies on the stock exchange, allows to determine how much money will remain with the

owner of the company, if he sells its property and pay off its liabilities.

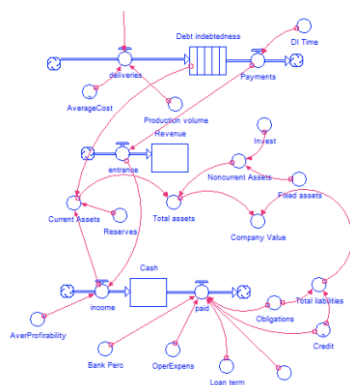


Figure 4: Financial part, forecasting, revenue and company valuation.

The "as-is" simulation model developed by the authors makes it possible to assess the dynamics of company development under current conditions, without significant changes in business processes.

3.2 Exploring the relationship between digital and ESG transformation

For the development of the model «to be» the study of the relationship of the structuring model of the elements of digital transformation and the key elements of ESG transformation (Table 1) was conducted.

Table 1: Relationship of digital and ESG transformation models.

		E	S	G
Work with clients	Better understanding of customers	-	+	+
	Increased revenue from existing customers	-	+	+
	Search for new points of interaction with customers	-	+	+
Operational processes	Automation of manufacturing processes	+	+	+
	Realizing the creative potential of employees	-	+	+
	Performance management based on "big data" analysis	+	+	+
Business model	Spot implementation of new technologies	+	+	+

	Implementation of new digital business models	+	+	+
	Digital globalization	+	+	+/-

Let's consider each of the assessments in detail:

1. E - ecology.

The environmental agenda is becoming increasingly important, both for employees and business owners, as well as for the government and the global community. Investigating the relationship between the digital transformation model and the environmental factor of ESG transformation, it is worth highlighting that this factor should be primarily included in projects to automate production processes, as well as in projects to introduce new technologies into business models. Environmental innovations allow enterprises to remain competitive in the current environment for a long time. Also, this factor is applicable in performance management based on big data analysis, as competent capacity management directly affects the use of resources, which subsequently affects the environment. Environmental digital globalization projects open up new market opportunities and can also improve the economic performance of businesses.

2. S - Social Development.

Social development is a key indicator for employees, suppliers and customers. The principles of social development show the company's attitude towards them.

Considering the relationship between the elements of digital transformation of business and the factors of ESG transformation, it can be concluded that factors of social development permeate the whole model of structuring elements of digital transformation. For example, customer service projects are fundamental to the social development of an enterprise. Application of new methods of interaction, research of customer behavior, application of new channels of interaction lead to an increase in revenue, as well as improve the image component of the brand, investment and commercial attractiveness. Social development also covers projects to change the operational processes of the enterprise and implies improvement of working conditions, team climate, employee interaction and realization of employee potential. All this leads to improved productivity.

Changing the business model of an enterprise also involves social development projects. For example, changing business models involves the introduction of social innovations, application of new methods in the organization of work and processes, which leads

to improved interaction and increased revenue. Digital globalization is a social phenomenon that allows to interact with customers, employees, suppliers anywhere in the world.

3. G - corporate governance.

Just as social development permeates all the elements of structuring the digital transformation model. Customer service projects lead to more effective corporate governance and enable to achieve corporate goals. Corporate governance is directly related to operational processes. Automation projects, performance management projects, and projects to realize the potential of employees lead to increased enterprise performance, increased productivity, which leads to an eventual increase in revenue.

Changing business models is a strategic process, which implies changing the methods of corporate governance and building a corporate structure appropriate to the changes.

Thus, ESG transformation factors permeate the entire model of structuring elements of digital transformation, which allows us to conclude that it is necessary to develop a comprehensive methodology for conducting business transformation, which will allow to conduct not only digital transformation, but also ESG transformation at the same time. This will allow achieving a significant complex effect and growth of both economic and socially significant business indicators.

3.3 The "to be" model

The development of the "to be" model is performed to forecast the impact of a complex digital transformation on the company's development. The developed "to be" model describes the dynamics of changes in revenue, profit and value of enterprises when development is carried out with significant changes in processes. For the development of the model «to be» the same data as for the development of the model «as is» are used.

The key difference in the "to be" model is the detailed tracking of digital processes (Figure 5), including digital communications with the customer, number of digital projects being implemented, process automation, staff training and employee competencies. It also tracks the transition of employees to the remote format of work, the level of technical equipment of the company.

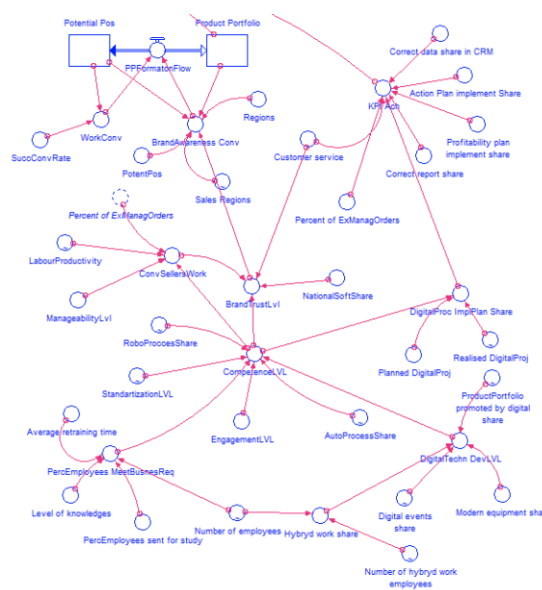


Figure 5: Evaluation block of digital transformation performance indicators.

Digital channel effect tracking added to the sales cycle block:

- Number of online sales channels;
- Percentage of customers consuming digital content;
- Percentage of incoming requests through online services;
- Percentage of customers with whom online interaction is carried out.

It was also decided to tie the complexity of deliveries to the product portfolio. This will allow to assess the complexity of the deliveries not only on the basis of average statistics on the share of complex supplies in enterprises, but also to assess the scale depending on the breadth of the range. That is, the wider the assortment, the greater the likelihood of integrated delivery.

The financial block, in comparison to the "as is" model, remained unchanged.

4 RESULTS

Modeling was carried out on the basis of average statistical data obtained as a result of analysis of statistical data, organizational and managerial, accounting reports of the engineering company. Let's run the simulation for a period of 10 years. This term is due to the fact that it is necessary to consider the dynamics of changes in indicators during the period of both medium and long term planning, in order to

assess the dynamics of the development of enterprises, without making significant changes in business processes and taking into account the complex transformation, by assessing the revenue (Figures 6,7) and the value of the company (Figures 8,9).

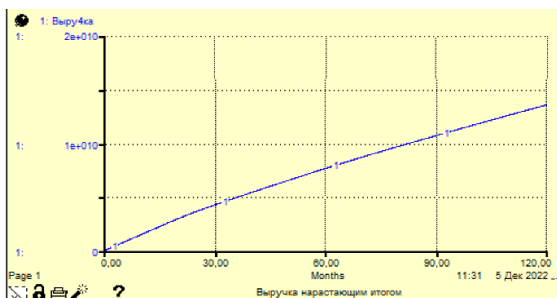


Figure 6: Cumulative "as is" revenue graph.

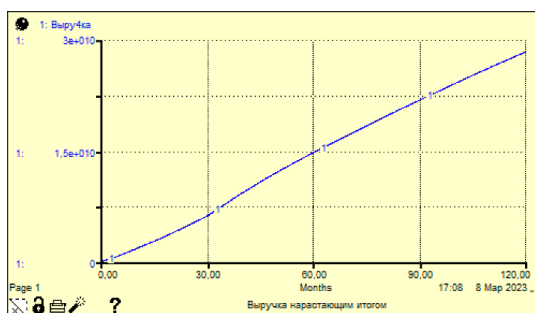


Figure 7: Cumulative "to be" revenue graph.

The cumulative revenue graphs should be decomposed to a table with annual revenue values (Table 2).

Table 2: Revenue values over a period of 10 years.

Year	Revenue «as is», rub.	Revenue «to be», rub.
2022	1 790 000 000	2 220 000 000
2023	1 731 000 000	2 611 625 463
2024	1 459 000 000	3 314 237 847
2025	1 360 000 000	3 585 656 250
2026	1 311 890 000	3 088 875 000
2027	1 278 950 000	2 919 375 000
2028	1 195 520 000	2 816 500 000
2029	1 190 228 000	2 755 250 000
2030	1 143 512 000	2 637 000 000
2031	1 126 600 000	2 508 750 000

Analyzing the data in the table, it can be concluded that the revenue generated by the experiment with the as-is model decreases every year, which may be due to:

- Low sales conversion rates;
- Low advertising effectiveness;

- Low conversion rates from word of mouth;
- Limitations in the volume of production;
- Low share of complex supplies;
- High debt load.

The revenue values from the experiment with the "as it should be" model actively grow during the first 4 years due to the digital transformation, then the revenue value is stabilized in the range of 2.5-2.9 billion rubles, because there are no more active changes in processes.

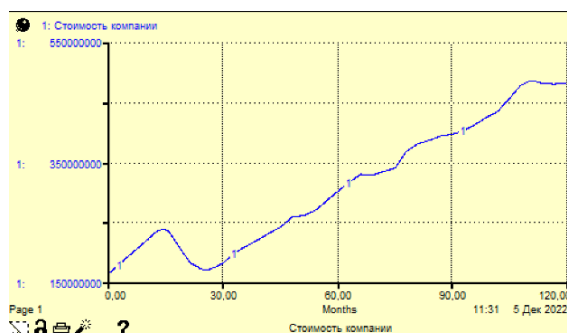


Figure 8: Company value graph «as is».

Analyzing the graph of the company value obtained from the experiment with the as-is model, it can be concluded that the company value is growing quite steadily. The decline in the third year is due to a sharp decline in accounts receivable, which continues to decline smoothly after the third year, and a decline in total assets, which then stabilize at one level. The growth is due to the smoothly growing reserves, growing profits in the first five years, as well as the reduction of debt, which occupy a significant part of the company's expenses. Although the value of the company is increasing, a lack of change in the future could lead to the company's decline and further bankruptcy as revenue and profit margins fall.

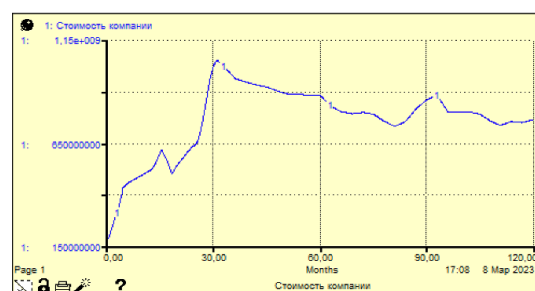


Figure 9: Company value graph «to be».

As a result of the experiment with the model «as it should be» the following graph of the company's value was obtained (Figure 9). The highest value of the company is observed at the 32nd month, then the

value of the company stabilizes around the mark of 750 million rubles, which is a significant indicator for this type of companies.

Thus, as a result of a complex digital transformation, the company is expected to stabilize in the shortest possible time - 2.5 years. This is confirmed by the graphs of revenue and company value. A comparison of the results of the model experiments shows a significant economic effect of a complex digital transformation, but the absence of further changes in the long term may lead to a decline in the company's performance.

4 CONCLUSIONS

Digital transformation is an important tool for a company to achieve sustainable development. The study produced the following results:

- Models for assessing the dynamics of enterprise development "as it is" and "to be" taking into account the digital transformation of the business process of sales of high-tech products of Russian Federation engineering company were developed. Models are characterized by the presence of an additional stage of interested buyers and complex assessment of dynamics of enterprise development, taking into account additional stages and factors of enterprise assessment. The models allow us to assess the prospect of a complex transformation of the company in comparison, to make a decision on its implementation and to assess the result in terms of revenue and value of the company;
- A study of the relationship between digital and ESG transformation is carried out;
- The models were verified using engineering enterprise data for 2018-2022, and modeling results were compared.

REFERENCES

- Popova, M., 2020. One click. In *Digital Economy*, №120, 4-5.
- Yashin, S.N., Tukkel, I.L., Koshelev, E.V., Ivanov, A.A., 2020. *Project and technology management*, BKhV Peterburg, Saint Petersburg.
- Mironenkov, V., 2023. Study of approaches to digital transformation in a rapidly changing environment. In *Concepts of Sustainable Development of Science in Modern Conditions: Collection of Articles of the International Scientific and Practical Conference, Ufa: Aeterna*, 56-64.
- Lychkina, N. N., 2022. *Simulation modeling of economic processes: textbook*, INFRA-M, Moscow, 54.

- HSE, 2020, Digital Transformation of Business Processes. Retrieved from URL: <https://hsbi.hse.ru/articles/tsifrovaya-transformatsiya-biznes-protsesov/> (date of access: 15.10.2023).
- Technical Documentation for the ITHINK & STELLA Software. High Performance Systems, Inc., 2003
- Shvedov, L.A., 2021. Modern State and Prospects of Digitalization of Russian Industry. In *Economics and Entrepreneurship Journal*, 6(131), 246-249.
- HSE, 2022, Digital Transformation: Expectations and Reality: Report to the XXIII Yasin (April) International Scientific Conference on Economic and Social Development, In *Higher School of Economics Publishing House*, Moscow.
- Chandola, V., 2015, Digital transformation and sustainability: Study and analysis, Cambridge, Massachusetts.
- Beltrami, M., Orzes, G., Sarkis, J., Sartor, M., 2021. Industry 4.0 and sustainability: Towards conceptualization and theory, In *Journal of Cleaner Production*.
- Martínez-Peláez, R., Ochoa-Brust, A., Rivera, S., Félix, V.G., Ostos, R., Brito, H., Félix, R.A., Mena, L.J., 2023. Role of Digital Transformation for Achieving Sustainability: Mediated Role of Stakeholders, Key Capabilities, and Technology. In *Journal Sustainability*.
- Hajishirzi, R., Costa, C.J., Aparicio, M., 2022. Boosting Sustainability through Digital Transformation's Domains and Resilience. In *Journal Sustainability*.
- Gomez-Trujillo, A.M., Gonzalez-Perez, M.A., 2022. Digital transformation as a strategy to reach sustainability, In *Journal Smart and Sustainable Built Environment*, 1137-1162.
- Junge, A. L., 2019. Digital transformation technologies as an enabler for sustainable logistics and supply chain processes – an exploratory framework. In *Brazilian Journal of Operations & Production Management*, 16(3), 462-472.
- Hanelt, A., Bohnsack, R., Marz, D., Antunes Marante, C., 2021. A Systematic Review of the Literature on Digital Transformation: Insights and Implications for Strategy and Organizational Change, In *Journal of Management Studies*, 1159-1197.