Selecting the path of the digital transformation of business-models for industrial enterprises

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Abstract. The enterprises transition from the conventional business model to digital one requires an adequate assessment of the digital transformation potential. The authors have considered the features of the digital business model as a “collective use” model based on digital integration, the key effectiveness criterion of which is the faster growth of business value. The aim of the study is to develop tools and recommendations for choosing the most rational path of industrial enterprises transition to a digital model based on the analysis of drivers and traps. A structured representation of growth drivers of digital income and value of the company is given in terms of key elements and processes of the business model. The efficiency matrix of digital business-models has been developed as the basis for formation of digital transformation paths. The typical paths are highlighted the necessary conditions for their implementation are given. A list of criteria for path selection was formed, a procedure for comparative analysis of possible paths based on the method of functional cost analysis was proposed. The approbation of developed tools was carried out; recommendations for selecting the path of digital transformation of the business model of an industrial enterprise were presented.

1. Introduction
The successes of Russia in the digital economy are still low: it ranks the 41st place in the condition of readiness for the digital economy and the 38th place in the rating of economic and innovative results of using digital technologies, and, herewith, with a significant gap from dozens of leading countries [1]. In 2015, a share of the digital economy in the Russian Federation was 2.1% of GDP, which is 1.3 times more than 5 years ago, but 3-4 times less than the leaders. On average in Europe, now a share of the digital economy exceeds 5% of GDP, in the USA – 6%. The leaders have the values, which are 1.5 times higher in terms of digitalization level: The United Kingdom has increased a share of the digital economy up to 8.4% of GDP [2].

The Program “Digital Economy of the Russian Federation” adopted in 2017 [1] is designed to eliminate this lag. According to MacKinsey [3], the real prospects of the sectoral development in the digital economy are:
increase of labor productivity in technical professions due to automation of work – by 45–55%;
– reduction of equipment downtime – by 30–50%;
– reduction of maintenance costs – by 10–40%;
– reduction of stocks holding costs – by 20–50%;
– increase of accuracy forecasting up to 85 ± 5%;
– time reduction to market – by 20–50%.
This is possible based on [4]:
– digitalization of products and services – firstly, addition of existing products with smart sensors or communication devices compatible with data analytics tools, secondly, creation of new digital products designed to provide integrated solutions;
– digitalization and integration of vertical and horizontal value chains from products development and procurement to production, logistics and service;
– application of new digital business models aimed at optimizing customer interaction and improving access, customer service by providing them with integrated solutions in a separate digital ecosystem.

Therefore, the purpose of this article is to develop recommendations on the choice of the most rational path of industrial enterprises transition to the digital business model. The interrelated tasks complex includes:
– study of the features of digital business models and interaction format between the participants of digital integration throughout the value chain;
– analysis of drivers and traps of digital transformation;
– development of procedures and tools for selecting the path of the digital transformation of business-models for industrial enterprises

2. Features of business-models in digital economy
Conventionally, the business model determines how an enterprise carries out its production-economic and entrepreneurial activities, namely, it creates customer value and added value, brings it to the customer, interacts with business partners and receives profit from this activity, satisfying the requests of stakeholders. This is a business concept that has found practical implementation [5]. The modern business concept, as a rule, consists of the following elements: key strategy, strategic resources and competencies, a value chain and forms of interaction with customers [6].

The business model is a way to provide income and ensure the growth of enterprise value. Digital business models are focused on generating digital revenues by means of integration with customers and partners and on the growth of enterprise value by means of vertical and horizontal value chains digitalization [7, 8].

The business model in the digital economy is characterized by a key feature – the digital integration of all participants in the process of value creation and consumption. From this point of view, the digital business model can be described as a business model of joint consumption, where not property ownership becomes important, as much as its effective application, use and provision of enterprise value growth on this basis. Integration of value chain participants is as follows.

1) Enterprise – client.
The enterprises are maximally client friendly and oriented to its continuous development by means of digital technologies that maximally understand and take into account the needs of the client and allow creating an individualized product. The customer is involved in the process of value creation, able to generate innovations. The digital business model allows integrating into the customer space. Joint design and product creation cover people, resources, assets, business processes, products, is scaled by means of the using the information technologies, assuming an effective personal service in terms of “everyone, everywhere, always” [5, 6]. In this case, the conventional form of product presentation is transformed into a network format, which ensures a high rate to market new products and services, and allows for obtaining exponentially growing profits.
2) Supplier, partner – enterprise.

The company is integrated with the suppliers and partners to the maximum in terms of provision and consumption of resources and competencies. Suppliers take into account the needs of the enterprise-consumer as much as possible, integrating into its working space. The enterprise-consumer is also integrated into the cooperation space of suppliers and partners and has the ability to influence their work processes.

3) Suppliers, partners – the manufacturer’s client.

Suppliers and partners of an enterprise that produces key customer value are also integrated into the end-user space, either through the enterprise or directly. The supplier most accurately examines and fully understands the needs of the client and offers the manufacturer new materials and technologies, acting as an additional incentive for innovation.

This integration which “erases” and expands the physical and virtual boundaries of industrial enterprises is based on the digital trust of participants carrying out shared use and consumption. This requires new rules and standards of interaction.

Generally, the interaction in the digital economy is carried out through digital platforms that allow participants to share assets, resources, time and competences. This allows interaction participants to use assets, which were not previously used or were underutilized. Digital platforms couples together participants, resources and results as a single, rapidly developing economic compatible system and thereby maximize the profits of all participants [9].

The digital platform is a business model that is entirely based on information technologies providing profits by means of the exchange between independent groups of participants, which are directly combined by means of the platforms, without intermediaries. They also enable various companies to share information and thus significantly improve cooperation, and create innovative products and solutions [4, 10].

Democratic nature and transparency of the digital platform business models generate new types of business relationships, covering all hierarchical levels of business and all participants. Digital platforms are mediation in C2C (consumer to consumer) schemes, B2C (business to consumer), C2B (consumer to business), B2B (business to business), G2B (government to business), G2C (government to citizen), C2G (citizen to government), P2P (equal to equal), etc. [10].

The effectiveness of digital models is based on the following key competitive advantages: product delivery rate; maximum productivity; maximum quality (value); minimum costs, including transaction ones due to economies of scale (shared use); high flexibility and rapid changes adaptability.

The transition to digital business models is inevitable and transitional business models shall be developed now. For this purpose, first of all, it is necessary to understand the nature and level of digital costs and digital dividends, their drivers and traps.

3. Digital business models: transition drivers and traps

When transiting to digital technology, enterprise management expects to obtain the following effects: business optimization; planning and control effectiveness increase; operational efficiency increase; improvement of customer relationships based on using their own intellectual resources and access to the intellectual resources of customers and partners at all stages of the product life cycle; more efficient use of assets; development or optimizing of new or existing products; increase of sales revenue; optimization of transport and logistics costs; improvement of product or process quality; efficient servicing of own clients' assets or products; improvement of collaboration and decision making with partner companies.

The detailed description of drivers for the digital business model is given in table 1.
Table 1. Drivers of digital business-model effectiveness (summarized by the authors based on [4, 8, 11–13]).

| Business model elements and processes | Drivers of digital revenue and company value growth | Digitalization result |
|--------------------------------------|---------------------------------------------------|-----------------------|
| Consumer value of the product (service) | Digitization of products and services within the existing portfolio | Growth of income from products and services provided in the new format |
| | New digital products, services | Increasing the market share of basic products due to their personalization |
| | Provision of big data and analytics as a service | Growth of market share due to digital customer integration |
| | Personalized products and global orientation | Revenues from the platforms creation. |
| | Customization of products and services | Capturing a highly profitable business by improving the understanding of data analytics |
| | Digital customer integration | |
| | Creation of digital platforms and shared use – on their basis | |
| Production arrangement processes logistics | Digital integration and cooperation with partners | Increase of company cost |
| Processes logistics | Intensive exchange of intellectual property in the form of open innovation | Growth of income from intellectual activity and implementation of intellectual property rights. |
| Information support | Standardization, harmonization of standards and rules of data protection; | Growth of information security effectiveness |
| Product promotion | Digital asset integration | Revenue growth by means of sale and rental of assets and digital distribution channels |
| | Digitalization of sales channels | |
| | Digital platforms | |
| Financial security | Investing in digital infrastructure, digital products | Growth of income from investing in digital infrastructure |
| | Crowd platforms creation | |

Like any innovation process, digitalization is controversial. It is costly, especially at the initial stages of the life cycle; characterized by a high level of risk; requires new competencies and skills, as well as significant systemic transformations that often meet with resistance and require costs to remove barriers. Digitization violates financial stability and is characterized by a time delayed effect, which contradicts the requirements of the stakeholders. One of the negative consequences of digitalization is reduction in a number of employees, which can lead to social conflicts [11].

The key traps of digitalization are: frequent lack of a clear vision of digital operations and lack of support from top management; resistance to systemic transformation; not always clear economic benefits and high financial investment requirements; unresolved data protection issues; lack of competence and qualifications of specialists; absence of digital standards, norms and certification; lag of digital infrastructure development. In addition, not all business partners can collaborate with digital solutions due to inconsistencies in their digitalization level; there is a risk of losing control over the intellectual property of the enterprise.

Particular importance are the risks of data security violation: high risks of liability due to data loss; unauthorized extraction or modification of data within the internal data flow of the enterprise; loss of reputation and loss of trust due to data loss; improper data during the exchange of information with partners [14].

Thus, the management of enterprises faces a multi-criteria choice of such a path in the transition to the digital business model that provides increased benefits and risks arrest.
4. Paths of the digital transformation of business-models

Assessment of the potential for digital transformation of industrial enterprise business models is particularly relevant for Russian enterprises that operate based on the background of investment activity reduction, lack of liquidity, high degree of depreciation of fixed assets, low values of equipment renewal ratios [2, 12].

The target for stakeholders is the enterprise value. Therefore, any business model and the relevant transition path are considered in terms of ensuring the growth of this indicator [13, 17]. The effectiveness of implementing the digital business model can be assessed as the contribution of digital technologies to the growth of enterprise value. Herewith, it is important to assess the sensitivity of the company's value to the implementation of innovation (digital) technologies in terms of “cost without digitalization – cost with digitalization”. The developed matrix of digital business models efficiency is shown in figure 1.

There are several business paths in the matrix that represent the sequence of business model changes.

The transformation path (DBM 4 – DBM 3 – DBM 2 – DBM 1) requires a global change of all elements of the enterprise. Sequential transformation will reduce the risk of value loss from transition to a new model. But in time this path is uncompetitive. The solution in this situation will be the strategy of digital cooperation at all transition stages.

The transformation path (DBM 4 – DBM 2 – DBM 1) requires the existing change of all elements of the enterprise. Rapid transformation will reduce the risk of value loss from transition to a new model by means of innovation application. But in time this path is more competitive than the previous one. As well as the solution in this situation will be the strategy of digital cooperation at all transition stages.

The transformation path (DBM 4 – DBM 1) is practically impossible on the basis of its own resources and without investments in unique innovative technologies. Depending on the enterprise assignment to one or another type of the business model (starting point), other paths are also possible, for example: (DBM 3 – DBM 2 – DBM 1) or (DBM 3 – DBM 1). Depending on the enterprise assignment to a particular type of business model and the implemented innovation strategy (leader, simulator, follower) [3], paths are possible (DBM 4 – DBM 3 – DBM 2) or (DBM 3 – DBM 2), etc.

As parameters that determine the selection of path for the digital transformation of the business model of the industrial enterprise, it was proposed to use:

- ensuring maximum integration with the consumer (maximum product value) – P₁;
- ensuring maximum production output – P₂;
- ensuring maximum competitiveness- P₃;
- ensuring maximum integration with partners (minimum transaction costs) – P₄.
Growth of company value as a result of implementation digital technologies

Significant

| Digitalization level | Low | High |
|----------------------|-----|------|
| **DBM 2 – Balanced growth business model** | The enterprises demonstrate a qualitative growth both in the implementation of digital technologies, and in the conditions for operation of current assets. The transformation potential is high. The support is supporting investments, investments in current activities expansion and investments in the creation of new growth opportunities. A ratio of business value growth with digitalization to growth without digitalization is equal to and greater than 1 | **DBM 1 – Outstripping growth business model** | Innovative enterprises are able to grow by increasing and effective use of innovative and digital assets and technologies. The transformation potential is high. The basis is the investments in creating new growth opportunities by means of digitalization. A ratio of business value growth with digitalization to growth without digitalization is significantly greater than 1 |
| **DBM 3 – Inertia growth business model based on the reactive strategy** | The enterprises do not demonstrate a value increase either in the existing conditions or in the conditions of digital technologies implementation. It is necessary to implement a complex of organizational innovations that orient the enterprise to the effective use of the existing potential. A ratio of business value growth after digitalization and growth without digitalization is 1 and greater than 1 | **DBM 4 – Overtake growth business model based on the survival strategy** | The company operates the existing assets, and it is not focused on finding new growth opportunities. The basis is the supporting investment, investment in the expansion of current activities. A ratio of business value growth after digitalization and growth without digitalization is equal to and greater than 1 |

Figure 1. The matrix of digital business models efficiency.

The selection procedure is built in accordance with the functional-value analysis logics [15, 16] and will be considered based on the example of a separate enterprise.

5. Obtained results

At the first stage, to determine the relative significance of the parameters, a parameter adjacency matrix is built (table 2).

| Parameter adjacency matrix for selection of the digital transformation path. |
|-----------------------------|-------------------------------------------------|-----------------------------|
| Parameter | P1 | P2 | P3 | P4 | Points sum | Parameter significance |
| P1 | 1 | 1.5 | 1 | 1.5 | 5 | 0.31 |
| P2 | 0.5 | 1 | 0.5 | 1.5 | 3.5 | 0.21 |
| P3 | 1 | 1.5 | 1 | 1 | 4.5 | 0.29 |
| P4 | 0.5 | 0.5 | 1 | 1 | 3 | 0.19 |
| Total | 16 | 1.0 |

The assessment is carried out by using a paired-comparison method. According to the assessment results, the first parameter has the maximum significance – ensuring the maximum integration with the
consumer (P1). Accepted points: 1.5 – important parameter (main function), 1 – minor parameter; 0.5 is a minor parameter.

According to the analysis results, the company in question takes a very unattractive position: DBM 4 – Overtake growth business model based on the survival strategy. Since the enterprise is strategically important for the region, a decision is made to transform the existing business model and achieve a digital leader position – DBM 1 (outstripping growth business model) or DBM 2 positions (balanced growth business model). Then, for an enterprise, the following paths of digital transformation can be formed:

1) DBM 4 – DBM 1;
2) DBM 4 – DBM 2 – DBM 1;
3) DBM 4 – DBM 3 – DBM 2

For each of the possible paths, parameters adjacency matrices are built in a similar way to assess their compliance with the ranked list of parameters. Table 3 compares the paths of the digital transformation in the first parameter – ensuring the maximum integration with the consumer. The results of generalizing the comparative analysis based on the formed list of parameters are given in Table 4.

### Table 3. The adjacency matrix of digital transformation paths by the first parameter.

| Path       | DBM 4 – DBM 1 | DBM 4 – DBM 2 | DBM 4 – DBM 3 – DBM 2 | Points sum | Significance as per P1 |
|------------|---------------|---------------|-----------------------|------------|------------------------|
| DBM 4 – DBM 1 | 1             | 0.5           | 1                     | 2.5        | 0.27                   |
| DBM 4 – DBM 2 – DBM 1 | 1.5          | 1             | 1.5                   | 4          | 0.45                   |
| DBM 4 – DBM 3 – DBM 2 | 1             | 0.5           | 1                     | 2.5        | 0.27                   |
| Total      | 9             | 1             | 2.9                   | 9          | 1.0                    |

### Table 4. Adjacent parameters and calculation of complex priority indicator.

| Path       | P1  | P2  | P3  | P4  | P compl. |
|------------|-----|-----|-----|-----|----------|
| DBM 4 – DBM 1 | 0.27| 0.27| 0.46| 0.32| 0.33     |
| DBM 4 – DBM 2 – DBM 1 | 0.45| 0.45| 0.32| 0.46| 0.41     |
| DBM 4 – DBM 3 – DBM 2 | 0.27| 0.27| 0.22| 0.22| 0.25     |
| Total      | 0.31| 0.21| 0.29| 0.19|          |

Thus, based on the assessment of the weight of the quality characteristics, the path (DBM 4 – DBM 2 – DBM 1) has become the best for the enterprise. However, the considered procedure does not contain the assessment of costs for the necessary transformations. To improve the accuracy of the recommendations, it is necessary to form an integral indicator reflecting a share of digital quality growth (complex indicator) that is accounted for a unit of enterprise expenses when selecting a path.

### 6. Conclusion

1. The digital economy is distinguished the integration of all participants in the value creation process as a key feature of business models. The format for implementation of interactions by individual links of the chain (enterprise – client; supplier, partner – enterprise; suppliers, partners – client of the manufacturer) has been determined.

2. Drivers and traps of digital transformation have been determined; among the main factors of growth in value of industrial enterprises in the digital economy are: creation and use of multilateral digital platforms; appearance of new digital products and services, and their personalization; intensive
The exchange of intellectual property in the form of open innovation. The most significant risks are: information security violation; lack of digital standards and norms; low digital maturity of enterprise management.

3. The matrix of digital business models efficiency was built, giving a detailed description of four types of digital business models (overtake growth, inertia growth, balanced growth and outstripping growth) in the coordinates of enterprise value growth only by means of traditional assets (without digitalization) and the use of digital economy capabilities.

4. Alternative paths of digital transformation of business models for industrial enterprises have been formed. The parameters of the path comparative assessment are proposed: ensuring the maximum product value, maximum production efficient, maximum competitiveness and maximum integration with partners.

5. Based on the example of regional industrial enterprise, the procedure for selecting the digital business transformation path based on the technology of functional value analysis was developed and approved. The feasibility of enterprise transition from the overtake growth business model to the balanced growth model, and then outstripping growth due to the accelerated transformation of all elements of the enterprise based on the industrial and organizational innovations was shown.

7. **Trends of further research**

The approach proposed in this article allows determining the most appropriate digital business transformation path from the view of ensuring competitiveness. However, it does not fully take into account the resource costs necessary for transformations implementation. A more accurate accounting of costs in the formation of an integrated estimated indicator, and ways to reduce costs due to the selection of participants and forms of cooperation are the actual trends of further research.

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