

Investment analysis of the formation of a digital platform of a cluster-type industrial ecosystem

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Abstract. The article discusses the theoretical provisions in the field of digital platforms formation, their key features and their classification is presented. The key differences between the concepts of industrial ecosystems and industrial clusters, as well as the relationship between them, are revealed. The main advantages of digital platforms have been studied in the form of reducing or completely eliminating territorial and temporary barriers, reducing transaction costs, and the possibility of creating additional value for goods and services, thereby creating a competitive advantage for companies. The approaches to assessing the effectiveness of the introduction of a digital platform in an enterprise by considering this process as an investment project, as well as the impact on the company's activities as a whole and evaluating the qualitative improvements of the changing business process are considered. The study of the obtained results of the application of these approaches to assess the effectiveness of the digital platform in a real enterprise operating in the market of specialized services. The introduction of the digital platform proved to be effective both from the point of view of the investment project for the company and from the point of view of improving the company's activities as a whole. In addition, the digital platform allowed the company to qualitatively improve the company's business processes according to a number of performance indicators developed taking into account the specifics of the implemented platform.

1 Introduction

New trends in the economy associated with the development of digital technologies and the introduction of Industry achievements 4.0/5.0 dictate companies to search for new, more efficient business models of doing business [1, 2]. Today, a successful manufacturing company must be flexible, innovative and highly efficient, because companies not only face fierce competition in the market, but also there is a constant increase in product requirements due to new legislation, regulations and growing customer expectations.

The answer to such challenges in a competitive market is the introduction of digital platforms by companies into their business processes, which allows removing many territorial and temporary barriers, reducing transaction costs, gaining access to more efficient analytics tools and much more [3, 4].

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We can consider the following definition of this phenomenon: «Digital platforms are digital infrastructures that enable two or more groups to interact. They therefore position themselves as intermediaries that bring together different users: customers, advertisers, service providers, producers, suppliers, and even physical objects» [5].

Based on this definition, it can be noted that digital platforms are analogous to the real market, where interaction takes place between different groups of participants: sellers, buyers, site owners and others, in the format of a digital environment, due to which each group of platform participants receives various advantages. It facilitates interaction between several groups of users and allows you to create more product value than the one that the participants could receive individually [6-8].

Thanks to the use of the digital platform, the productivity of the enterprise is increased by reducing the time required to develop a new product, launch it on the market and deliver it to the consumer, optimizing the company's resources, improving product quality, the possibility of more accurate forecasting, improving safety and productivity, and much more.

Ultimately, all this makes it possible to achieve two main goals of the work of almost any organization:

- Increase in profit by increasing sales volume or by increasing the price without much change in sales volume.
- Reduction of various costs without deterioration of the quality of production, execution of orders.

The introduction of digital technologies involves both horizontal digitalization and integration of processes - that is, there are changes in the form of interaction with suppliers, consumers, partners within the value chain - and vertical changes in processes during the development of products and services, their production, the procurement process, logistics, etc.

It is also impossible not to note the versatile nature of digital platforms, which can manifest itself in differences in the scale of their distribution, the number of participants, etc.

The authors' analysis of publications [9-11] allowed us to propose the following classification of digital platforms in the economy:

By the scale of the platform's activities:

- Global - operate at the global level.
- National - operate at the country level.
- Regional - operate at the level of individual regions.

By field of activity:

- Industry - digital platform for improving the efficiency of the enterprise, reducing the number of defects, automating processes, etc.
- Communication - social networks (Facebook), video sharing (TikTok), photos (Instagram)
- Transport - taxi aggregators, passenger or cargo delivery (Uber)
- Tourism - rental of housing, purchase of tours (Booking.com)
- Trade - exchange of goods between the participants of the platform (Ebay)

By type of activity:

- Advertising platforms - analysis of the interests of site visitors, drawing up a portrait of consumers, providing information to other interested parties of the platform
- Product platforms - delivery of products and other goods
- Cloud platforms - a set of tools designed for remote launch and use of applications without the cost of purchasing server equipment

By aggregator functions:

- Building relationships - users make a request, after which they have the right to agree or refuse the service (Uber)

- Building correspondences - searching for the right services by filter with the output of the most optimal options (Airbnb)
- Conducting a comparison operation - platforms for comparing different goods and services by category (Various marketplaces)

And these are far from the only possible approaches to the classification of digital platforms, which once again confirms the versatile and multifaceted nature of this phenomenon.

The era of digital transformation caused by the transition of industrial enterprises to new forms of production and the active use of diverse information and communication technologies has led to the formation of integrated intellectual structures called industrial clusters, the main feature of which is that they work on unified digital platforms [12].

Such an association allows companies to reduce transportation costs, reduce the time for transporting goods between production entities, create a single raw material base and simplify the process of purchasing the necessary raw materials due to more complete information that is quickly transmitted between production entities.

In addition, the integration of participants on a single platform allows companies to reduce production risks, conduct an internal exchange of knowledge and experience between companies in the cluster, which increases the productivity of companies, the reliability of business processes, and the quality of goods. Another significant advantage of the industrial cluster is to increase the efficiency of innovation implementation at all stages of production [13].

The following definition of an industrial cluster can be considered: an industrial cluster is an association of interconnected and interacting organizations in a separate localized territory within the framework of related economic activities that have a single chain of product creation, a tendency to innovate, due to which the competitive advantages of participants are combined and synergetic effects are achieved.

As a result of the changes introduced by the introduction of the digital platform, as the scale of distribution increases and the structure of the platform becomes more complex, the digital ecosystem of the company is gradually being formed, which includes suppliers of resources and components, consumers, partners, service services [14].

This allows you to combine the efforts and resources of many participants in order to obtain the common advantages of the platform model. This is due to higher requirements for knowledge, technology, and large material costs compared to the classical model, which are necessary for the introduction of digital technologies.

The formed ecosystem of the enterprise has the following features [15]:

- Minimization or absence of barriers to entry
- Constantly changing list of participants
- Ecosystem sustainability in the form of the ability to successfully develop without external influence
- Striving for development in the form of adding or improving existing ecosystem services, expanding the membership, etc.
- Almost complete absence of hierarchical top-down control between ecosystem participants

Thus, the ecosystem can also be considered as a more perfect form, the next stage in the development of the organization of interaction of participants in comparison with industrial clusters.

The industrial ecosystem has a greater openness in comparison with the cluster, a wider composition of participants due to the active involvement of consumers, wider opportunities for territorial distribution, acts as a rule at the junction of innovations in several industries at once.

The purpose of the study is to conduct an investment analysis of the formation of a digital platform of a cluster-type industrial ecosystem.

Research objectives:

- To present the theoretical aspects of digital platforms, industrial ecosystems and clusters, their main features, classifications.
- Consider approaches to assessing the effectiveness of the introduction of digital platforms in the enterprise.
- To study the main indicators for evaluating the effectiveness of investment projects.
- To evaluate the effectiveness of the implementation of the digital platform at a particular enterprise according to the formed approaches.

The object of the study is a cluster-type ecosystem, the main enterprise of which is the enterprise considered in the framework of the study, operating in the market of specialized services.

2 Methods

The method used in the course of the study is a review of the literature on digital platforms, industrial clusters and ecosystems, Industry 4.0/5.0, supported by relevant research.

By applying the methods of analysis, synthesis and comparison of case studies, the concept and essence of the digital platform, production ecosystems and clusters were examined and the classification of digital enterprise platforms based on them was formed.

Among the special methods – an analysis of the financial and economic activities of the organization was carried out, methods of evaluating the effectiveness of investment projects were applied.

In the course of the study, the impact of the introduction of a digital platform on the company's activities is being studied on the example of a real company - for which the following assessment approaches were used: studying the impact of the introduction of a digital platform on the company's activities as a whole, considering the implementation of the platform as a separate investment project, as well as the use of a number of performance indicators to study qualitative improvements in the changing business process.

To assess the economic effect of the introduction of a digital platform at the enterprise, the hypothesis was used about the possibility of considering the introduction of a digital platform at the enterprise as an investment project, that is, an investment of capital for a certain period in order to generate income. This assumption allowed us to apply a number of indicators for evaluating investment projects to study the success of the implementation of the platform.

The following are most often used as indicators for evaluating the effectiveness of investment projects:

1. Net income - total income less total expenses and income tax.
2. Net present value NPV - analogue of net income taking into account the time factor, the difference between the income brought to a certain point and the reduced costs. It must be greater than zero so that the project does not go into negative territory.
3. The internal rate of return is a discount rate at which the net discounted income of the project will be zero. The higher the IRR, the higher the profitability of the project, because you can put more risks into the project.
4. Cost return index - the ratio of the amount of cash inflows to the amount of cash outflows.
5. Profitability index - the ratio of the amount of discounted cash flows to the initial investment, the project will be profitable if the value for this indicator is higher than one.

6. The payback period of the project is the period of time required for the cash flows from the project to reimburse the initial costs of the project.

But it is important to understand that the effect of the introduction of a digital platform can be expressed not only in monetary terms – for example, it can be aimed at growing the customer base in order to increase future income or for other purposes. Another possible direction may be to reduce the duration of the production cycle due to the advantages of digital technologies, thereby the product will be able to enter the market faster.

In addition, digital platforms can also be aimed at reducing production costs – by freeing up part of the staff (the computer will take over their functions) or reducing the cost of production due to more efficient production, equipment operation, etc.

Often, when implementing the platform at once at different levels of the enterprise, it leads simultaneously to many of the described changes.

Thus, in addition to studying the effectiveness of the implementation of the digital platform from the point of view of the investment project, it makes sense to consider the impact of the implementation of the platform on the company's activities as a whole.

In addition, digital platforms are usually implemented by companies to obtain the qualitative advantages of digital technologies discussed in the previous section of the study, in connection with which it also makes sense to consider the impact of the introduction of a digital platform on the key performance indicators for the business process being changed.

In the course of the study, the effectiveness of the implementation of the platform was studied in practice in accordance with the approaches considered: first as an investment project, then the impact on the company's activities as a whole, as well as changes in the performance indicators of the business process being changed.

3 Results

To assess the feasibility of implementing a digital platform of the industrial ecosystem, a study of this process was conducted on the example of an enterprise operating in the market of specialized services, introducing a digital platform in the form of electronic document management to improve the company's business processes, which replaces paper document management. In turn, this allows the company to reduce the number of employees to perform the same amount of tasks related to the maintenance of documentation, the formation of registers and many others.

Moreover, the company expected to gain a number of advantages through the introduction of digital technologies:

1. Control over the expenditure of funds (their intended use).
2. The ability to download supporting documents in electronic form, without paper.
3. Formation of payment registers on the electronic platform.
4. Step-by-step monitoring of the registry approval process.
5. Information about the approving persons is displayed directly on the site.
6. Improving the timing of approval of registers (For wages and tax registers - 2 working days, for the rest - 5 working days).
7. The ability to make adjustments to the registry right on the site.
8. There is no need to re-upload supporting documents for payment orders if they were uploaded for registries.
9. Automatic tracking of the fact of execution of the declared amount in the payment register.
10. The ability to track the fulfillment of the stated financing needs (for example, purchased fuel for construction).

From the point of view of qualitative advantages, the following can be noted:

1. Control - conducting a bank examination of documents justifying the intended use of funds.
2. Informative - a more visual representation of the processes in electronic form.
3. Transparency of processes - all processes are automatically monitored.
4. Simplicity of processes - simplification or avoidance of many unnecessary actions, paper formats.
5. History - you can track changes in a single electronic form.

To begin with, let's consider the impact of the introduction of a digital platform in the enterprise on the company's activities as a whole. Due to the introduction of digital platforms, the company can reduce part of the staff while maintaining the same level of task performance.

Table 1. Staff costs before and after the platform implementation in 2023, thousand rubles (developed by the author)

Employee's position	Was before implementation		Became after implementation		Deviation	
	Number, people.	Total expenses, t. rub.	Number of employees, pers.	Total expenses, t. rub.	Number of employees, pers.	Total expenses, t. rub.
General Director	1	12000	1	12000	0	0
Deputy General Director	4	24000	4	24000	0	0
Head of Department	10	30000	10	30000	0	0
Manager	20	48000	20	48398	0	398
Logistician	24	48960	22	44880	(2)	(4080)
Accountant	17	30600	15	27000	(2)	(3600)
Economist	8	12480	7	10920	(1)	(1560)
Clerk	1	1320	2	2640	1	1320
Courier	4	4320	1	1080	(3)	(3240)
<i>Total</i>	<i>89</i>	<i>211680</i>	<i>82</i>	<i>200918</i>	<i>(7)</i>	<i>(10761)</i>

Based on this table, it can be noted that the digital platform allows you to reduce the staff for solving current tasks by 7 people – from 89 to 82 people. For the most part, the changes concern the courier service, as well as logisticians and accountants. At the same time, it is also necessary to attract an additional clerk due to the increased use of multifunctional devices.

From the point of view of numerical values, the changes will allow the company to reduce its personnel costs by 10 762 thousand rubles, which in absolute terms is a fairly significant amount even for a large company.

Moreover, it should be noted that the reduction in personnel costs will also lead to a reduction in a number of related costs – meals, travel, rent, etc., which is shown in Table 2.

Table 2. Total changes in general operating expenses for 2023 before and after the implementation of the platform, thousand rubles (developed by the author)

Article BDR	Was, thousand rubles.	Became, thousand rubles.	Deviations, thousand rubles
Labor and personnel	211 680	200 918	(10 761)
Expenses for maintenance and operation of fixed assets	29 351	27 742	(1 609)
Lease	22 926	21 918	(1 008)
Amortisation	2 283	2 283	0
Other expenses	51 542	48 419	(3 123)
<i>Total</i>	<i>317 783</i>	<i>301 281</i>	<i>(16 502)</i>

Despite the fact that the main source of cost reduction is precisely labor costs: wages, insurance premiums, vacation reserves – about 65% of total expenses, the reduction of interrelated expenses is also quite significant for the company and in total reaches values of 16 502 thousand rubles.

Let's consider the impact of the implemented digital platform on the company's activities as a whole using the example of the company's financial results report presented in Table 3.

Table 3. Report on the company's financial results for 2023, in thousands of rubles (developed by the author)

Indicator	Code	Value was, thousand rubles.	The value has become, thousand rubles.	Deviation, thousand rubles	Deviation, %
<i>Revenue total</i>	2110	22 060 429	22 060 429	0	0
Cost of sales	2120	(20 519 904)	(20 519 904)	0	0
<i>Gross profit (loss)</i>	2100	1 540 525	1 540 525	0	0
Business expenses	2210	(858 276)	(858 276)	0	0
Management expenses	2220	(317 784)	(301 282)	16 502	(5.19)
<i>Profit (loss) from sales</i>	2200	364 465	380 968	16 502	4.53
Income from participation in other organizations	2310	0	0	0	0
Interest receivable	2320	4 833	4 833	0	0
Interest payable	2330	0	0	0	0
Other income	2340	126 040	126 040	0	0
Other expenses	2350	(147 645)	(147 645)	0	0
<i>Profit (loss) before tax</i>	2300	347 694	364 196	16 502	4.75
Current income tax	2410	(69 539)	(72 839)	(3 300)	4.75
incl. permanent tax liabilities (assets)	2421	0	0	0	0
Change in deferred tax liabilities	2430	(2 417)	(2 417)	0	0
Change in deferred tax assets	2450	7 185	7 185	0	0
Other	2460	(520)	(520)	0	0
<i>Net profit (loss)</i>	2400	282 403	295 605	13 202	4.67

In general, it is possible to note the improvement of the company's activities after the introduction of the digital platform at the enterprise, which may indicate its effectiveness.

Due to the reduction of general economic expenses by 5.19%, the operating and other types of profit of the company also increase.

Nevertheless, we must not forget that these changes will also lead to an increase in profit before income taxes, which means that the volume of taxes themselves will increase somewhat due to the growth of the tax base.

In this regard, net profit as a result of the change will grow by 13 202 thousand rubles or 4.67%, which is a very significant amount on the scale of a large company, including.

We will also consider the results of evaluating the effectiveness of the implementation of the digital platform from the point of view of the investment project.

To implement the digital platform implementation project, the company takes a bank loan for 3 years at 8% per annum in the amount of 15 000 thousand rubles with payment of 1/3 of the loan body during each year, together with annual interest on the loan.

During the 1st and 2nd quarters of 2023, the company invests more than half of the funds received for the development and implementation of the digital platform, while the advantages of the platform are not realized during this period, therefore, there are no changes in labor costs, etc., during the 3rd and 4th quarters, the platform is planned to reach operational indicators, due to than the company will begin to receive a "return" from the use of digital technology, while the amount of investment will decrease significantly. In subsequent periods of time, the company plans that the platform will fully reach operating capacity, and investments will be associated with minor improvements and modifications of the platform, as well as its maintenance.

The results of evaluating the effectiveness of the platform as an investment project by a number of indicators are shown in Table 4.

Table 4. Calculation of a number of investment indicators to assess the feasibility of implementing the platform as an investment project for the company under consideration (developed by the author)

№	Indicator	Units of measurement	Estimated value	Planned value	Deviation
1	PP	years	2	5	+
2	DPP	years	2	5	+
3	NPV	thousand rubles	4 868	0	+
4	IRR	%	19	8	+
5	PI	-	1.325	1.000	+

NPV at the end of 2025 will amount to 4.868 thousand rubles, which is higher than 0, the simple and discounted payback period of the platform will be 2 years - which is much faster than 5 years, during which the company hopes to recoup the implemented technology, the internal rate of return IRR is 19%, which is higher than the discount rate, and the PI is equal to 1.325, which exceeds the value of 1.

From the point of view of the investment project, the introduction of a digital platform in the company is appropriate for each of the criteria under consideration.

Thus, it can be concluded that the introduction of a digital platform for the company in question will be beneficial both from the point of view of the company's activities as a whole, and when considering this process as an investment project.

4 Discussion

It should be noted that the digital platform is still not without its drawbacks, which also applies to the example under consideration:

1. The stated deadline for approving registers (2 and 5 working days) is not always fulfilled, may be increased depending on the workload of the coordinating units.
2. The declared amount in the register is not always financed by the customer on time - for example, the register can be agreed, and the declared amount arrives only after 1-2 months.
3. It is not possible to add missing documents when sending the registry for approval, if it is not returned for correction.
4. The inconvenience of switching between several electronic platforms for conducting the banking support process.
5. Some inconveniences from the point of view of the platform interface.

Based on the analysis of these shortcomings, it is already possible to propose a number of improvements for the digital platform being developed, related to simplifying the procedure for approving registries, as well as refining the platform interface taking into account the experience of employees who use it on a regular basis – for example, add the ability to upload documents even when sending a package of documents for approval.

In addition, as already noted in the previous sections of the study, when implementing a digital platform, companies tend to, among other things, qualitatively improve the transformed business processes, which can be expressed in speeding up operations, reducing the number of failures, reducing the influence of the human factor, and so on.

To do this, it is necessary to work out key performance indicators for the digital solution under consideration, which will allow the company to assess the economic effect of the introduction of digital platforms not only from the point of view of monetary indicators, but also to assess the impact on the qualitative characteristics for which, among other things, changes were made.

The value of the change in indicators is obtained based on the assessment of the company's employees involved in the implementation of the platform, as well as employees who use this platform in their work processes.

Information on performance indicators is presented in table 5.

Table 5. Key performance indicators for the implemented digital platform at the enterprise (developed by the author)

Metric for measuring	Units of measurement	Changes in the value compared to the original	Meeting the set expectations
Average document processing time	Hours	Reduced by 2 times	+
Employee productivity	%	Growth by 30%	+
The time of the full document processing cycle	Days	Reduction by 3-5 times depending on the type of documents	+
The number of applications processed by the specialist	Pieces	Increased by 1.5 times	+
Percentage of situations where document changes were not communicated to employees	%	Decreased by 2%	+
Percentage of requests "hanging" in processing	%	Decreased by 1.5%	+
Percentage of correct decision-making	%	Increased by 2.5%	+
The number of failures in the program	Pieces	Is at an acceptable level	+

Table 6 presents possible metrics that can allow a company to evaluate the effectiveness of the implementation of a digital platform in terms of improving the quality indicators important for this technology.

Thus, the metric "time of the cycle of documents at the enterprise, days" allows you to estimate the speed of document flow and compare the values after the introduction of the digital platform in the company with the indicators before the changes, when the document flow was mainly in the form of paper.

In the case of the introduction of a digital platform, the approval period is 2 working days for tax registers and wages and 5 working days for other documents, while in the case of paper document management, this process could last weeks or even months.

Nevertheless, even in this case, the stated approval period is not always fulfilled - and for this purpose another metric is also used, such as «Percentage of requests "hanging" in processing», which allows us to consider the proportion of such situations, and in the future to understand in detail the reasons for such deviations - whether the fault lies with the employee, conducting a document, or a long-term agreement is connected with the heads of the directions with which the agreement is made, etc. Thus, the company has the opportunity to respond appropriately to the situation that has arisen, as well as to control the process of its correction.

The company tracks the values of indicators after the introduction of the digital platform with the basic values before the introduction, which allows us to conclude about the effectiveness of the digital platform not only as an investment project, but also in terms of qualitative improvements of the changed business process of the company.

5 Conclusions

Based on the conducted research, it can be noted once again that it makes sense to assess the feasibility of implementing a digital platform from different angles - the main method is to evaluate the project for the implementation of the platform as an investment project, but the impact of the introduction of a digital platform on the company's activities as a whole cannot be ignored.

Depending on the goals of the company, qualitative changes in business processes are often no less important for the enterprise than improvements in monetary terms, therefore, the study and study of qualitative indicators is also of great importance.

For the considered enterprise, the introduction of a digital platform proved to be effective from the point of view of each of the approaches used, however, this does not mean that there are no areas for improvement.

The area of further research could be further elaboration and improvement of the methodology of investment analysis of the formation of a digital platform, as well as its application to industrial ecosystems in practice.

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