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战略决策和风险管理

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- 作为认知过程的决策，做出管理决策时利用神经科学的结果；
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Determinants of export entrepreneurship development: A comprehensive analysis of their heterogeneous impact

S.I. Kravchenko[1]

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Abstract

The article aims to analyse current trends in the export entrepreneurship sphere. The main objective of the study is to identify a possible relationship between the attained level of export performance achieved in different countries and various institutional and other determinants. The article provides a concise theoretical overview and bibliometric analysis of publications, highlighting promising directions for the promotion of export entrepreneurship and identifying key factors influencing its effectiveness. To achieve the study's objective, data are used on the time to export a single cargo, the number of procedures to register a new business, the creditworthiness of countries, GDP per capita, the share of natural resource rents in GDP, the efficiency of government institutions, the share of urban population in the total population, and the average years of education. The specified parameters have been collected for the period from 2006 to 2020. To analyse the nature of the influence of the selected determinants, a sample of 135 countries with different levels of population income was compiled. Statistical data processing was carried out using the software tools EViews 13 and Stata/MP 14.2. Initially, a series of econometric tests were used to check the panel data for multicollinearity, variable stationarity, and their cointegration. Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) methods were then used to estimate the statistically significant long-term relationship between the variables. As a result, a pool of significant factors of institutional and other factors has been identified that determine the effectiveness of export entrepreneurship in the country. The results obtained allow for a more comprehensive justification of measures to support the development of export business activities.

Keywords: export, entrepreneurship, risk, uncertainty, institutional factors, state regulation, bibliometric analysis, modelling.

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出口企业发展的决定因素：对其异质影响的综合分析

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简介

该文章致力于分析出口企业发展领域的现有趋势。研究的主要目标是确定不同国家出口活动的成果水平与一系列制度性和其他因素的潜在关联。文章提供了简要的理论综述和文献计量分析，重点强调了出口企业发展的前景方向，并确定了影响其效益的关键因素。为了实现研究目标，研究了一些数据，包括货物出口时间、注册新企业的程序数量、国家信用评级、人均国内生产总值（GDP）、自然资源租金在GDP中的比重、政府机构效率、城市人口占总人口的比例以及平均受教育年限。这些参数的数据收集时间为2006年至2020年。为了分析选定决定因素的影响性质，对 135 个不同收入水平的国家进行了抽样调查。统计数据的处理使用了 EViews 13 和 Stata/MP 14.2 软件产品。在第一阶段，通过一系列计量经济学测试，对面板数据进行了多重共线性、变量的平稳性以及它们的协整性检验。然后，为了评估变量之间的长期显著关系，应用了完全修改的最小二乘法（FMOLS）和动态最小二乘法（DOLS）。因此，形成了一组影响出口企业发展的重要因素，这些因素包括制度性和其他因素。所得到的结果有助于更加深入地为促进出口企业发展而采取的措施提供论据。

关键词: 出口、企业家精神、风险、不确定性、制度因素、政府监管、文献计量分析、建模。

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Introduction

Creating favourable conditions for export entrepreneurship plays a crucial role in the economic development of a country by leveraging opportunities in international markets. Effective entrepreneurship can enhance balance sheet size, facilitate the transfer of new knowledge, and foster increased competitiveness and diversification. Export activities positively impact national foreign exchange reserves and wealth, drive domestic industry growth, and boost productivity and employment [Navarro-Garcia et al., 2015b].

It is important to recognise that both entrepreneurship and export activities are the focus of numerous scientific studies, each exploring their characteristics and implementation aspects in depth. For instance, research on boosting entrepreneurial activity is covered extensively in works such as [Klapper et al., 2010; Aparicio et al., 2016; Barinova et al., 2018; Zemtsov & Tsareva, 2018; Kravchenko & Bogachev, 2023], among others. Specifically, [Aparicio et al., 2016] examines institutional factors that stimulate entrepreneurial activity and their impact on economic growth using the three-stage least squares method.

The efficiency of export activities and international trade, and their impact on sustainable development, are subjects of considerable interest to the scientific community. This is evidenced by the number of papers published on the topic, including those by Fernandes et al. (2016), Forslid et al. (2018), Qu et al. (2018), Li (2019), Linder (2020) and An et al. (2020). To illustrate, a group of authors in Forslid et al. (2018) investigated the influence of exporting firms on environmental pollution. They conclude that export activities, which facilitate an increase in production volumes, result in a reduction in the intensity of pollutant emissions.

However, the emergence of new challenges arising in connection with ongoing geopolitical changes, as well as the specificity and versatility of such an activity as export entrepreneurship, highlight the necessity for further research. Concurrently, one of the most significant areas of investigation is the identification of the characteristics of the interdependent development of export activities and entrepreneurship. In light of the aforementioned considerations, the objective of this study is to ascertain whether a correlation exists between the level of export performance achieved in different countries and a range of institutional and other factors that facilitate an increase in entrepreneurial activity. This will help refine strategies to advance export entrepreneurship during unforeseen circumstances.

1. Theoretical framework

The subject of the study, export entrepreneurship, is not adequately delineated in the scientific literature. In the majority of publications, it is equated with export activities. One of the earliest references to export entrepreneurship can be found in the work of K. Raipuria (1978), which

examines the emerging challenges of developing export entrepreneurship in India. However, this publication did not gain significant traction in the scientific community in the subsequent years, and the topic of export entrepreneurship only regained interest among researchers only in the early 2000s.

For example, in their work, researchers K. Ibeh and S. Young defined export entrepreneurship as 'a process by which individuals benefit from market opportunities in foreign markets, either independently or within an organisation, taking into account available resources and environmental factors that influence them'. [Ibeh, Young, 2001]. In this definition, the authors highlight the interdependence of export entrepreneurship on the availability of resources, which are regarded as internal factors, and the state of the environment, which is viewed as an external factor. In a subsequent publication (Ibeh, 2003), particular emphasis was placed on the examination of the impact of these variables on the process of establishing export enterprises by small firms. The author's findings indicate that a company's entrepreneurial orientation is associated with a greater likelihood of success in export-oriented business activities. This orientation is also deemed an appropriate strategic position for small firms operating in challenging environments. The researcher points out that this orientation is associated with specific characteristics of decision-makers, including international orientation, contacts, and previous business experience, as well as competencies at the firm level.

A group of authors led by A. Navarro-García [Navarro-García et al., 2015a; Navarro-García, 2016] define export entrepreneurship as 'the ability to recognise or create an opportunity and take action in international markets.'The publication [Navarro-García et al., 2015b] employs a resource-based approach and the Schwartz value approach to analyse the internal driving forces of export entrepreneurship. The findings of the study indicate that export entrepreneurship is positively influenced by a number of internal factors, including commitment to export, the value of managers, and resources related to experience and structure. In scientific publications devoted to the analysis of factors determining export entrepreneurship, the author concludes that young managers who exhibit a high level of entrepreneurial orientation, possess experience in a specific industry, and have established social connections, as well as a comprehensive understanding of the export market, exert the greatest influence on export entrepreneurship.

In [Munemo 2022a], the concept of entrepreneurship is linked to the opening of new firms, and it is proposed that export entrepreneurship be evaluated based on the rate of entry of firms into the market. The author defines the rate of entry of firms into the market as the number of export participants divided by the number of exporters. Furthermore, the paper investigated the correlation between regulatory time delays in countries and institutional quality, on the one hand, and export entrepreneurship, on the other. The scientist thus corroborates the hypothesis that the reduction of temporary barriers resulting from regulation has a favourable impact on the net market entry rate and the survival rate of export business participants. Furthermore, high-quality institutions (such as political stability, the rule of law, the fight against corruption, the protection of private property rights, etc.) markedly enhance the magnitude of this positive outcome.

It is notable that three dimensions of export entrepreneurship (speed, scale, and intensity) have been identified in the works of [Navarro-García et al., 2015a; 2015b; Navarro-García, 2016]. The dimension of speed refers to the time during which companies begin exporting. The term 'scale' is used to describe the number of foreign markets in which export companies generate income. The degree or intensity of exports is determined by the level of orientation of the company to foreign markets in relation to the domestic market [Kuivalainen et al., 2007]. This is usually measured as the ratio of export sales to total sales. For each of these attributes, [Navarro et al.] examine the permissible range of variation. In summary, the researchers conclude that export entrepreneurship is a process through which a company exploits export opportunities in foreign markets during the initial six years of its life cycle. Regardless of size, companies typically commercialise their products and/or services through a market diversification strategy (typically establishing a presence in more than ten countries simultaneously) and exhibit a high export intensity (typically exceeding 20%).

2. Literature review

A bibliometric analysis was employed to review the extant literature on entrepreneurship, export, and contingency. This entailed several sequential steps, including the collection and preliminary processing of publications deemed relevant to the study, the analysis of the resulting sample of scientific papers and the visualisation of its individual components using the VOSviewer program. The obtained results were then integrated and potential directions for future research were discussed.

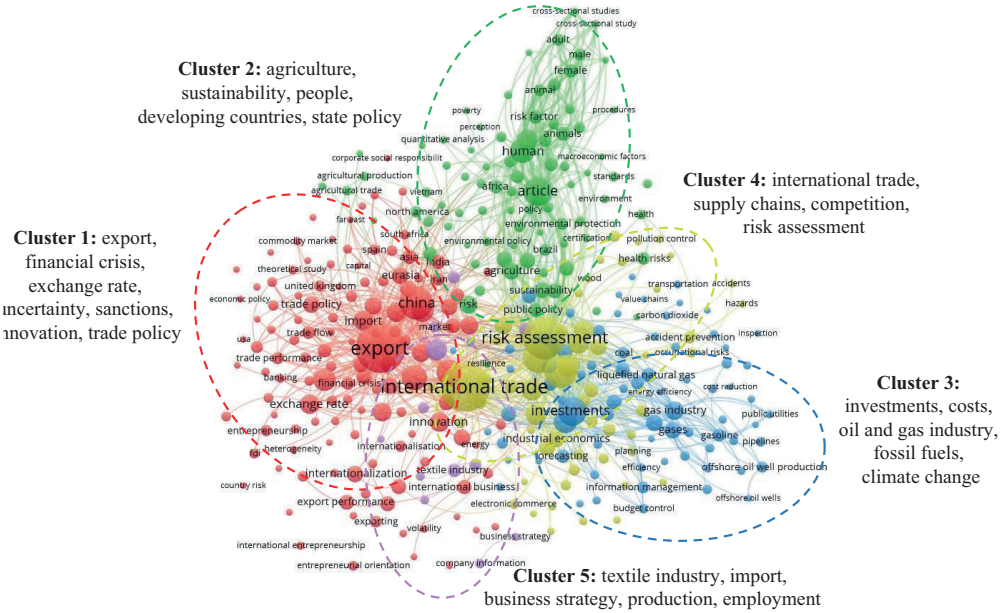
The selection of relevant publications was conducted using the Scopus database, employing a combination of three keywords in accordance with the following criteria:

1) export component - export*;
2) entrepreneurial component - entrepreneurship, company*, enterprise*, firm*, business*;
3) environmental conditions - risk*, uncertainty, sanction*.

The "*" operator was employed to account for the various endings of keywords, and the "AND" operator permitted the combination of the specified directions of keywords in the search query. Accordingly, 3,473 publications indexed by the Scopus database for the period 1990-2023 were selected for analysis.

The results of the analysis of bibliometric data from the selected sample of articles, together with their visual representation, are presented in Figures 1 and 2. The map (Fig. 1) was constructed taking into account the frequency of occurrence of keywords and the overall strength of connections. This enabled the identification of the principal scientific clusters corresponding to specific areas of

Fig. 1. A neural network map showing the relationships between keywords in publications on export entrepreneurship under conditions of uncertainty



Source: compiled by the author based on materials from the Scopus database.

publication activity of the authors. In order to guarantee the dependability of the clusters, a minimum of 10 keyword matches was employed, thus enabling the selection of 354 keywords from 15,039 and the formation of five clusters based on them.

The largest cluster (red in Fig. 1) encompasses 127 pivotal categories and is primarily concerned with the examination of uncertainty, financial crises, innovations, and other elements pertaining to export performance. Additionally, it considers these aspects in the context of the trade policies across different countries. The scientific work by Fernández-Mesa and Alegre (2015) corroborates the hypothesis that entrepreneurial orientation, conceptualised as a managerial position encompassing three key aspects (inclusion of frequent or radical innovations, orientation towards competition, and aggressive or proactive decisions associated with high risk), exerts a positive influence on the intensity of exports of small and medium-sized enterprises (SMEs). [Muhammad and Chelliah, 2024] also demonstrate that organisational innovations are a crucial instrument for attaining enhanced export performance in the global market, due to competitive advantages.

The second largest cluster (green in Fig. 1) includes 84 keywords and focuses on the analysis of agricultural exports to developing countries to prevent risks associated with food security and ensure sustainable development, especially the social component. For example, [Grace, 2015] argues that low-income countries are witnessing a surge in foodborne illnesses due to the exponential rise in the consumption of risky foods (livestock, fish, and other foods) and the expansion of value chains. In the study by Qet al. (2018), an investigation was conducted into the influence of water scarcity risk on the global trading system. The researchers identified five leading national sectors (China, India, Turkey, Spain and France) that exhibited a high level of vulnerability to virtual water scarcity risk. This risk is defined as the potential for local water scarcity in a given country to be transmitted to other countries through the export of goods.

The third cluster (blue in Fig. 1) encompasses 76 key categories and is dedicated to the examination of the interrelationship between investment volumes in the oil and gas industry and export indicators. Additionally, it is concerned with the analysis of the extraction of fuel and energy resources and their impact on climate change. To illustrate, [An et al. 2020] analyses the impact of the US-China trade war on the energy and resource sectors in Africa, employing data from this region. The researchers confirm that as a consequence of the trade war, the real changes in the stock prices of Chinese companies (-0.07%) in the energy and resource sectors are less pronounced than similar changes in US companies in Africa (-0.32%) in 2019. This supports the notion that US companies with greater reliance on exports and imports from China exhibit diminished stock and bond returns, concomitant with elevated short-term default risks. The publication [Demirer et al., 2015] explores the impact of accounting for oil price risk on stock returns in net oil exporting countries. Utilising data on the returns of companies in the stock markets of the Arab Gulf states, the authors identify a correlation between stocks that are more sensitive to changes in oil prices and significantly higher returns. This suggests that exposure to oil price risk may serve as a predictor of returns in these stock markets.

The fourth cluster (yellow in Fig. 1), comprises 55 keywords and is concerned with the analysis of global supply chains, risk assessment and management in international trade, competition research in international markets, and so forth. As an example, [Keilhacker and Minner, 2017] investigate strategies for mitigating the risks posed by external interventions in the supply chain for critical goods. [Cao et al., 2019] attempts to quantify the impact of dynamic risk spillover within and between integrated firms in global fresh produce supply chains.

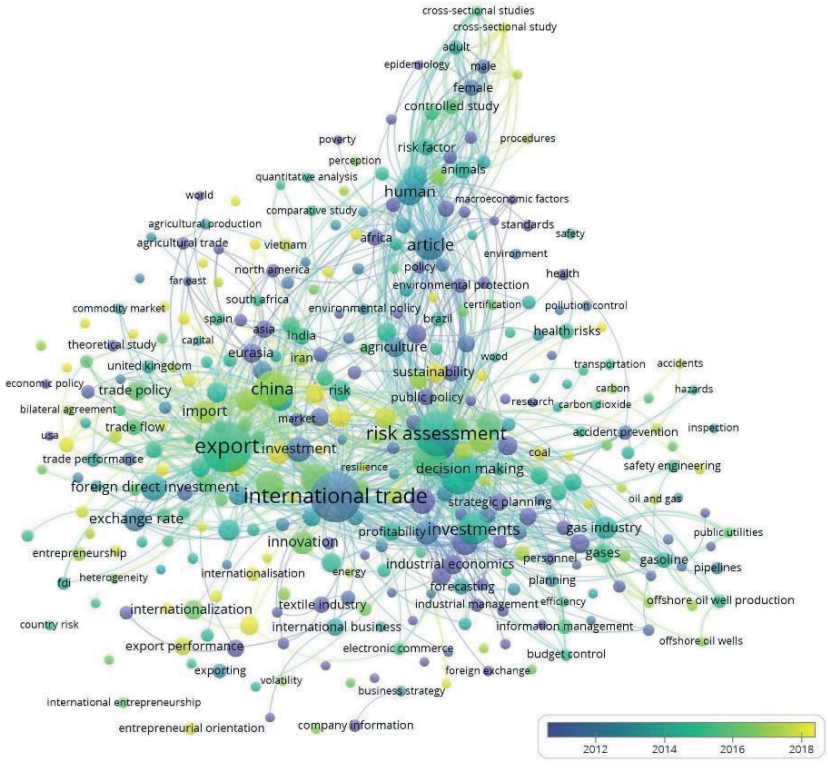
The smallest cluster (purple in Figure 1), comprises 12 keywords and is concerned with the study of export issues in the textile industry. These include the relocation of production to other countries with a view to reducing labour costs. The publication [Lin et al., 2018] is thus devoted to the study of the impact of technological progress on the textile industry of China, which is the largest textile exporter in the global market, as well as to forecasting the future energy saving potential. To achieve this, the authors establish the relationship between energy intensity and five main factors (enterprise scale, technological progress, labour productivity, dependence on foreign trade, and the price of electricity in industry) using the cointegration method. This leads them to conclude that there is a long-term equilibrium between these factors.

Figure 2 presents the findings of a study on the evolution of the relationship between exports, entrepreneurship, and risk. The results enable us to identify shifts in the use and relevance of keywords.

The data obtained allows us to identify five significant stages in the development of scientific research on this topic. Therefore, before 2012, the primary focus of scientific research was on topics such as industrial economics, the oil industry, multinational enterprises, costs, marketing, strategic planning, legislation, and the law. From 2012 to 2014, research shifted its focus to international trade, exchange rates, and productivity. Between 2014 and 2016, the most prevalent subjects of research within this field were export, price dynamics, risk assessment and management, economic growth, and sustainable development, among others. In the period between 2016 and 2018, research output on topics including supply chains, innovations, uncertainty and its analysis, climate change, and related areas increased significantly. Since 2018, the focus of scientific research has shifted towards global supply chains, the impact of the Coronavirus Disease (COVID-19) 2019 Pandemic, the effects of sanctions, the role of political uncertainty, the contribution of small and medium-sized businesses, and the importance of entrepreneurial orientation.

The findings of the bibliometric analysis highlighted the interconnectivity between the themes of export, entrepreneurship, and risk/uncertainty. In particular, the analysis demonstrated that international trade is associated with a multitude of factors that contribute to environmental instability, including financial crises, sanctions, and government policy. It is evident that in the near future, the most notable studies will concern digitalisation and export entrepreneurship. The latter is becoming a catalyst for the introduction of new technologies, achieving competitive advantages in the global market, and ensuring the economic growth of states.

Fig. 2. A neural network map illustrating the evolution of relationships between keywords in publications on exports, entrepreneurship and risk



Source: compiled by the author based on materials from the Scopus database.

3. Variables, data, and methodology

3.1. Explanatory and explained variables

A summary of the literature review materials on entrepreneurship, export, and contingencies was prepared based on the works of Nielsen (2014), Barinova et al. (2018), Linder (2020), Munemo (2022a), and Kravchenko and Bogachev (2023). The theoretical foundations of export entrepreneurship were also considered, in addition to the stated objective of the study. This process allowed for the selection of the main variables for subsequent analysis and construction of a functional dependence model. The volume of exports per employee was selected as the explanatory variable, representing the achievements of all business entities in the country engaged in the

export of goods and services over a specified period. It is assumed that this indicator accurately reflects the efficacy of export entrepreneurship.

In selecting explanatory variables, consideration was given to the influence of institutional factors on the level of entrepreneurial activity in the country, as well as the potential for increasing export volumes. One of the most crucial parameters is the time required for export, which encompasses the number of days necessary for cargo documentation, customs procedures, domestic transportation, and processing at the port and terminal [Djankov et al., 2010; Li, 2019; Munemo, 2022a].

Furthermore, the simplicity of establishing a business is a crucial factor in fostering export entrepreneurship. As observed by Munemo (2022b), the deregulation of market entry is typically linked to enhanced economic outcomes, including elevated per capita income, improved formalisation of firms, and augmented labour productivity. As demonstrated in [Nielsen, 2014 and Aparicio et al, 2016], reducing the number of procedures associated with business registration has a positive effect on the level of entrepreneurial activity. In light of the aforementioned evidence, the indicator reflecting the number of procedures required to register a business is employed as a measure of the regulation of entry into the export market.

The availability of financing also plays a significant role in stimulating entrepreneurial activity [Barinova et al., 2018; Zemtsov and Tsareva, 2018]. Therefore, the relaxation of credit restrictions can facilitate the growth of newly established enterprises and encourage the expansion of small and medium-sized businesses, including those engaged in export activities [Klapper et al., 2010; Munemo, 2022b]. In order to evaluate the accessibility of financial resources, a credit rating was employed, which ranges from 0 to 100, with 0 representing the most unfavourable indicators of banking sector regulation and 100 indicating the most favourable[1].

A number of studies have demonstrated that the level of economic development exerts a significant influence on entrepreneurial activity within a given country. This is evidenced by the findings of studies conducted by [Fernandes et al., 2016; Barinova et al, 2018; Munemo, 2022a]. The scientific community has reached a consensus that the more efficient allocation of resources in economically developed countries results in lower rates of new enterprises entering the export market. This is because existing exporting companies are highly productive and therefore do not seek to leave occupied export markets. In this regard, the most universal indicator characterising the level of economic development of a country is the volume of gross domestic product (GDP) per capita, which is included in the sample of explanatory variables.

In the context of export entrepreneurship, it is essential to consider the structure of the economy and the potential for increasing the volume of exported products. As observed in the study by [Barinova et al., 2018], economies based on raw materials tend to exhibit a higher level of income among the population. Consequently, the elevated purchasing power of citizens serves as a catalyst for entrepreneurial growth. In order to achieve this, the indicator of total rent from natural resources (in % of GDP) was selected as one of the explanatory variables. This included rent on oil, natural gas, coal (hard and brown), minerals (gold, silver, copper, iron, zinc, etc.), and wood.

A significant body of literature emphasises the influence of state institutions on the development of entrepreneurship in a given country. This perspective is espoused by [Djankov et al., 2010; Nielsen, 2014; Munemo 2022a]. However, the direction of such influence may vary. On the one hand, a stable state policy can be seen to promote the growth of entrepreneurial activity. However, on the other hand, it can also create conditions that are manifestly unfair for firms of different sizes, forms of ownership, and locations. In their 2023 study, Kaufmann and Kraay put forth a framework for evaluating the quality of public administration. This framework employs six aggregate indicators: voice and accountability, political stability and absence of violence, government effectiveness, quality of regulation, rule of law, and control over corruption. As indicated in [Munemo, 2022a], the first two of these indicators characterise the process of selection, control, and change of state power, the third and fourth describe the government's ability to effectively formulate and implement public policy, and the remaining two represent the respect of citizens and the state for the institutions regulating economic and social interactions between them. Each indicator is measured on a scale from -2.5 to +2.5, with higher values indicating superior results. J. Munemo used the principal component method to validate the effectiveness of utilising a comprehensive indicator of the quality of public institutions, calculated as the average of the six metrics [Munemo, 2022a]. Accordingly, an indicator of the quality of public institutions was constructed based on the data provided by [Kaufmann and Kraay, 2023], in accordance with the recommendations set forth by [Munemo, 2022a]. This indicator was also incorporated into the set of explanatory variables.

The works [Nielsen, 2014; Barinova et al., 2018] indicate that the level of entrepreneurial activity can be significantly influenced by agglomeration effects, which have the potential to stimulate or slow it down. Consequently, urban agglomerations can facilitate business activities due to the presence of entrepreneurial networks and the corresponding infrastructure. However, they can also impede the growth of the number of new enterprises due to high competition in the market, which results from the significant concentration of economic agents. In light of the above, it would be prudent to incorporate an indicator delineating the proportion of the urban population in the country into the econometric model.

The level of education of a country's population represents a significant factor influencing the development of export entrepreneurship. As stated by [Nielsen, 2014; Trachuk and Linder, 2018], entrepreneurs with a higher level of education are more likely to possess the requisite business skills for success. Furthermore, a higher level of education fosters the development of innovative thinking and a creative approach

[1] World Bank open data (2023). https://data.worldbank.org/.

Table 1
Research sample of countries with income distribution

Group	Country
High income level	Australia, Austria, Bahamas, Bahrain, Belgium, Brunei Darussalam, Great Britain, Hungary, Germany, Greece, Denmark, Israel, Ireland, Iceland, Spain, Italy, Canada, Qatar, Cyprus, Kuwait, Latvia, Lithuania, Luxembourg, Malta, Netherlands, New Zealand, Norway, UAE, Oman, Poland, Portugal, South Korea, Saudi Arabia, Singapore, Slovakia, Slovenia, USA, Uruguay, Finland, France, Croatia, Czech Republic, Chile, Switzerland, Sweden, Estonia, Japan
Above average income level	Albania, Algeria, Argentina, Armenia, Belarus, Belize, Bulgaria, Bosnia and Herzegovina, Botswana, Brazil, Gabon, Guatemala, Georgia, Dominican Republic, Jordan, Iraq, Iran, Kazakhstan, China, Colombia, Costa Rica, Lebanon, Mauritius, Malaysia, Mexico, Namibia, Paraguay, Peru, Russia, Romania, Samoa, North Macedonia, Serbia, Thailand, Tonga, Turkey, Fiji, Montenegro, Ecuador, Equatorial Guinea, South Africa, Jamaica
Below average income level	Angola, Bangladesh, Bolivia, Bhutan, Vanuatu, Vietnam, Ghana, Honduras, Egypt, Zimbabwe, India, Indonesia, Cape Verde, Cambodia, Kenya, Kyrgyzstan, Ivory Coast, Lesotho, Mauritania, Moldova, Mongolia, Nicaragua, Pakistan, Republic of Congo, El Salvador, Senegal, Solomon Islands, Sudan, Tunisia, Ukraine, Philippines
Low income level	Benin, Burundi, Chad, Democratic Republic of Congo, Gambia, Haiti, Madagascar, Mali, Nepal, Niger, Rwanda, Sierra Leone, Tajikistan, Tanzania, Uganda.

Source: compiled by the author based on data from [Hamadeh et al., 2023].

Table 2
Descriptive statistics of the variables

Variable	Symbol	Units of measure	Average value	Min	Max	SD
Export per 1 EAP	*Export*	In constant 2015 prices, USD/ person.	17237.4	39.3	423163.0	40640.7
Time for export	*TE*	Days	21.3	6.0	102.0	15.0
Property registration	*RP*	Number of procedures	5.8	1.0	14.0	2.1
Credit rating	*CS*	Index score	47.0	0.0	100.0	23.0
GDP per capita (PPP)	*GDP*	2017 constant international dollars	22271.4	711.4	120647.8	21505.5
Rent from natural resources	*NRR*	% of GDP	6.7	0.0	63.7	10.6
Efficiency of government institutions	*WGI*	Index score	0.1	–1.7	1.9	0.9
Urban population	*UP*	% of country population	61.3	9.6	100.0	22.0
Average years of education	*EdY*	Years	8.9	1.2	14.1	3.1

Note. EAP - economically active population, PPP - purchasing power parity, Min/Max - the minimum and maximum values respectively, SD - standard deviation.

Source: calculated by the author.

to problem-solving, which enables aspiring entrepreneurs to develop their own ideas for new businesses and thereby increase the profitability of entrepreneurial activity [Kolodnyaya et al., 2022; Kravchenko, 2024]. In light of the aforementioned evidence, the set of factors analysed in this study is supplemented by an indicator of the quality of human resources, measured by the average number of years adults spend in education.

Accordingly, the most pertinent variables were identified for subsequent empirical investigation and econometric modelling of the extent of export entrepreneurship development.

3.2. Selection of countries and description of initial data

The sample was selected to encompass a range of income levels, as classified by the World Bank (Table 1).

For each country, data from 2006 to 2020 have been collected on the factors impacting the development of export entrepreneurship and for which statistical information is publicly available. Thus, the initial data have a temporal structure characterising the general period of the study (T = 15) and a spatial structure indicating the number of countries in the sample (n = 135). The descriptive statistics of the variables selected for modelling are presented in Table 2.

Data on export time, property registration, and credit rating are taken from the Doing Business database[2]; GDP per capita, urban population as a percentage of the country's population, total rent from natural resources - from World Bank open data[3]; average years of schooling - from the Human Development Index database[4]. The quality of public institutions is calculated using the Worldwide Governance Indicators [Kaufmann, Kraay, 2023] as the arithmetic mean. All initial data selected to build the models were transformed into logarithms in order to stabilise the variance of the errors in the regression model and to increase its homoscedasticity, which is an important assumption of regression analysis.

3.3. Methodology for building an econometric model

The following regression model was used to identify the functional relationship between the parameters characterising entrepreneurial activity and the efficiency of the country's export activities:

$$Export_{it} = \beta_0 + \beta_1 TE_{it} + \beta_2 RP_{it} + \beta_3 CS_{it} + \beta_4 GDP_{it} + \\ + \beta_5 NRR_{it} + \beta_6 WGI_{it} + \beta_7 UP_{it} + \beta_8 EdY_{it} + \varepsilon_{it}, \quad (1)$$

where t - temporary data $t = \overline{1,T}$; i - spatial data $i = \overline{1,n}$; $(\beta_0,\ldots, \beta_8)$ - coefficients estimated from the regression equation; ε_{it} - error.

The first step in empirically testing the model is to check the panel data for multicollinearity, stationarity of the variables, and their cointegration, as these factors may lead to inappropriate estimates and hence misleading results. The variance inflation factor (VIF) was used to assess multicollinearity, as well as the calculation of pairwise correlation coefficients. If significant multicollinearity is found, it is important to eliminate it in order to obtain accurate estimates of the coefficients in the model. Based on the findings in [O'Brien, 2007; Lin et al., 2011], a threshold of 10 was applied for VIF (if VIF ≥ 10 for any variable, it is advisable to exclude it from the regression model).

Data stationarity was tested using Levine-Lin-Chu (LLC) panel unit root tests, Dickey-Fuller-Fisher (ADF)

Table 3
Correlation matrix and variance inflation factor results for the research variables

Variables	*TE*	*RP*	*GDP*	*CS*	*NRR*	*WGI*	*UP*	*EdY*	*Export*	*VIF*
TE	1.00									2.65
RP	0.01	1.00								1.13
GDP	–0.47	–0.22	1.00							5.85
CS	–0.42	–0.20	0.24	1.00						1.17
NRR	0.40	0.04	–0.01	–0.39	1.00					1.45
WGI	–0.62	–0.30	0.64	0.46	–0.37	1.00				2.92
UP	–0.50	–0.06	0.68	0.25	0.05	0.55	1.00			3.21
EdY	–0.45	–0.24	0.61	0.51	–0.31	0.58	0.59	1.00		2.47
Export	–0.27	–0.08	0.74	0.01	–0.07	0.48	0.37	0.33	1.00	–

Source: calculated by the author.

[2] Doing business legacy. Historical data - Doing business (2023). https://www.worldbank.org/en/businessready/doing-business-legacy.
[3] World Bank open data (2023). https://data.worldbank.org/.
[4] Subnational Human Development Index (v7.0) (2023). Global Data Lab. https://globaldatalab.org/shdi/download/msch/.

Table 4
Stationarity analysis of variables empirical results

Test	Test statistics	Variables								
		Export	*TE*	*RP*	*GDP*	*CS*	*NRR*	*WGI*	*UP*	*EdY*
		Level								
LLC	Statistics	–3.91	–59.9	–2.91	–5.68	–2.10	–5.54	–5.32	–7.76	–9.48
	Probability	0.00	0.00	0.002	0.00	0.02	0.00	0.00	0.00	0.00
IPS	Statistics	0.59	–18.1	1.71	1.93	2.24	–0.24	0.82	1.89	1.87
	Probability	0.72	0.00	0.96	0.97	0.99	0.40	0.79	0.97	0.97
ADF-Fisher	Statistics	246.5	422.7	69.5	212.9	188.3	291.5	258.1	388.8	260.5
	Probability	0.84	0.00	0.99	0.99	0.81	0.18	0.69	0.00	0.65
PP-Fisher	Statistics	307.4	447.0	73.8	331.1	374.3	286.1	283.4	1252.0	478.9
	Probability	0.058	0.00	0.99	0.01	0.00	0.24	0.27	0.00	0.00
		First differences								
LLC	Statistics	–13.5	–44.3	–3.53	–4.04	–7.92	–28.9	–15.7	–8.1	–10.3
	Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IPS	Statistics	–13.5	–16.9	–2.84	–8.33	–10.7	–20.9	–13.8	–0.32	–6.27
	Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.00
ADF-Fisher	Statistics	685.0	466.7	49.0	527.3	365.8	941.9	672.7	302.0	474.8
	Probability	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.05	0.00
PP-Fisher	Statistics	1045.2	660.7	129.9	594.8	680.8	1404.4	1282.9	322.5	717.9
	Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00

Note. Probabilities for Fisher's tests are calculated using the asymptotic chi-square distribution. Other tests assume asymptotic normality.
Source: calculated by the author.

Table 5
Results of the Pedroni and Kao panel cointegration tests

Test name	Test statistics name	Statistics	Probability	Statistics	Probability
				Weighted	
Pedroni test	Panel v-statistic	–3.23	0.99	–4.59	1.00
	Panel rho-statistic	8.07	1.00	7.57	1.00
	Panel PP-statistic	–1.75	0.04	–5.24	0.00
	Panel ADF-statistic	–3.44	0.00	–6.74	0.00
	Group rho-statistic	9.95	1.00	–	–
	Group PP-statistic	–9.71	0.00		
	Group ADF-statistic	–5.74	0.00		
Kao test	ADF t-statistic	–10.21	0.00	–	–
	Residual variance	0.017	–		
	HAC-variance	0.019			

Source: calculated by the author.

augmented unit root tests, Phillips-Perron-Fisher (PP) and Im-Pesaran-Shin (IPS). For these tests, the null hypothesis was formulated as follows: the presence of a unit root implies that the selected variable is non-stationary.

Pedroni and Kao residual cointegration tests were used to identify cointegration between variables, with the null hypothesis being the absence of cointegration [Pedroni, 2018]. In the case of cointegration, a statistically significant long-run relationship between variables was tested using panel cointegration methods (fully modified least squares - FMOLS; dynamic least squares - DOLS).

4. Research findings

In order to check the quality of the constructed panel data sample, tests are carried out to identify problems leading to spurious regressions at an early stage. For this purpose, we calculate pairwise correlation coefficients and the dispersion inflation coefficient to detect multicollinearity (Table 3), perform tests to identify non-stationarity (Table 4), and apply Pedroni and Kao tests for cointegration (Table 5).

The obtained results of the multicollinearity check of the data (Table 3) show that the variables selected for building the model are independent of each other, with the highest pairwise correlation coefficient recorded at 0.74. As indicated in [Kwilinski et al., 2023], a stable correlation is evident when the coefficient exceeds the threshold of 0.80. Using this criterion, it can be concluded that the present study is not burdened with problems related to multicollinearity. In addition, the VIF value is below the threshold for all variables (the highest VIF value of 5.85 is recorded for the GDP per capita variable). This suggests that it is appropriate to include all the selected variables in the subsequent modelling.

A series of tests (Table 4) was used to test the null hypothesis of non-stationarity for the initial data on the variables and their first differences. If the test statistics are insignificant at the level and significant at the first difference, the null hypothesis is not rejected [Alekhine, 2021; Kravchenko, Dementyev, 2023].

The results of the stationarity analysis presented in Table 4 confirmed that only the TE variable was stationary at the levels in all tests. In addition, all variables became stationary after their increment (taking the first difference). The results obtained allowed us to reject the null hypothesis of non-stationarity at a 1% significance level, therefore it is advisable to further test the cointegration of the variables using Kao's t-statistic, as well as Pedroni's panel and group statistics (Table 5).

It should be noted that the Pedroni and Kao tests are characterised by different assumptions and computational approaches. At the same time, they are characterised by a common objective, which simultaneously assumes the heterogeneity of fixed effects and short-term changes for different panel groups, as well as the pooling of information on the long-term convergence of the variables analysed.

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Thus, the results of the tests carried out on the initial sample of panel data have confirmed the presence of joint integration and the absence of multicollinearity, which makes the sample of variables suitable for assessing the long-term dependence of the variables. Based on the revealed facts, it is advisable to use the FMOLS and DOLS models for heterogeneous panel data. The results of the application of these techniques are presented in Table 6.

Table 6
Estimates of long-run cointegration regression coefficients

Variables		FMOLS		DOLS	
Explained	**Explanatory**	**Coefficient**	**Probability**	**Coefficient**	**Probability**
Export	*TE*	0.193329	0.0042	0.100676	0.0531
	RP	–0.052076	0.3450	–0.014120	0.7854
	GDP	0.828675	0.0000	1.044299	0.2287
	CS	0.016038	0.1000	0.011091	0.0000
	NRR	0.035472	0.0048	0.028515	0.0086
	WGI	0.340186	0.0000	0.189354	0.0016
	UP	4.419289	0.0020	2.707204	0.0174
	EdY	–0.120840	0.5589	–0.109310	0.5467
Adjusted R^2		0.991324		0.991907	

Source: calculated by the author.

It should be noted that, according to the data obtained using the FMOLS model, statistically significant influence (at the level of 1-10%) on the efficiency of export activities is exerted by such variables as time for export, GDP per capita, credit rating, rent from natural resources, efficiency of state institutions, and the share of urban population in the total population of the country. According to the DOLS model, all the same variables as in the FMOLS have a significant influence, except for the factor characterising the level of economic development of the country - GDP per capita. Thus, in both models, the educational level of the population and the ease of starting a business (i.e. the *RP* and *EdY* variables) have a statistically insignificant influence at the same time.

For the FMOLS and DOLS models, the adjusted coefficients of determination are over 99%, which indicates the cointegration of exports with the variables included in the study and a high degree of reliability of the models constructed. This makes it possible to establish the existence of a long-run equilibrium relationship between the explanatory and explained variables. According to the obtained empirical results, the theoretical assumption that the effectiveness of export entrepreneurship is significantly influenced by the quality of state institutions, the country's credit rating, the time of export of cargo, the level of urban population, the actual contribution of mineral extraction to the formation of GDP and, consequently, the potential for the extraction of natural resources in the long term, is confirmed.

5. Conclusions and limitations

A brief theoretical review and bibliometric analysis of scientific publications in the field of export, entrepreneurship, and contingency confirm their close relationship, as well as their relevance in terms of increasing the effectiveness of export entrepreneurship, which becomes a catalyst for the introduction of new technologies, achieving competitive advantages in the global market and ensuring economic growth of states.

This study attempts to create a formalised theoretical model that describes a set of factors that influence the country's export entrepreneurship. Based on a series of econometric tests on panel data collected for 135 world economies for the period 2006-2020, the influence of a number of institutional and other factors on the effectiveness of a state's export activities has been identified and assessed.

The results of applying the dynamic and fully modified least squares method, as well as a series of accompanying verification tests on the initial data, made it possible to confirm that the volume of exports per unit of economically active population is cointegrated with the variables included in the analysis. In one way or another, this characterises the quality of state institutions, as the constructed models explain more than 99% of the variation in the resulting indicator. In both models, the following variables had a statistically significant influence on the efficiency of export activities: the number of days to export cargo, the country's credit rating, the level of natural resource rents as a percentage of GDP, the efficiency of government regulation, and the share of the urban population in the total population. It should be emphasised that all statistically significant factors in the constructed models directly impact the resulting indicator, i.e. an increase in the value of the specified variables leads to an increase in export volumes calculated per economically active person.

Despite the factual findings on the existence of a relationship between the efficiency of export entrepreneurship in different countries with certain institutional and other factors, this study is characterised by some limitations.

As geopolitical tensions rise, countries are divided into two blocs (China-Russia, USA-Europe) and certain restrictive measures are taken that directly affect the ability to enter export markets, which in turn can significantly reduce the efficiency of export activities of various countries. This geopolitical division has not been taken into account in the modelling process at this stage. In addition, the panel data examined is limited to 2020, as the World Bank will stop collecting and publishing global statistics for the Doing Business report after this period. As a result, the existing statistics do not take into account the current export experience of certain countries, including those due to the current geopolitical situation.

In general, the complexity and multifaceted nature of the problem of developing export entrepreneurship, which depends on a significant number of traditional and emerging factors, determines both new opportunities and challenges. In this respect, future studies on this aspect of the country's economic development should use an extended list of variables to identify a larger number of significant cause-and-effect relationships that could serve as a basis for improving the regulation of export activities of countries and enterprises. In addition, it is advisable to analyse the impact of the situational geopolitical division of countries on the effectiveness of export entrepreneurship.

The results of the work contribute to a more thorough justification of policies aimed at developing export entrepreneurial activity under conditions of uncertainty.

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Framework for the development of digital strategies for industrial companies: Principles, methods and tools

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Abstract

Strategic management and strategy as a tool for managing business development have become responses to the increasing instability of the external environment. With the advent and development of digital technologies, there has been another quantitative and qualitative leap in the growth of uncertainty in the operating conditions of industrial enterprises. In order to remain competitive, they have embarked on a digital transformation process, the success of which also largely depends on having a clear strategy for implementing the transformation. The requirements for such a strategy, and the methods and tools used to develop it, are in some respects very different from those used in traditional strategic management. This determines the research relevance in the field of determining the nature of the digital strategy of the industrial enterprise, methods and tools for its development. It is shown that a digital strategy is a strategy for business development in a digital environment and that the key problem in its development is the need to significantly increase flexibility while maintaining a certain stability. Analysis of trends in the area of adaptation and development of methods for strategy development in the digital environment was carried out. Four broad sets of methods for increasing strategic flexibility have been identified: based on scenario development, experimentation, the use of organisational and management mechanisms, and on the use of ecosystem capabilities. Taking into account the stages of digital transformation process of the industrial enterprise and the basic practices of adaptive management, a landscape of methods and tools for the formation of a digital strategy of a company has been built up, allowing to broaden the understanding and to make a reasonable choice of an instrumental and methodological base. The concept of a minimum viable strategy is highlighted as a promising direction for developing a flexible digital strategy for an enterprise. A tool for its development is proposed in the form of a one-page presentation (canvas) that logically combines the key components of a digital strategy, ensuring its flexibility and sustainability.

Keywords: enterprise, digital strategy, flexibility, landscape of methods and tools, minimum viable digital strategy.

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工业企业数字战略开发框架：原则、方法与工具

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简介

战略管理和战略作为企业发展管理工具，早已成为应对外部环境不稳定性增强的策略。随着数字技术的出现和发展，工业企业经营环境的不确定性又经历了一次数量和质量上的跃升。为了保持竞争力，它们开始进行数字化转型，而这一转型的成功程度在很大程度上取决于是否有明确的转型策略。对于这样一种策略，其要求、方法和开发工具在某些方面与传统战略管理中使用的要求、方法和工具显著不同。这决定了对工业企业数字战略的实质、方法和开发工具进行研究的重要性。研究表明，数字战略是指在数字环境中发展业务的战略，其开发的关键问题是在保持一定稳定性的同时，需要大幅提高灵活性。在数字环境中，进行了关于战略开发方法的适应性和发展趋势的分析。四种提高战略灵活性的方法被归纳为：基于场景开发、实验、组织管理机制应用以及利用生态系统的可能性。考虑到工业企业数字转型的阶段和基本的自适应管理实践，建立了企业数字战略形成方法和工具的景观，这有助于扩展理解并进行合理选择工具和方法。作为形成灵活数字战略的前景方向，提出了最小可行战略概念。提出了一种以单页形式呈现的工具（画布），它在逻辑 上将数字战略的关键组成部分进行了整合，从而确保其灵活性和稳定性。

关键词：企业、数字战略、灵活性、方法和工具景观、最小可行数字战略。

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Introduction

The process of digital transformation has become an integral component of the development of industrial companies. The efficacy of the implementation of digital technologies and business models, initially postulated, has been substantiated by numerous successful instances [Gurumurthy et al., 2020; Angevine et al., 2021; Wang, Shao, 2024]. Ilkevich's work [Ilkevich, 2022] presents the effects of introducing smart manufacturing technologies as part of a digital transformation strategy in an industrial enterprise. However, not all digital initiatives have been successful. Major consulting firms (McKinsey, BCG, Deloitte, KPMG, and Bain & Company) have identified a significant risk of failure associated with digital transformation, with failure rates estimated between 70 to 95% (Forth et al., 2020; Block, 2022). The absence of a clearly defined digital transformation objective and strategy has been cited as the primary reason for these failures [Kane et al., 2015; Baculard, 2017; Forth et al., 2020; Holt, Gibson, 2023]. A comparable result was documented in a survey of Russian enterprises' digital transformation practices [Digital Transformation in Russia..., 2020], where over 50% of respondents identified a strategy and management support as pivotal factors for success in digital transformation, with only 'necessary skills of employees' receiving a higher number of votes (64%).

In recent decades, corporate strategy has served as a primary instrument for directing business growth and evolution. However, the digital environment has exacerbated the fundamental contradiction in strategy between its sustainability and its flexibility. As a tool for long-term planning, a strategy must have a certain level of stability. Yet, in a digital environment, key factors for competitiveness are flexibility and the ability to adapt quickly (Hunsaker & Knowles, 2020; Teece et al., 2020).

Furthermore, the hierarchical structure of strategy (corporate strategies, business unit strategies, functional strategies) has led to a lack of consensus regarding the scope and objectives of an enterprise's digital strategy. This underscores the importance of research in strategy development for digital transformation and business growth in the digital environment. Consequently, this

Table 1
Approaches to defining a digital strategy

Definition	Source	Notes
Stage 1: Functional Level		
The strategy of digital transformation of production entails a substantial increase in business benefits through comprehensive automation of business processes and the introduction of new information technology (IT) solutions that markedly alter business processes, thereby reducing the workforce required	[Mikhailov, 2023]	Digital transformation strategy as a functional IT strategy
Stage 2: Business Strategy Level		
Digital strategy is a comprehensive view that integrates both IT and business strategy, focusing equally on business and technology	[Chanias et al., 2019]	Integration of business strategy with IT strategy
A digital transformation strategy is a business development strategy that employs modern digital solutions. It should address two key questions: what outcomes should the company aim to achieve and how can it best achieve them. It is essential to establish the fundamental objectives and strategic direction of the business before exploring how digital technologies can support achieving the company's goals. The strategy prioritises business development over IT.	About Digitalisation and Digital Transformation: Textbook 4 CDTO. Club 4CIO, 2020	The primacy of business development strategy
Digital strategy is a business strategy in which technology enables innovation and creativity, allowing companies to create new and better customer experiences.	[Adner et al., 2019]	Business strategy, technology, and innovation
Digital strategy as a route for an organisation, industry, or region. It is based on understanding the current situation and predicting the future. The strategy allows for choosing goals, direction, routes, resources, and backup options.	[Digital transformation strategy.., 2021]	Emphasis on strategy flexibility: route, reference point, goal, fallback options
Digital transformation strategy as a state company document that defines the goals, KPIs and their target values, strategic directions, digital infrastructure, organisational changes, personnel development, and management model for digital transformation.	Methodological recommendations for the digital transformation of state corporations. M., 2023	Formalisation of requirements: document and its contents
Stage 3: Corporate Level		
A digital transformation strategy is an action plan for repositioning a business in the digital economy. It is not a standalone digital strategy but a business development strategy in a digitally enriched environment	[McKeown, 2017]	Business (enterprise) development strategy in the digital environment

article aims to provide a systematic overview of the approaches and methods, as well as to develop tools for formulating a digital strategy for an industrial enterprise.

1. Theoretical overview

Defining a digital strategy or an enterprise's digital transformation strategy can be approached in several ways. Analysis reveals three relatively distinct stages in understanding its essence (Table 1).

Initially, enterprises' digital strategies were frequently regarded as extensions of their IT strategies, classified as functional strategies. However, the limitations of this approach and the need for a more comprehensive perspective, one that includes creating business value, have been well-articulated in the works of Bharadwaj et al. (2013) and Adner (2019). The second stage involves merging digital strategy with business strategy, marking the transition towards an understanding of digital transformation. Initially, digital technologies were implemented for individual projects to increase production efficiency (digitalisation). Over time, there has been a shift towards changing business models and creating new value opportunities for consumers [Digital Transformation Strategy, 2021]. Based on extensive consulting experience, BCG experts proposed the concept of a smart digital strategy [Wald et al., 2019], focusing on making intelligent investment choices to gain a competitive advantage, ensure growth, and achieve profitability and value.

The objective of digital transformation is to create a continuously evolving and flexible company, capable of adapting to changing conditions through appropriate technologies, organisational learning, and decision-making processes that use high-quality data in shorter time frames (Shu et al., 2017). In this context, digital strategy is introduced at the corporate level, representing the next stage in defining digital strategy [McKeown, 2017].

As part of the digital transformation process, the development of digital strategies is also evolving. One of the main challenges is to make strategies more flexible to manage enterprise development in the digital environment. This is reflected in the definitions in Table 1, where digital strategies are presented as a journey, a common approach to strategy development [McKeown, 2017].

Given the inherent instability of the external environment, strategic planning can be considered a form of perspective planning. Research in strategy flexibility has been going on for a significant period, with notable contributions such as the Harvard Business Review study [Courtney et al., 1997], which focused developing strategies in the context of uncertainty. The study identified four levels of uncertainty: (1) a fairly clear future; (2) an alternative future, which can be described as one of several alternative outcomes or discrete scenarios, with probabilities that can be established for each scenario; (3) a range of future options, when the actual outcome can lie anywhere along a continuum defined by a selected range of variables; and (4) true uncertainty, marked by the following characteristics:

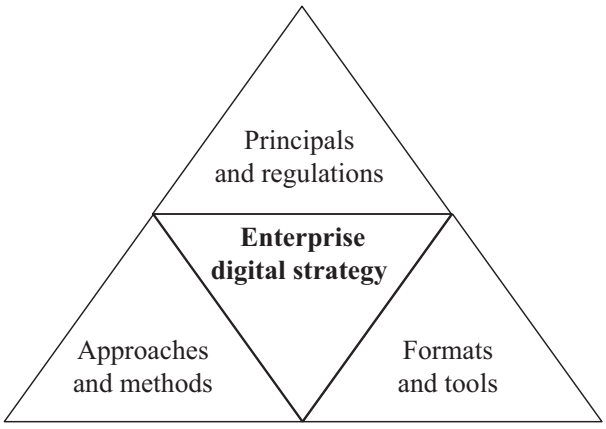
- the interaction of numerous uncertain factors creates an environment that is virtually impossible to predict;
- the range of potential outcomes is undefinable, and the scenarios within that range are similarly unidentifiable;
- it is often impossible to identify, much less predict, all the important variables that will shape the future.

Additionally, the study provided recommendations for each level of uncertainty. This environment is conducive to the digital world today, necessitating further research into developing agile digital strategies for enterprises.

2. Methodology and methods

The framework for developing an enterprise digital strategy is presented in Figure 1. The necessary flexibility of the strategy is largely determined by the procedures and methods used in its development. Let us highlight a number of trends in terms of the development of approaches and methods of strategic management of an enterprise in the digital environment [Gileva, Shkarupeta, 2022].

Fig. 1. Enterprise digital strategy development framework



1. An increasing number of researchers are questioning the applicability of traditional systematic calendar planning principles to strategy development in the digital environment, suggesting that such an approach may be inexpedient or even impossible. According to D. Bonnet and P. Maulik, the era of clear strategic planning has ended. The traditional approach of defining a strategy as a series of sequential steps to be taken in the predetermined

future is no longer tenable. Instead, strategy must be conceptualised as a dynamic, evolving process [Bonnet, Maulik, 2018, pp. 23-26]. Effective response to continuous change requires adopting an event-situation approach and viewing strategy as a flexible trajectory to achieve key objectives[1]. Authors [Hunsaker, Knowles, 2020] argue that it is essential to focus on what is changing rather than what is stable, enabling the identification of how changes can neutralise historical advantages while creating new opportunities and expanding the number of stakeholders whose needs and potential contributions should be given due consideration in the strategic planning process.

2. The set of methods for analysing the external environment has been updated with new additions and changes of emphasis:

- increasing role of such traditional but insufficiently applied methods of strategic planning and management such as scenario analysis and weak signal management [Venkatraman, 2019];
- expanding the scope of analysed external factors as potential sources of disruptions [Webb, 2020], singling out ecosystem impact factors as a separate group [Toner et al., 2015], and considering the interrelationships between different factors [Wiles, 2021];
- in-depth analysis of technology development as a source of destruction and new opportunities, increasing the role of technology scanning and scouting [Ashton, 2020];
- expanding the application of big data analytics in technological and competitive analysis (Open Source Intelligence, OSINT).

In order to analyse internal capabilities of an enterprise in the digital environment, digital maturity assessment is typically employed. Identifying and assessing gaps between current and target digital maturity levels helps identify promising development directions and projects.

Key trends in strategic decision-making include:

- increasing role of mission and vision as guidelines for strategic sustainability;
- choosing a limited number of strategic priorities to link long-term vision and medium-term goals [Sull, Turconi, 2017];
- blurring the boundary between long-term and medium-term planning using flexible roadmaps[2], like the 'Waves and Stones' method, as a strategy presentation tool. "Waves" are major changes on the way to a target future state, while 'Stones' are tactical actions for the short or medium term;
- developing approaches and methods to increase strategy flexibility, including forming a smart KPI structure for faster, more accurate monitoring and necessary trajectory adjustments towards strategic priorities. The concept of smart KPIs [Scharge, Kiron, 2018] involves using big data analytics and AI technologies to collect, analyse, and justify the composition of the most representative indicators.

Let's explore methods to enhance strategic flexibility.

1. The Strategy Palette, developed by M. Reeves and colleagues (Reeves et al., 2016), classifies strategies based on three dimensions: predictability, or the ability to foresee future events; plasticity, or the capacity of the firm and its partners to influence the environment; and aggressiveness, or the level of external threats to the firm's survival.

In the absence of predictability or changeability in the environment, it is recommended that companies adopt an adaptive strategy, characterised by continuous experimentation. The process of adaptation involves developing and testing diverse strategic alternatives, followed by selecting and scaling the most successful options. This approach is similar to the widely adopted concept of the minimum viable product, although the underlying assumptions differ. The evolution of these concepts is the notion of Minimum Viable Strategy [Childs, 2018; Gileva, Babkin, 2022], which appears to be a promising avenue for further exploration.

2. The concept of Open Strategy primarily relies mainly digital technologies and organisational mechanisms, such as using crowdsourcing platforms to search for and select strategic ideas and solutions [Tavakoli et al., 2017]. It also involves expanding knowledge-sharing processes within online communities and stakeholder interactions [Morton et al., 2020].

3. Agile Approaches to Digital Strategy Development. According to Chanias et al. (2019), strategy should be seen as a 'moving target' that requires constant updates, emphasising the need to apply agile technologies not only during implementation but also during strategy development. The Russian consulting company Strategy Partners uses a dynamic and structured process for digital strategy development that includes three sprints: generation and evaluation of new ideas, in-depth testing of the most promising strategic options, and final strategic selection[3].

4. Scenario Building Approach. The 'circle of uncertainty' developed by Bain & Company [Toner et al., 2015] involves identifying key uncertainties, creating a set of plausible future scenarios, and analysing them to plan strategic actions for each scenario. It also establishes a clear set of indicators that signal important market changes and trigger pre-defined actions within the scenario planning process.

5. Gartner's Methodology for Developing Adaptive

[1] Digital strategy and roadmap (2016). https://www.cgi.com/sites/default/files/pdf/digital_strategy_and_roadmap.pdf.
[2] Building your digital transformation journey (2019). IDC, December 2019. https://www.ge.com/digital/sites/default/files/download_assets/idc-building-your-digital-transformation-journey.pdf; Digital strategy and roadmap (2016). https://www.cgi.com/sites/default/files/pdf/digital_strategy_and_roadmap.pdf.
[3] Agile-стратегия и цифровая трансформация (2023). Strategy Partners. https://strategy.ru/services/agile-transformatsiia-biznesa.

Strategies in the digital landscape [Wiles, 2023] is based on four fundamental practices: embracing and exploring uncertainty, initiating execution at the earliest possible stage, responding promptly and flexibly to changes, and engaging all relevant stakeholders in the strategy creation process.

6. The use of visualisation tools, specifically a 'one-page' format for the presenting strategic concepts (Colella, 2015), is an effective approach to articulate and visualise key aspects of strategic planning, thereby facilitating engaged discourse. A group of tools collectively known as 'canvases' has recently gained considerable popularity. While they are quite widespread in foreign management practice, there is only one representative of this group has gained significant recognition: the Canvas business model of A. Osterwalder and its modification, the Lean Canvas of E. Maurya. The term 'canvas' is frequently rendered in English as 'template', which implies a range of analogous solutions. However, a canvas is more than just a template; it is a tool for creativity that systematises and establishes logical relationships between the identified key success factors. It ptovides a structured basis for joint discussion, integration, and development of ideas and opinions in a clear and visual manner. This is the context in which this tool is discussed in this article.

7. The Ecosystem Approach and Ecosystem Strategy. The ecosystem format offers many opportunities for enterprise development [Jacobides, 2019; Pidun et al., 2022], such as obtaining missing resources and competencies, including new knowledge, more quickly and cheaply, participating in the creation of a highly attractive integral value proposition, and engaging in co-development (coevolution). Deciding to engage with ecosystems is a pivotal strategic choice for modern industrial enterprises [Chanias et al., 2019; Wald et al., 2019; Gileva et al., 2020]. While this article does not delve into ecosystem strategy development in terms of creating new ecosystems, it highlights the benefits of participating in existing ecosystems. This includes ecosystem selection, assessing the attractiveness of component enterprises, identifying potential ecosystem roles, and selection of models of interaction between ecosystem participants. Additionally, it is important to consider the impact of digital platforms on the development of industrial enterprises. These platforms can provide competitive advantages by offering better products, increasing market access, and enabling network interactions that are difficult to replicate.

The abundance of available approaches and methods can often prove to be more of a hindrance than a help when seeking solutions to specific problems. To enhance clarity, we present the author's grouping of the considered methods (see Table 2).

It should be noted that these groups of methods are complementary rather than mutually exclusive. The concept of a minimally viable strategy, for example, involves creating an adaptive strategy based on experimentation, leveraging ecosystems opportunities for scaling and and utilizing various organisational and management mechanisms. This includes continuous implementation monitoring, while maintaining such traditional 'strategic anchors' such as as reliance on the company's core competencies and competitive advantages in a continuously changing world, and defining a system of strategic priorities.

Table 2
Approaches to increasing flexibility in digital strategy of enterprises

Based on the development of scenarios	Experiment-based
Based on the application of organisational and management mechanisms	Based on ecosystem interactions

Summarising the analysis of digital strategy development for enterprises, several key rules and principles can be identified.

1. The primacy of strategy over technology. Positioning digital strategy at the corporate and business levels is analogous to competitive strategy, as digital transformation is now a essential for the competitiveness of industrial enterprises.

2. The primary aim of formulating a digital strategy is to enhance flexibility while balancing the inherent tension between flexibility and sustainability. Flexibility is primarily based on developments in ecosystem creation and minimum viable strategies, while sustainability involves establishing a system of strategic priorities. Integrating flexibility and sustainability leads to the development of a tool such as flexible roadmaps.

3. The integration of long-term and medium-term perspectives in the planning process.

4. The interactive approach to strategy development and implementation is the key element of this process. Applying agile development technologies and roadmaps with three horizons, formed by methods like the 'surging wave' or 'Waves and Steps', is crucial.

5. Systematic and validated methods. Utilising a wide array of methods and tools for digital strategy development, including both traditional methods (updated for current relevance) and those specific to the digital environment (e.g. digital maturity assessment models, one-page presentation formats, flexible roadmaps, etc.).

3. Results of the study

When considering digital strategy as a roadmap, it is logical to group the methods of its development and implementation according to the stages of the digital transformation process. This is based on the most generalised scheme from the joint study by the World Economic Forum and Bain & Company[4], which combines four key aspects: digital strategy, business model, identification of drivers and creation of the foundation of the company's digital transformation, and orchestration as an agile management process. Given the position that agile technologies should be applied not only during the implementation phase but also in the strategy development phase [Chanias et al., 2019], we will use the adaptive planning approach proposed by Gartner analysts [Wiles, 2023] as the second dimension to systematise methods and tools for developing an agile digital strategy for an enterprise. The proposed management practices are:

- accept and explore uncertainty (P1);
- start implementation as early as possible (P2);
- respond to changes as they occur (P3);
- involve everyone in the strategy (P4).

At each of the stages of digital transformation, different methods and tools should be used to implement these practices (see Table 3). The purpose of building this landscape is to broaden the perspective and create transparent navigation in applying methods and tools for forming the digital strategy of an enterprise.

The methods and tools presented in the landscape can be divided into several groups:

- Traditional and widely used strategic planning methods, such as critical success factors, benchmarking, SWOT analysis, GAP analysis;
- Methods that are well-known but not widely used. These include technology scanning, scenario analysis, and weak signal analysis. These methods have gained relevance due to increased uncertainty in the external environment and significant advancements in Big Data and Artificial Intelligence;
- Methods updated for the digital environment. This group includes macro-environmental analysis methods like the analysis of 11 sources of possible failures [Webb, 2020], the circle of uncertainty [Toner et al, 2015], and the method of creating a

Table 3
Landscape of methods and tools for building a digital strategy for the enterprise

<table>
<tr><th></th><th>Digital Strategy</th><th>Business Model</th><th>Drivers of Digital Transformation</th><th>Orchestration</th></tr>
<tr><td>P1</td><td colspan="2">Analysis of drivers of change (macro environment): analysing 11 sources of failure, TESTRE, circle of uncertainty,
technology scan,
weak signal analysis,
customer journey map,
benchmarking,
SWOT analysis,
scenario analysis</td><td></td><td></td></tr>
<tr><td>P2</td><td>Critical success factors,
North Star Metric,
strategic priorities,
minimum viable strategy,
one-page strategy
strategic sprints</td><td rowspan="2">Digital platform, partner ecosystems
asset-light business models,
user flows (user story mapping),
predictive forecasting</td><td colspan="2">Digital maturity monitoring
GAP analysis, operating model linked to digital strategy, 3 horizons of the roadmap, p artner ecosystems, predictive forecasting, agile management technologies, investment decisions based on big data analytics</td></tr>
<tr><td>P3</td><td>Ecosystem strategy, 'rolling wave' method, prioritisation methods, experimentation-based strategy, smart KPIs</td><td colspan="2">Flexible roadmaps, partner ecosystems, intelligent agile operations, real-time solutions</td></tr>
<tr><td>P4</td><td colspan="4">Digital organisational cultures ambitious and transparent goals (OKR system), talent management, flexible workforce, agile teams</td></tr>
</table>

[4] The digital enterprise. Moving from experimentation to transformation (2018). World Economic Forum. https://www.weforum.org/publications/the-digital-enterpise-moving-from-experimentation-to-transformation/.

Table 4
Minimum viable enterprise digital strategy canvas

<table>
<tr><td colspan="5">Key Features</td></tr>
<tr><td>Partners (ecosystem)</td><td rowspan="2">Competitive advantages (key competencies)</td><td>Markets/ products</td><td rowspan="2">Mission and Vision</td><td>Success Criteria</td></tr>
<tr><td>Digital technologies</td><td>Strategic priorities</td><td>Metrics (KPI)</td></tr>
<tr><td colspan="5">Key risks</td></tr>
</table>

'tapestry' of interrelated factors TPESTRE [Wiles, 2021]. It also includes forming a system of strategic priorities [Sull, Turconi, 2017], flexible roadmaps[5] and other visual tools for decision-making (Canvas);

- A group of new methods complementing the traditional arsenal: customer value mapping methods (Customer Journey Map, User Flows, User Story Mapping, etc.), enterprise digital maturity assessment models, agile planning and management techniques, real-time data-driven decision making, minimum viable strategies, and smart KPIs [Scharge, Kiron, 2018]. The World Economic Forum's[6] analytical report presents a broad range of agile strategy methods, including strategy sprints, intelligent agile operations, and investment decisions based on big data analysis. An important aspect of management flexibility, particularly in strategy implementation, is the close link between the business model and the company's operating model[7].

As additional comments to Table 3, we note the following.

First, it is nether practical nor advisable to employ all methods simultaneously. To ensure the validity of strategic decisions, methods should be chosen to correspond to each stage of the digital transformation process, considering all four practices of adaptive planning. It is critical not to rely solely on traditional methods of strategising. To achieve the necessary flexibility in a digital strategy, methods from both the 'actualised' and 'new' groups must be employed.

Secondly, the current era is characterised by a high demand for developing methods and tools that cater to the digital environment peculiarities. This demand drives active research and leads to the emergence of new methods and tools, necessitating ongoing updates to the landscape of available methods.

Third, the development of new tools is feasible by combining different approaches and methods. For example, developing a one-page format (canvas) to create a minimally viable digital strategy for an industrial enterprise illustrates this.

Despite the promising nature of this concept in increasing strategy flexibility (analogous to the development of a minimum viable product - MVP - widely and effectively used in management practice today), only theoretical and methodological provisions for a minimum viable strategy have been established to date [Childs, 2018], with no practical implementation tools.

Benchmarks for developing the canvas of the minimum viable digital strategy for an enterprise (see Table 4) are as follows:

- canvas of minimum viable product[8];
- the essence of strategy as an instrument of enterprise development management: analyzing and considering the influence of external opportunities and threats; creating competitive advantages based developing organisational competencies; determining priority areas of development (products, markets) by aligning external factors with the internal capabilities of the enterprise;
- research in the field of increasing strategy flexibility (enhancing the role of the mission and vision of the enterprise, developing a system of strategic priorities, utilising digital technologies and ecosystems as drivers of digital transformation; monitoring progress based on KPIs).

Thus, a minimum viable digital strategy (MVDS) is a tool for managing the development of enterprises in the digital environment. It provides the necessary management flexibility through the selection of a limited number of clearly defined strategic priorities and criteria for the enterprise success in relevant markets. It leverages digital technologies and ecosystems, allowing timely adjustments based on analysing external factors (opportunities and threats) and continuous monitoring through a representative system of key performance indicators (KPIs).

[5] Building your digital transformation journey… https://www.ge.com/digital/sites/default/files/download_assets/idc-building-your-digital-transformation-journey.pdf.
[6] Digital transformation: Powering the great reset (2020). Weforum, July 17. https://www.weforum.org/publications/digital-transformation-powering-the-great-reset/.
[7] Digital operating model. A structured approach to choosing and implementing new technologies (2020). Deloitte, February. https://www2.deloitte.com/content/dam/Deloitte/de/Documents/technology-media-telecommunications/DELO-6056_Digital%20Operating%20Models.pdf.
[8] Caroli P. (2023). https://caroli.org/en/build-the-mvp-canvas/.

Conclusions

Formulating a digital strategy is critical for the success of industrial companies undergoing digital transformation. It is a business strategy that focuses on enhancing company development through increased production efficiency of production based on digital technologies and creating new opportunities for greater customer value using new behavioural models grounded in digital technologies and a culture of continuous change.

Given the significant rise in external instability driven by the proliferation of digital technologies, both quantitatively and qualitatively, there is a pressing need to refine the principles, methods, and tools of traditional strategic management. The emphasis is on methods designed to enhance the flexibility of digital strategies. Key steps in this process include employing a scenario approach, continuously experimenting with successful practices, using various organisational and management solutions (such as crowdsourcing platforms, stakeholder networking, agile teams, and fostering the necessary organisational culture), and engaging with the broader ecosystem.

The flexibility of a strategy is largely determined during the analysis stage, which includes both the external and internal environments. The article presents a landscape of methods and tools for designing a company's digital strategy, allowing the selection of methods that ensure flexibility at all stages of digital transformation.

Integrating diverse approaches and methodologies forms the foundation for creating innovative tools that align with the requirements of the digital landscape. As an example, the article introduces a canvas for a minimum viable digital strategy for a company. The one-page presentation format provides a visual representation of the company's vision and strategic priorities, defining key markets and products, while considering external opportunities and risks, as well as the company's competitive advantages and organisational competencies developed through digital technologies and partnership interactions within the ecosystem. The advantages of such a presentation are threefold. Firstly, it allows the company to clearly and concisely define its vision and strategic priorities. Secondly, it ensures high visibility, facilitating employee understanding of the company's key values and priority areas. Thirdly, it provides a flexible platform for discussion and adaptation without the need for lengthy, often unreadable documents.

The framework of approaches, methods and tools of digital strategy development presented in the article offers a valuable opportunity to enhance the formation of a successful digital transformation strategy in an industrial enterprise. Further research should focus on developing a more detailed framework for a minimum viable digital strategy for enterprises. This should include a methodology for determining strategic priorities and a system of KPIs, as well as a roadmap for developing a digital strategy that considers various factors, such as enterprise size, market growth rates, and the impact of ecosystem players.

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Innovation ecosystems: Research of corporate innovation ecosystems and prospects for the formation of intercorporate ecosystems in Russia

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Abstract

The author examines the ecosystem approach, corporate innovation ecosystems and intercorporate innovation ecosystems. Considering the importance of their development for achieving the required pace of innovative development of Russian companies and the Russian economy, the study of their condition and development prospects determines the purpose of this paper. An analysis of the literature revealed an increase in the number of studies on innovation ecosystems and their diversity, indicating the potential for further development of the concept of innovation ecosystems. The analysis of the innovative activity of Russian companies shows that the main indicators reflecting the degree of innovative development in Russia in 2019-2022 are growing, but not enough. The average share of innovation costs in 2020-2022 was 2.1%, and in industry - only 1.7%, there was a reduction in the volume of inter-enterprise cooperation on the development of innovations. The author formulated the definition of a corporate innovation ecosystem as a singular innovation ecosystem established by a given company to create innovative value necessary for its development. The author has also formulated the features of its configuration that determine the logic of its functioning. The results of the study show the high potential for scientific and technological cooperation between Russian companies. Therefore, the author formulated the concept of an Intercorporate Innovation Ecosystem, which is a singular innovation ecosystem created on the initiative of two or more participants by partially integrating their corporate innovation ecosystems into an Intercorporate Innovation Ecosystem. Their aim is to carry out joint innovation activities and then independently commercialise the results. The proposed concept, implemented in accordance with the principles of the ecosystem approach, in terms of contractual relations, as well as implying the development of a single platform or functioning on a multi-platform basis, has theoretical validity and seems applicable in the practice of Russian companies and significant for the development of the Russian economy.

Keywords: innovations, corporate innovation ecosystem, intercorporate cooperation, intercorporate innovation ecosystem, scientific and technological alliances.

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创新生态系统：对企业创新生态系统的研究及在俄罗斯形成跨企业生态系统的展望

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简介

研究生态系统方法、企业创新生态系统和企业间创新生态系统对于俄罗斯企业和整体经济实现必要的创新发展速度至关重要，这也确定了本文的目标。文献分析表明，对创新生态系统的研究数量增加并且涵盖的方面多样化，这表明了创新生态系统概念发展的潜力。

通过对俄罗斯企业的创新活动进行分析表明，2019年至2022年间反映俄罗斯创新发展程度的主要指标有所增长，但增长速度仍然不够快：2020年至2022年间，俄罗斯经济整体的创新支出占比平均为2.1%，而工业领域仅为1.7%。此外，企业间合作开发创新的规模也出现了缩减。基于这一情况，提出了将企业创新生态系统定义为一种特殊的创新生态系统，由企业形成，旨在创造对其发展至关重要的创新价值，并阐明了其构造特点，确定了其运作逻辑。进行的研究表明，俄罗斯企业之间的科技合作潜力巨大。这促使提出了跨企业创新生态系统的概念，它是一种特殊的创新生态系统，由两个或更多参与者发起，通过部分整合它们的企业创新生态系统形成跨企业创新生态系统，旨在共同开展创新活动并进而独立商业化其结果。提出的这一概念符合生态系统方法的原则，基于合同关系，同时暗示着开发统一平台或运行在多平台基础上，具有理论基础，并可在俄罗斯企业实践中应用。

关键词: 创新生态系统、创新、企业间合作、企业间创新生态系统、 科技联盟。

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Introduction

The current stage of economic development is characterised by intensifying competition, an increasing complexity of business processes, and the rapid development of digital technologies. These factors have created conditions conducive to the formation of an ecosystem approach to the organisation of business processes in the practical sphere and the emergence of a theoretical concept of innovative ecosystems. The a posteriori nature of knowledge about innovative ecosystems - this interesting phenomenon - places researchers in the position of an analyst observing its development. Many, however, strive to form a priori knowledge about this phenomenon, which has led to the formation of a significant number of approaches to its study and selected emphases. This indicates that the theoretical design of innovative ecosystems (henceforth referred to as IES) is still evolving, with new emphases, models, and approaches being continually added. At the same time, the relevance of studying these ecosystems and the ecosystem approach itself will only increase.

IES is an intriguing research object due to its multifaceted conceptualisation. In some studies, it is conceptualised as an ecosystem specifically designed for innovation. In contrast, in other studies, it is conceived as a business ecosystem, which is not necessarily created for the purpose of innovation. In this regard, it is necessary to clarify that IES (in any variation) continue to represent an innovative form of organising business activities. While there are positions according to which the degree of innovativeness of business ecosystems is questionable at a fundamental level, their platform organisation - in the modern economy - allows us to consider that these are innovative forms of organising business activities. A review and analysis of this topic can be found in [Matkovskaya, 2021]. Secondly, it is necessary to formulate a postulate, or at the very least, to make a note of it. It is erroneous

to assume that every business ecosystem is innovative and that every business ecosystem is formed with the explicit intention of creating innovations. While there is a clear need to differentiate between business ecosystems and IES, it is nevertheless evident that business ecosystems possess considerable innovative and technological potential (Matkovskaya et al., 2022). In light of the above, it is proposed that the existing criteria for classifying ecosystems be expanded to include the presence or absence of a goal of creating innovations, namely innovative values (hereinafter IV), among the initiators of their formation. It is therefore the intention of this study to examine in detail the specific case of the IES, which has been deliberately created with the objective of generating IV.

The focus on the study of corporate innovation ecosystems (hereinafter referred to as CIES) and inter-corporate innovation ecosystems (hereinafter referred to as ICIES) makes the subject of the study even more interesting. It is assumed that the development of ICIES through the partial integration of two or more CIES will make it possible to utilise the potential of enterprises and obtain a synergistic effect from inter-firm cooperation, and may become one of the key factors in accelerating the innovative growth of the Russian economy. In addition, the aim of the 'co-opetition'/'com-operation' (i.e. a combination of cooperation and competition) based ICIES is to create conditions firstly for the joint creation and separate use of information resources (and their exchange), and then to increase the competitiveness of companies cooperating within the ICIES. As a result, research becomes not only transdisciplinary but also transconceptual, based on the sum of knowledge embedded in concepts such as open innovation, digital economy, knowledge economy, innovation economy, sharing economy, concepts of 'corporate' and 'factory' science, network interactions, platform models, knowledge ecosystem, intellectual ecosystem, multi-agent networks, as well as scientific and technological alliances and consortia, inter-enterprise cooperation, etc.

All this determines the relevance of the topic, and it is also extremely significant that the development of CIES and cooperation between Russian companies within the framework of ICIES can create conditions for accelerating the achievement of the goals of import independence at a minimum, and the goal of accelerating innovative development - at a maximum. At the same time, the results are quite universal and can be applied by companies in other countries.

The article aims to carry out a study of ideas about IES, to study the characteristics of CIES, to characterise the specifics of its configuration and the logic of its operation, thereby establishing a foundation for developing the ICIES concept.

The article begins with the concept of IES and views on it, then presents the results of a study of the innovative activity of Russian enterprises, their experience in the creation and operation of CIES, the state of inter-enterprise scientific and technical cooperation of Russian enterprises, and also proposes a model of ICIES.

It can be seen that the structure of the article is designed to stimulate interest among those engaged in the fields of CIES formation, corporate governance, and innovation policy. Additionally, the study's findings can guide the development of strategies to advance IES at both corporate and inter-company levels, while also shaping the direction of state scientific and technological policy.

1. Research object and theoretical review

The research object characteristics are varied and have been explored by numerous researchers who have concentrated on specific aspects. In this work, however, we will highlight the nine most critical points (noted in brackets). For example, in [Plata et al., 2021] it is stated that IES is usually understood as a complex system in which different firms, organisations, and support mechanisms are combined to carry out knowledge dissemination activities (1), and that the purpose of their creation is to generate value and deliver a focal product or service (2).

The work [Akberdina, Vasilenko, 2021] points out that 'many authors working with the concept of IES repeat Moore's postulates and add an innovative component to them' (3). Based on a broad analysis of IES, the same researchers rightly state that IES is a 'multi-component concept' (4) and formulate a point of view, fully shared by the author of this work, that 'the emergence of this concept marks a transition to a new paradigm in management...'. For theorists, this paradigm encapsulates the latest achievements in management as a science and becomes the basis for subsequent research; for practitioners, it simplifies the implementation of modern management knowledge by dealing with one complex concept rather than a dozen disparate ones. The articles [Smorodinskaya, 2013; 2014] formulate that the knowledge economy presupposes a new 'architecture' of connections between economic entities and the formation of new types of systems based on network cooperation and network interactions. The scale of these changes is so significant that we can describe it as a 'civilisational shift' and a change in the development paradigm. This marks the emergence of a new universal method for producing public goods (5), as agreed upon by the authors of the study [Tolstykh et al., 2020]. The ecosystem approach emphasises the interactions among participants (collaborations) that facilitate the generation and dissemination of knowledge, which is then transformed into innovations' (6).

Criticism of the concept of IES 'should not be perceived as a signal of the inconsistency of the concept, but as a vector for further research' and 'the concept of IES itself is a starting point for many different approaches designed to solve specific practical problems in certain conditions, including in a relatively narrow segment' (7) [Akberdina, Vasilenko, 2021].

The next point (8) is that a number of works use numerous variations that have formed a whole family of terms, including ecosystems: 'entrepreneurial' [Venchurnye Investitsii.., 2011], 'stakeholder' [Da Silva et al., 2019], 'platform' [Volkova, Yakovleva, 2017], 'universal' [Kleiner, 2019], 'network' [Smorodinskaya, 2014], 'digital' [Tolstykh et al., 2018], 'nuclear' [Brito, 2018], 'regional' [Plakhin et al., 2020], 'smart' [Ciasullo et al., 2020]; many of the above, as well as 'unitary', 'multi-actor networks' and others, are explored in [Popov et al., 2022]. The authors of [Tolstykh et al., 2020], on the other hand, distinguish between 'innovative' and 'industrial' ecosystems, noting that they are 'generally implemented independently and in parallel', while raising the 'status' of these research objects to the level of 'theories', highlighting respectively the 'IES theory' and the 'industrial ecosystem theory' (9) and summarising that, in general, 'ecosystem theory is still at the stage of methodological development'. This opinion is also expressed in [Plata et al., 2021], where it is emphasised that the IES concept is 'still under development'.

Thus, the peculiarities of IES as an object of research are determined by its 'young' age, its direction, which is in the stage of methodological formation, and its multi-component nature, which together create conditions for the development of the concept of IES (both in scientific and practical activities). At the same time, the author of this article is increasingly convinced that the distinction between concepts will not contribute to the development of 'ecosystemic thinking' with the same dynamism and effectiveness that is currently being observed and which is progressive in nature.

Turning to the details of the content of the theoretical review, I would like to draw attention to the fact that the team of authors [Tolstykh et al., 2020; Tolstykh et al., 2020], referring in particular to [Chesbrough et al., 2006; Tsujimoto et al., 2018], notes that 'five theoretical directions of research on IES have been formed' and that 'many modern works are devoted to the study of initial barriers that negatively affect the implementation of sustainable practices'.

At the same time, the author's study of the works published in the last decade, and especially since 2019, has revealed an increasing number of research angles. These are presented in Table 1.

In concluding the theoretical review, it is necessary to pay attention to some more important points. Firstly, it should be noted that the author belongs to the group of researchers who are convinced that the creation of the IC is one of the key aspects that predetermined the formation of the IES and the goal of any IES. This highlights the growing importance of developing a value-based approach and underscores the significance of research focusing on the concept of value. The article by A.V. Trachuk, N.V. Linder, and V.O. Tuaev is undoubtedly such a work, which systematises the key aspects of the understanding of value. The author of this article, considering the analysis conducted in it to be extremely thorough, refrains from conducting her own analysis of this category and relies on the results of the study [Trachuk et al., 2022], additionally emphasising the great practical significance of the model for creating a successful value proposition formulated by them.

Secondly, it is important to note that the journal 'Strategic Decisions and Risk Management' has already published research related to, but not identical with, the subject of this article. Among them, it is particularly worth highlighting the works devoted to identifying the impact of digital platforms on the study of industrial enterprises [Trachuk, Linder, 2023]; studying management education, as well as formulating a position that fully agrees with the author's position that management science must understand the changes that are taking place [Gitelman et al., 2022; 2023]; studying the strategic aspects of the functioning of digital platforms and the interaction of their participants [Kuznetsova, 2022; Khovalova, 2022].

The methodological basis for studying the problem under investigation was a combination of general scientific methods (analysis and synthesis, scientific abstraction, generalisations, analogies), methods of economic analysis, classification and grouping, ranking and structuring, and quantitative and qualitative analysis of data, as well as methods of systemic, logical, structural, and comparative analysis, graphical analysis, and design methods.

2. Characteristics of the ecosystem and their structure

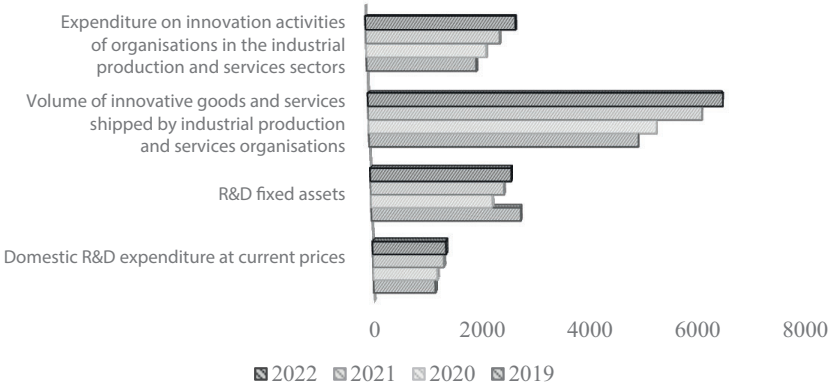
This section presents an understanding of IES and CIES. The review carried out and the previous studies of the author of this article have allowed us to form our own integral understanding of the IES, the key points of which are as follows:

1) IES aim to create ICS and create attractive conditions for their participants through the possibility of optimising their transaction costs;
2) IES are based on a new form of ('non-combative') competition - co-opetition/com-operation;
3) IES are developing thanks to advances in ICT and the growing demand for digital products;

Table 1
The most interesting views on Innovation Ecosystems (IES) and approaches to their research in the scientific literature, 2019–2024

Context (focus, emphasis, or angle of research), source	Vision
Identification of significant features [Tolstykh et al., 2020].	Key features: complementarity and coordination of companies from different sectors, united by the principle of common specialisation.
In the context of Society 5.0 [Fukuda, 2020; Weerasinghe et al., 2024].	An ecosystem view of the model of scientific, technological, and innovative activity (STI) in Society 5.0, associated with the transition from a STI ecosystem based on push methods to an STI ecosystem based on pull methods. The authors also examine the socio-economic risks.
Transformational aspects of the transition to a green economy [Konietzko et al., 2020; Yan et al., 2023; Zhang et al., 2023].	Innovative ecosystems as a tool for transforming linear economies into circular ones Green Ecosystems and Green Innovation Ecosystems
Digital IES [Beltagui et al., 2020].	Digital IES
Talent orientation [Huang et al., 2023]	The study of the conditions of the IAS, which ensures high competitiveness of talents, and the differentiation of types of UES on this basis
Generation of new metaphors for NIS [Ghazinoory et al., 2021; Ghazinoory et al., 2023]	Introducing new metaphors: – Ecotone, not ecosystem; – National innovation biomes
Standardisation in platform ecosystems [Nylund, Brem, 2023]	The influence of dominant platforms on standardisation in IES at the level of technologies, firms, and societies
Social ecosystems [Catala et al., 2023]	Key characteristics of social economy ecosystems are the balance between economic objectives and the creation of social value and social innovation, collective social entrepreneurship, and specific institutional components
Platform capitalism [Srnicek, 2020]	The concept of platform capitalism
Global IES [Cho, Park, 2022]	On the Interaction of NIS and Global Innovation Systems (GIS)
Proposal for the application of a ‘holographic strategy’ [Barile et al., 2022]	The ‘holographic strategy’ is another typical pattern that characterises a platform IES that transcends existing market boundaries
Responsibility of the IES [Stahl, 2022]	It is assumed that the influence of IES extends beyond their immediate technical environment, which determines the need for responsible behaviour of these IES (the concept of RRI - Responsible Research and Innovation)
Co-evolutionary aspect, limits, and value proposition [Breslin et al., 2021; De Vasconcelos Gomes et al., 2021]	IES are complex adaptive systems in which patterns of change emerge from co-evolutionary interactions between actors at the micro level, providing ‘co-evolutionary rules of interaction’. Innovation supports and stimulates change in IES
Variable Innovation Ecosystems [Liu et al., 2022]	IES provide access to additional resources such as knowledge of advanced science and technology and ‘intensive market knowledge’.
IES as complex networks, or meta-networks [Plata et al., 2021; Robertson et al., 2023]	IES are composite systems of innovation meta-networks and knowledge meta-clusters that act as building blocks for the creation of knowledge and innovation architectures
Transformational Governance of Innovation Ecosystems [Könnölä et al., 2021]	Transformational governance, aimed at increasing the adaptability and resilience of the ecosystem, organises socio-technical transformations based on the balanced presence of diversity, interconnectedness, poly-centricity, redundancy, and orientation
Technological learning and small states [Petraite et al., 2022]	Technological education is at the heart of technological modernisation, particularly important for small countries with open economies facing the challenges of innovation-driven growth
Transfer [Shmeleva et al., 2021]	A study of the experience of creating technology transfer networks in Russia and the development of a promising national technology transfer model based on the concept of an innovation ecosystem and open innovation

Fig. 1. Dynamics of some indicators of innovation development in Russia in 2019–2022 (billion roubles)



Source: compiled by the author on the basis of: Brief Statistical Compendium (2023). Moscow: IPRAS RAS. P. 11.

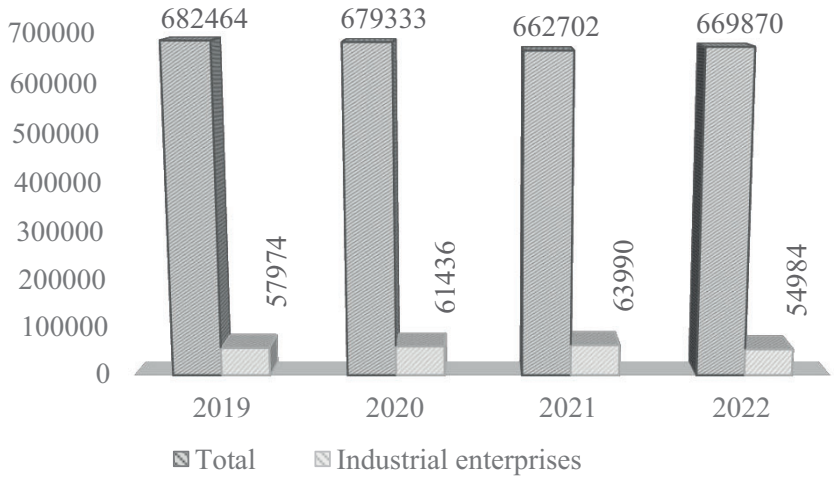
4) IES represent a particular analogue-digital continuum of business organisation;
5) IES mark the emergence of a new form of management - orchestration;
6) IES are self-sufficient;
7) IES involve participants connected by 'co-creation of value', as presented in [Breslin et al., 2021], and determine co-innovation activities [Matkovskaya, 2021; Matkovskaya, et al., 2022; Lafuente et al., 2023; Matkovskaya 2023a; 2023b]. The presented understanding of IES correlates primarily with the understanding of IES formulated in works such as [Scott et al., 2015; Adner, 2017] and others.

Given the multi-component nature of the IES, it should be noted that they can be differentiated according to a number of criteria. In this regard, it is necessary to supplement the previously presented criteria [Matkovskaya, 2021] with other criteria relevant to the study:

1) by industry, region;
2) by level (CIES, MCIES, macro and global);
3) by economic activity (industry, finance, education, etc.);
4) by scalability;
5) according to the initiators and the composition of participants (state, business groups, companies, individuals)
6) by the number of digital platforms involved (single-platform and multi-platform), etc.

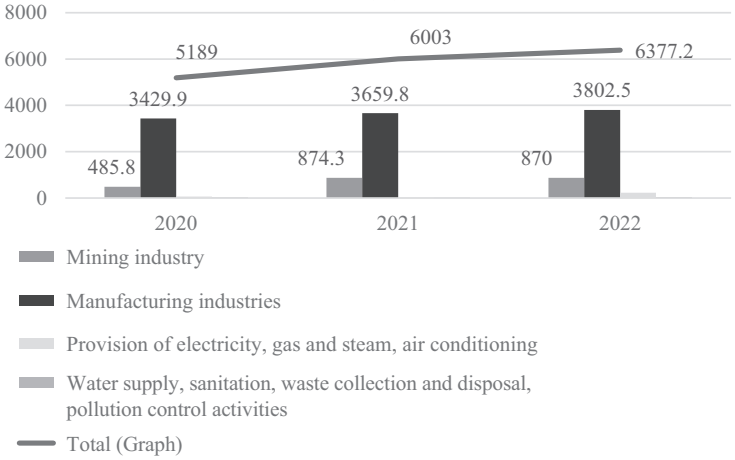
Based on all the above, it can be concluded that a CIES is an IES created by a company for the purposes of its innovative and technological development, which can: operate within the framework of a separate company

Fig. 2. Share of personnel engaged in R&D in industrial enterprises and in the economy as a whole in Russia, 2019–2022 (%)



Source: compiled by the author on the basis of: Brief Statistical Compendium (2023). P. 22.

Fig. 3. Volume of shipped innovative goods and services provided by industrial production and service organisations by type of economic activity in 2020-2022 prices (excluding the scope of scientific R&D) (billion roubles)



Source: compiled by the author on the basis of: Brief Statistical Compendium (2023). P. 89.

or holding (in the latter case, it can be a network structure); be a formalised or informal structure.

The peculiarities of the logic and configuration of a CIES are that any IES (including the CIES) implies:

1) the presence of a platform or is in varying degrees of digitisation of business processes;
2) has a synergistic nature;
3) allows the implementation of a deep collaboration model according to [Mezentseva, 2023].

In the study of KIES in this article, the author does not consider the direct involvement of academic science organisations and universities in KIES, although she does not deny the importance of such cooperation. The focus is on the company's work on the use and development of its innovative potential for the creation of the ICT.

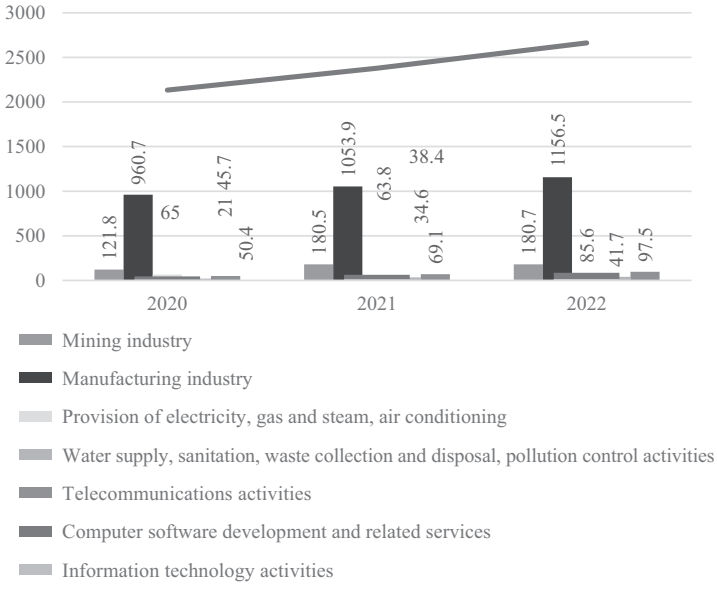
3. Results of the empirical study

3.1. Study of the innovative activity of Russian companies and the availability of CIES among them

In order to assess the level of innovative activity of Russian enterprises, some significant parameters characterising the innovative potential of the economy were studied in order to identify the problems that can be largely solved in the context of the formation of the CIES.

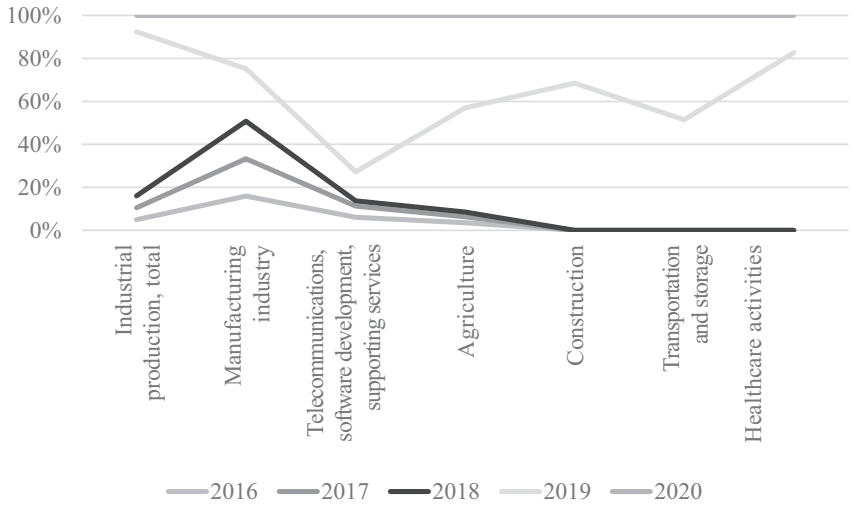
Thus, Figure 1 shows the dynamics of some indicators of innovative development in Russia in 2019-2022. The graph shows that there is an increase in all

Fig. 4. Innovation costs of industrial production and service organisations by type of economic activity in 2020-2022 prices (excluding R&D) (billion roubles)



Source: compiled by the author on the basis of: Brief Statistical Compendium (2023). P. 91.

Fig. 5. Joint projects for R&D in 2016–2020 (%)



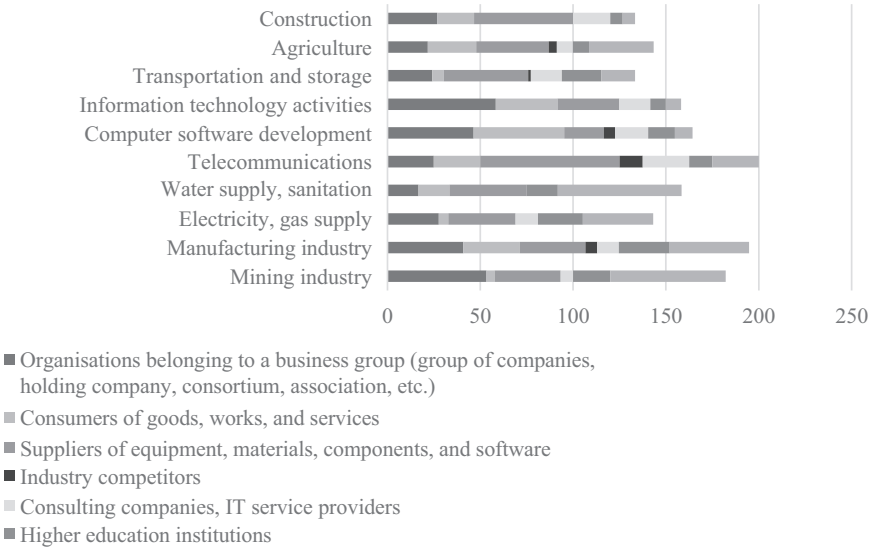
Note. Indicators are calculated for organisations that have engaged in innovative activities; prior to 2019, this applied to organisations with technological innovations.
Source: compiled by the author on the basis of Indicators of Innovation Activity: 2022 (2022). Moscow: National Research University Higher School of Economics. P. 168.

analysed indicators, which can only be recognised as a positive phenomenon, although the growth rate remains extremely low.

However, it should be noted that the share of innovation costs in the volume of goods shipped by industrial production and services organisations by type of economic activity is low. On average, in 2020-2022, it was 2.1% in the economy, 1.7% in industry as a whole, 3.6% in telecommunications, 4.2% in computer software development and related services, 1.77% in information technology, and the highest rates were in scientific research and development - 35.9% (which is natural, but also insufficient)[1].

On the negative side, in 2018-2020, 5.4% of Russian organisations seriously delayed their innovation activities, 5% suspended them, and 5.6% did not start any projects. During the same period, there were 29,672 uninitiated innovation projects, 27,509 projects that were halted, and 28,772 projects that experienced significant delays. The highest rates of uninitiated projects are found in the manufacturing industry, particularly in low-

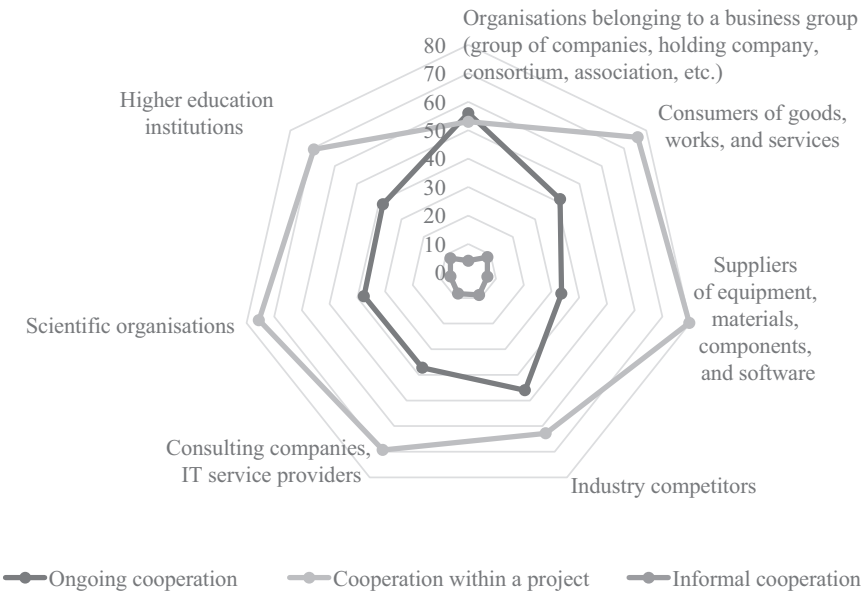
Fig. 6. Distribution of organisations involved in joint R&D projects, by type of partner and by type of economic activity, 2020 (number)



Note. Indicators are calculated for organisations that have engaged in innovative activities; prior to 2019, this applied to organisations with technological innovations.
Source: compiled by the author on the basis of Indicators of Innovation Activity (2022). P. 171-175.

[1] Short statistical summary (2023). Moscow: IPRAS RAS. P. 93.

Fig. 7. Cooperation in performing R&D by type of cooperation relationship, 2020 (% of the total number of organisations involved in joint projects)



Note. Indicators are calculated for organisations that have engaged in innovative activities; prior to 2019, this applied to organisations with technological innovations.
Source: compiled by the author on the basis of Indicators of Innovation Activity (2022). P. 190.

tech and mid-tech sectors, and in the service sector, especially in transportation projects and activities related to law, accounting, and healthcare[2].

The largest contribution to scientific and technological development comes from the field of science and education. Figure 2 shows the dynamics of the number of persons employed in research and development (R&D) in industrial enterprises and their share in the total number of persons employed in the economy.

The low number of personnel engaged in R&D in industrial enterprises reflects the insufficient activity of Russian companies in the field of innovative development; the growth rate needs to be increased. In order to clarify the details of this problem, Figure 3 shows the industrial distribution of the production of innovative goods, and Figure 4 shows the costs of innovation of industrial production and service organisations by type of economic activity in current prices for 2020-2022.

The data presented raises the question of the prospects for increasing the pace of innovative development of Russian enterprises. While there is potential, it is essential to boost the management's motivation and foster an understanding that enhancing the company's innovative capabilities is crucial for its sustainability and competitive growth.

It can be concluded that the formation of CIES should become a condition for the growth of innovative activity of Russian enterprises. At the same time, it should be noted that the practice of using CIES tools is already being carried out by domestic companies, and we can observe quite effective experience in a number of cases. At the same time, open innovation tools are quite actively used to develop their CIES, including competitions of innovative projects, business accelerators, business incubators, business technology parks, scouting, etc. According to [Mezentseva, 2023], such methods are used by the State Autonomous Institution of the Russian Scientific and Technical Complex BashTechInform, PJSC Severstal, PJSC United Aircraft Corporation, SC Rostec, PJSC United Machine-Building Plants, PJSC Sibur, JSC Russian Railways, EFKO, JSC Tatneft, Rusal, and according to [Matkova, 2018], open innovation models are being developed by state corporations Rostekhnologii and Rosatom, and open innovation principles are being implemented by Sberbank, Lukoil, Russian Railways, and MTS.

When addressing the issue of the mechanism of IES formation, which is significant for the development of IES by Russian companies, it is worth paying attention to the work of [Wiki et al., 2021], who proposed a concept for the formation of IES of a large company. They note that large companies need to stop thinking and acting as if they were monolithic organisations with a single business model and start applying an ecosystem approach to their activities. Every modern company needs to have a balanced mix of existing products that are in high demand and new products that are looking for a profitable business model. Managing

[2] Innovation indicators: 2022: Statistical Summary (2022). Moscow: National Research University Higher School of Economics. P. 202-204.

such an innovative portfolio requires the use of the right management tools depending on where the new products are in their innovation journey. Wiki et al. [Wiki et al., 2021] formulate five principles of CIES that should go through a cycle: create - evaluate - learn. It seems that this approach should be used when Russian companies create their CIES - of course, taking into account cultural characteristics, traditions, macro- and microeconomic situation, and adaptation to the specific conditions in which they operate.

The short conclusion of this sub-clause is that the innovative development of Russian companies has not yet reached the required growth rates; the existing potential must be developed within the framework of CIES, which will allow the use of own resources, thereby improving the quality of corporate culture, not to mention increasing competitiveness.

3.2. Research on the cooperative activity of Russian companies and inter-company cooperation in the creation of the IC

The original plan for writing this article did not include addressing the issues of the degree of readiness of Russian companies to form inter-company IES and develop a corresponding model. However, the study of the innovative potential and practice of Russian IES has forced us to pay attention to the most important point (which can also be presented as a research hypothesis). Perhaps, the establishment of an IES is difficult for a single company, and this gives reason to assume that the initiation of the formation of ICIES is relevant for the Russian economy. Incidentally, the works [Xie, Wang, 2020; Akberdina, Vasilenko, 2021] emphasise that a company's membership in an innovation ecosystem expands its capabilities; the authors identify six types of configurations of open innovation ecosystems.

The above allows us to conclude that in the current situation there are two options. The first is to postpone the decision on creating conditions for intensifying cooperation between Russian companies through the creation of intercompany IES. The second is to develop a set of measures to create conditions for overcoming disunity and creating such IES in the country. Of course, the state should also be involved in the process of creating ICIES.

At the same time, it should be noted that Russian companies have been engaged in inter-firm cooperation in R&D for quite some time. For example, in [Ezangina, 2013] evidence of the prospects for institutionalising inter-company relations, their clustering and a number of examples are given, including the organisation of the Union of Pharmaceutical and Biomedical Clusters... the creation of the Russian Union of Innovative Territorial Clusters in the field of information technology and electronics.

Despite such positive experiences, a number of data show a decline in the activity of enterprises in the field of innovative cooperation (Fig. 5).

Figure 6 shows the distribution of organisations involved in joint R&D projects by type of partner and by type of economic activity in 2020, and Figure 7 shows R&D cooperation by type of collaboration in 2020.

The statistical data and their analysis indicate a decline in the cooperative activity of Russian companies across various sectors; however, this decline does not imply a complete absence of cooperation, as there is still collaboration among competing companies. In this regard, it is necessary to assume the high potential of inter-firm cooperation in the conduct of R&D and the formation of ICIES. There is already a request from practitioners to representatives of the scientific community to develop a methodology for creating a structure that ensures the implementation of effective inter-firm interaction in the creation of innovations. The approach to the formation of ICIES can be implemented, inter alia, with the help of the model proposed below and its conceptual description.

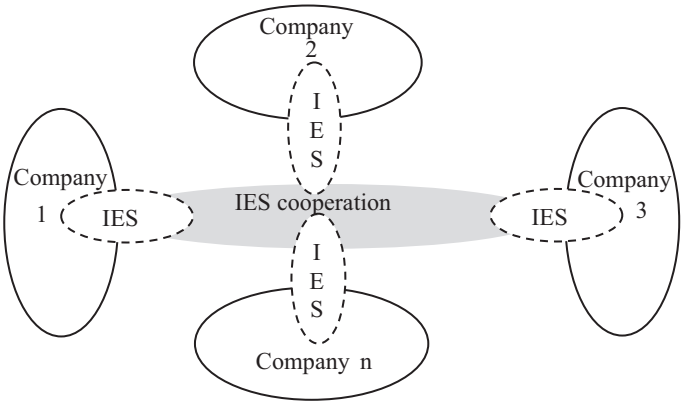
4. ICIES model

As for the presentation of the ICIES model, it must be emphasised that the author is only announcing her development of this concept and intends to continue this work in subsequent studies. Thus, this article presents only the beginnings of the formation of the ICIES concept.

At this stage of the research, the MCIES concept is based on the following postulates:

1. The feasibility of constructing the model is justified by the need to develop proposals for Russian enterprises (the real sector of the Russian economy) to develop their innovative potential and accelerate the pace of innovative and technological development of the Russian economy.
2. The feasibility of using the ICIES in practice is justified by the effectiveness of the ecosystem approach in implementing inter-company scientific and technical cooperation, carried out with the aim of creating economically significant joint ICs, the commercialisation of which is carried out independently by the ICIES participants (within the framework of their CIES).
3. The conceptual foundations of the ICES integrate the concepts, theories, and approaches of open innovation, the ecosystem approach (and the IES), inter-firm interaction (scientific and technological strategic alliances), neo-institutionalism, contract theory, multi-agent systems, network interactions, and cluster and project approaches.
4. The ICIES implies the interest of the parties that unite in accordance with the theory of ecosystem

Fig. 8. Intercorporate innovation ecosystem (IES) model



Source: compiled by the author.

contractual relations (disclosed in [Matkovskaya, 2023a]) and is based on the co-ompetition/com-operation of several independent participants who may be competitors in their product (and resource) markets.

5. The ICIES is called upon (functions): (1) to facilitate the effective unification of the efforts of the CIES of competing companies to solve problems and create joint ICs and can be implemented on a project basis; (2) to serve as the most effective way to consolidate the efforts of participants in creating joint ICs; (3) to optimise the costs of creating IICs. In addition, the ICIES envisages the possibility of creating a bank of technological solutions for the development of these companies.

6. Participants: (1) have their own IES that can be integrated into the common platform, or have the ability to be fully or partially integrated; (2) are independent organisations and are independent in their decision to join the ICIES; (3) are interested in creating innovation, are willing to make the necessary investments, recognise the presence of specific ecosystem risks, and are willing to hedge against them.

The ICIES model is shown in Figure 8.

The author does not imply that all companies in a sector of a given economy should be included in the ICIES or that their number should be limited to four companies, as shown in Figure 8. The number of companies included in the ICIES can vary from 2 to n (where n is all national companies or all companies operating in the national market), which also implies the likelihood of healthy competition between different ICIES within a country.

Thus, the ICIES is a special IES promoting the development of an ecosystem approach and possibly representing a new way of implementing the concept of open innovation created on the initiative of two or more participants by integrating their ICIES (partly under contractual agreements) into a common IES (ICIES) with the aim of carrying out joint R&D and subsequent independent commercialisation of the results of the innovative activities, implemented in accordance with the principles of the ecosystem approach and under the conditions of contractual relations [Matkovskaya, 2021], implying the development of a single platform or functioning on a multi-platform basis.

The development of ICIES can be facilitated by two key factors: first, the findings from authors who have studied inter-organisational relations (IOR) management issues related to innovative cooperation [Cropper et al., 2008; Mesquita et al., 2017; Lumineau, Oliveira, 2018; Aagaard, Rezac, 2022]; and second, the results from the study [Wei et al., 2020] that examined the IOR of Haier, Chery, and Siemens.

5. Discussion of findings, controversies, and directions for future research

The study of theoretical issues allowed us to establish their a posteriori nature, which makes the studies considered relevant from both a practical and theoretical point of view. The analysis of the literature has allowed us to note the growth in the number of studies on IES and their multi-aspect and multi-directional nature, which determines the potential for the development of the IES concept and allows us to believe that we are witnessing the formation of a new management theory.

The study of the theoretical foundations of IES presented in this article and the author's previous studies allowed to formulate her own vision of the concept of IES and CIES, to record their features and specific aspects, and to develop approaches to the typology of CIES. The analysis of the innovative activity of Russian enterprises revealed a still insufficient level, with a decline in the pace of innovation, a reduction in joint R&D projects, and a decrease in the number of participating organisations. Yet, the potential of

inter-firm innovation cooperation allows us to make assumptions about the feasibility of forming the ICIES. At the beginning of this work, the author formulated the postulates of the ICIES and proposed a conceptual model of its functioning. These postulates can be interpreted as 'the rules of the ICIES' and they can become the basis for forming the methodology for creating and ensuring the functioning of the ICIES. The latter generally determines the directions of further work.

At the same time, of course, the article is not without controversial points and limitations. Certainly, the issue that needs to be discussed in the scientific and practical environment is the need to develop not only the methodology for the formation of ICIES, but also the methodology for the formation and organisation of the effective functioning of CIES. At the same time, it is advisable to develop these concepts in parallel, coordinating and measuring the direction of conclusions, theoretical constructions, and practical solutions.

The limitation is the deliberate exclusion of organisations in the banking, scientific, and other sectors, as well as mechanisms for involving academic science and the higher education system in ICIES. This decision was made not only due to the article's limited scope but also because it focuses on studying the unification of competing participants within ICIES. Additionally, these structures and aspects have already been examined by the author in other works. Of course, insufficient attention has been paid to the study of the risks involved in creating and participating in ICIES, as well as to the problem of financing. The latter also determines the directions of the author's further research.

However, the aim of the article has been achieved. The author notes the advantage of the article in its broad formulation of the problem regarding the development of CIES and ICIES. In light of this, the author invites the scientific community and business leaders to engage in discussions and develop a methodology or concept for ICIES. This is significant given the urgent need to adapt or create an accelerating mechanism for the innovative development of the Russian economy.

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The role of functionality and quality of service of Internet services in improving the business efficiency of pharmaceutical companies

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Abstract

With the continued growth of business-to-busines (B2B) and business-to-consumer (B2C) Internet services, online providers offer an increasing range of services that support and improve their core products or services. In this article, we will explore Internet services in the pharmaceutical market in E-Pharma.

The results of the field study confirm that the functionality and quality of the services provided by Internet services are important predictors of customer beliefs and behaviour, and have a significant impact on indicators of pharmaceutical company development as sales and advertising revenue. The constructed econometric model confirms that the monthly traffic of the Internet service is primarily sensitiveto the speed of order processing, i.e. a change in the speed of order processing will be reflected in the growth of traffic after a shorter period of time compared to other factors. The functional value is also confirmed, reflecting the usefulness of the Internet service in a practical aspect due to the influence of selected factors in the multiple regression model studied.

The study allowed us to identify the most effective ways to develop Internet services in the E-Pharma market. These include: promotion of Internet services through social networks, which will ensure an increase in both the social and emotional value of the Internet values studied; implementation of other measures to increase public awareness of Internet services operating in the Russian pharmaceutical market; development of a loyalty programme for customers of a pharmacy organisation who purchase medicines through an Internet service, thereby contributing to an increase in their functional, social, and emotional value.

Keywords: e-commerce, customer satisfaction, functionality, quality of service, consumer behavior.

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功能性和服务质量在提升制药公司业务效率中的作用

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简介

随着互联网服务在商业和消费者领域不断增长，在线供应商提供越来越广泛的服务范围，以支持和改进其核心产品或服务。在本文中，我们将探讨电子制药领域中的互联网服务。

田野调查结果证实，互联网服务的功能性和服务质量是客户信念和行为的重要预测因素，并且在很大程度上影响着制药公司的营收和广告收入等发展指标。建立的计量模型证实，互联网服务的月度流量主要受订单处理速度的影响，即订单处理速度的变化将更快地反映在流量增长上，相对于其他因素。功能价值也得到了确认，反映了互联网服务在实践中的实用性，这是通过所选因素在研究的多元回归模型中的影响来确认的。

因此，对互联网服务的工作满意度对其工作效率产生重要影响，而这又直接影响到公司的发展。该研究还揭示了在电子制药市场发展互联网服务的最有效方法：推广互联网服务通过社交媒体，将提升所研究的互联网价值的社会和情感价值；采取其他措施扩大俄罗斯制药市场上的互联网服务的宣传信息；制定客户忠诚计划，针对通过互联网服务购买药品的药店客户，从而提升它们的功能性、社会性和情感价值。

关键词: 电子商务、消费者满意度、功能性、服务质量、消费者行为。

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Introduction

Currently, the issues of implementing Internet services and their impact on business activities are becoming increasingly relevant. Research shows that Internet services play an important role in business and can influence the results of a company's activities. Electronic business to customer (B2C) has shifted the focus of the use of Internet technologies (IT) from internal management tools to customer-oriented Internet services and has stimulated a sharp increase in the use of IT in the provision of all types of customer services [Straub, Watson, 2001].

Research on Internet services examines the characteristics that determine their value to consumers and businesses. These include various economic, social and psychological aspects. Thus, according to F. Kotler, value is the combination of three components: quality, service and price (QSP), and value itself is a key concept in marketing [Kotler, 2011]. The first works in the field of service value research were the works of V.A. Zeithaml, A. Parasuraman [Zeithaml, Parasuraman, 2004] and others. In particular, Zeithaml's theory of service value states that 'the value of services is determined by the relationship between the quality of customer service and the perceived quality of service and the associated payment' [Zeithaml, 2000]. This statement formed the foundation for the development of the Service Quality Gap Model, which posits that consumer dissatisfaction (low value) is attributable to two gaps: the first gap (Gap1) between the service provider's and consumer's understanding of quality, and the second gap (Gap2) between the design and actual implementation of service quality.

In the study conducted by Huth and Allee (2002), the following characteristics of the value of Internet services for customers were identified: economic value, knowledge value, and intangible value. In [Krizanova et al., 2019], the authors introduce the concept of 'relative value', which is understood as 'the value of acquiring a certain product (service) by using an Internet service, taking into account the cost of purchasing (acquiring) this product (service)'. [Spohrer et al., 2007] state that the Internet service is produced by the service provider and the customer at the same time (simultaneously) and that the value is determined in the process of interaction that meets the needs of both parties (supply and demand). Thus, the main goal of an Internet service as a 'co-production' is to create value for both parties - demand and supply.

In addition to value creation, many studies have examined the service quality of B2C Internet services

(e.g. [Devaraj et al., 2002; Gefen, 2002; Zeithaml et al., 2002; DeLone, McLean, 2003; Đurašković, 2017]). At the same time, the question remains unanswered: what services should Internet services provide, what functionality should Internet services have?

The purpose of this study is to determine how the functionality and quality of services provided by Internet services affect the performance indicators of the companies that develop them.

1. Literature review

1.1. Concept of functionality and quality of support services

Internet services/web applications are increasingly being used around the world to create customer-centric solutions and are having a significant impact on the overall efficiency of businesses. The study [Cenfetelli et al., 2008] identifies four categories that reflect the degree of influence of Internet services on a company's efficiency: quality of service, satisfaction, usefulness and users' ongoing intentions.

The satisfaction category allows us to evaluate the relationship between the results obtained and the customer's expectations, and to identify the result of positive and negative deviations that indicate customer satisfaction or dissatisfaction [Cenfetelli et al., 2008].

The service quality category assesses interaction with process participants and the degree to which customer needs are met [Parasuraman et al., 1985; 1988; Dabholkar et al., 2000]. The SERVQUAL concept is widely used to assess the quality of service, which reflects the customer's perception of the supplier's activities, reliability, trust, loyalty to the supplier, physical aspects of the infrastructure and the appearance of the Internet service [Parasuraman et al., 1985; 1988; Dabholkar et al., 2000; Cenfetelli et al., 2008].

The utility category determines the degree of user satisfaction with the product received. The evaluation of the utility level of different products determines consumer preferences.

The reasons why a user makes a search query are reflected in the persistent user intent category.

The study [Cenfetelli et al., 2008] introduces the concept of Supporting Services Functionality (SSF), which reflects the benefits of using IT to provide services that support a product. There are three models of such services: additional services [Lovelock, 1994; Lovelock, Yip, 1996], extended services [Levitt 1980; Kotler, 1997], and customer service life cycle (CSLC) models [Ives, Learmonth, 1984]. These models are based on the idea that sellers who offer additional services alongside their core product or service can differentiate that product or service, making it more attractive.

The use of support service functionality is our guarantee of high quality. This is firstly because related services are a source of customer support and service quality is the value created for customers [Lovelock, 1994; Lovelock, Yip, 1996; Parasuraman, Grewal, 2000; Piccoli et al., 2004]. Secondly, full customer satisfaction is one of the key factors of service quality and related services contribute to it [Zeithaml et al., 2002; Piccoli et al., 2004; Cenfetelli et al., 2008]. The functionality of supporting services provides the basis for interaction between suppliers and customers in B2C, which is the basis for assessing the quality of service of B2C websites [Parasuraman et al., 1985; Parasuraman, Grewal, 2000; Cenfetelli et al., 2008]. The use of support service functionality allows the creation of a wide range of related services, which ensures a higher level of customer satisfaction compared to traditional offline retailing [Cenfetelli et al., 2008]. At the same time, the use of related services creates value for consumers [Zeithaml, 1988; Bolton, James, 1991; Oliver, 1996; Cronin et al., 2000; Parasuraman, Grewal, 2000; Homburg et al., 2002]. The idea behind this assertion is that a core product or service offered with ancillary services is more valuable than offering the core product or service alone [Levitt, 1980; Lovelock, 1994; Kotler, 1997]. Using a website also helps to increase customer satisfaction. Customers who are more satisfied with a website are more likely to continue using the site because their satisfaction is higher [Bagozzi et al., 1999; Dabholkar et al., 2000; Devaraj et al., 2002; Cenfetelli et al., 2008].

1.2. The impact of Internet services on the efficiency of a company at the different stages of the value creation chain

In the work [Pham, Ahammad, 2017], the main aspects of the influence of Internet services on the overall performance of companies were identified (Table 1).

Thus, each stage of the value creation process of Internet services should be aimed at increasing customer satisfaction and creating a positive image not only of the product but also of the company as a whole, which will ensure high efficiency of the company.

In light of the above, we formulated a research question, 'How does the functionality and quality of services provided by Internet services affect the performance of companies that develop these services?'.

2. Research methodology

The research question posed suggests the use of an inductive approach, combining the description of reality and the interpretation of the results obtained. In this respect, the case study method was chosen, which allows a comparative analysis of cases to be used to obtain results.

The empirical analysis is based on three Russian pharmaceutical companies, each of which has been using

Table 1
The impact of Internet services on the company's performance at different stages of the Internet services value chain

Stages of value creation for Internet services	Characteristics of the impact of Internet services on efficiency
Pre-sale stage	At this stage, customers typically engage in a number of activities: searching for information about the product, comparing different alternatives, reading customer reviews. A high level of quality and functionality of online services has a positive impact on customer satisfaction with e-retailers and the company as a whole. [Srinivasan et al., 2002; Liu et al., 2008; Rose et al., 2012; Pham, Ahammad, 2017]
Search for product information	Information provided by online services helps shoppers make purchasing decisions [Wang, Strong, 1996; Wolfinbarger, Gilly, 2003; Pham, Ahammad, 2017]. E-retailers with detailed product information increase customer satisfaction compared to those without detailed product information [Jiang, Rosenbloom, 2005; Pham, Ahammad, 2017]
Ease of use	A user-friendly website makes it easier to find the information you need about the product and increases customer satisfaction. [Srinivasan et al., 2002; Rose et al., 2012; Pham, Ahammad, 2017]
Website look and feel	The appearance of the site (aesthetics) has an impact on the formation of positive impressions in the minds of consumers and an increase in their level of satisfaction. [Kotler, 1973; McKinney, 2004; Rose et al., 2012; Pham, Ahammad, 2017]
Product customisation	Customisation (the degree to which products are adapted to customer needs) increases customer satisfaction by improving product quality, providing services to help customers make quick decisions about purchasing a product, etc. [Shapiro, Varian, 1999; Haubl, Trifts, 2000; Srinivasan et al., 2002; Rose et al., 2012; Pham, Ahammad, 2017]
Purchase stage	This aspect includes the following activities for shoppers: choosing a payment and delivery method, filling in payment details, confirming the order at checkout. [Pham, Ahammad, 2017]
Easy to order	The faster and easier it is to place an order and complete a transaction, the higher the customer satisfaction. [Pham, Ahammad, 2017]
Ensuring safety	The higher the cybersecurity of ordering and transacting, the higher the customer satisfaction.
After sales service	Post-purchase product evaluation influences future customer behaviour [Kotler, 1997]
Fulfilling an order	The higher the quality of order fulfilment, the higher the level of customer satisfaction. [Coyle et al., 1992; Stank et al., 1999; Stock, Lambert, 2001; Stank et al., 2003; Davis-Sremeck et al., 2008; Rao et al., 2011; Pham, Ahammad, 2017]
Speed of customer service	Research shows that there is a strong link between customer satisfaction and service quality, an important aspect of which is efficiency. [Devaraj et al., 2002; Gounaris et al., 2010; Pham, Ahammad, 2017]
Ease of return	Research shows that more than 60% of shoppers read the return policy carefully before making a purchase[a]. Ease of return is therefore also an important component of customer satisfaction. [Pham, Ahammad, 2017]
Repurchase option	Customer satisfaction is expressed in the desire to make repeat purchases. [Srinivasan et al., 2002]

[a] Online shopping customer experience study commissioned by UPS (2012). https://thenewlogistics.ups.com/cdn/enus/whitepapers/Online_Shopping_Cust_Experience_Study.pdf.
Source: compiled by the authors.

Internet services for more than 5 years. The Internet services of these companies operate in the territory of the Russian Federation and allow the purchase of medicines. The cases were selected from a wider database of pharmaceutical companies, including eleven Russian pharmaceutical companies that participated in this study. The remaining eight were not selected because the online service did not allow online purchases (it only worked as a showcase) or had been in operation for less than 5 years.

Data collection. Data collection was carried out between March and May 2023 using semi-structured interviews with employees and management of companies during personal visits. The interview questions concerned the strategy for promoting Internet services, defining the functionality of support services, assessing the customer's perception and satisfaction with the Internet service, creating and assessing the quality of the service provided by the Internet service and its usefulness.

Data analysis: Four key questions were identified regarding the role of Internet services in the development of a pharmaceutical company:

1) why Internet services are important for the development of the pharmaceutical business;
2) how the quality and functionality of the Internet service as perceived by the customer influences the further development of the pharmaceutical company;
3) how the customer's satisfaction with the Internet service influences the development of the pharmaceutical company;
4) how the efficiency of the Internet service affects the overall performance of the pharmaceutical company.

The data analysis was carried out in four stages. The first stage collected key characteristics of the business model of Internet services. The second stage analysed the efficiency of the Internet services under study. The third stage conducted a consumer survey and identified assessments of the functionality and quality of service of Internet services. The fourth stage assessed the relationship between the level of perception of functionality, quality of service and satisfaction with the Internet service by the consumer and the efficiency of the pharmaceutical company.

Evaluating the effectiveness of Internet services. The effectiveness of the use of Internet services can be determined using various methods and tools [Mutigullin, Prasolova, 2018]:

- Return on investment (ROI) methodologies to determine the effectiveness of funds invested in the development and deployment of Internet services;
- Methods for assessing the impact of an Internet service on the achievement of business objectives (COBIT), which involves comparing the cost of developing and implementing Internet services with the performance indicators and development of the business as a whole;
- Methods for analysing the costs and risks associated with the use of Internet services, the benefit of which is the ability to fully quantify the costs of developing and deploying these services over their entire lifecycle;
- Expert methods using tabular data. The method of expert evaluation consists in obtaining the opinions of experts and, based on them, forming the necessary information, the analysis of which is carried out using logical and mathematical-statistical methods. Currently, there are different classifications of expert judgement methods (e.g. weighting coefficient methods, sequential comparisons, paired comparisons, etc.);
- ALE methodology, which involves the assessment of potential financial losses (damages) that make up the total amount resulting from the implementation of information security threats;
- Methods of usability evaluation based on users - these are subjective methods of evaluation of Internet services, the results of which cannot be interpreted by means of monetary instruments, but their use is advisable for the purpose of determining, for example, a company's image and the influence of Internet services on it, etc;
- Usability evaluation methods based on evaluators. These methods belong to the group of expert evaluation methods. Their essence is to determine the usability and efficiency of Internet services by such subjects as experts in the field of functioning of the services under study. The most common method in this category is heuristic evaluation, where, for example, each evaluator individually walks through the system interface at least twice. The result of such an assessment is a list of problems with the Internet service, with reference to the broken heuristics, etc. In fact, the participants in the evaluation methods are people who are specialists in the field of creating Internet services, so they can not only present a report with problems, but also name the cost of the Internet service being evaluated;
- Web evaluation methods - involve studying the Internet as a holistic phenomenon and the place of Internet services within it, calculating statistics on the detailed use of an Internet service and providing data on web traffic, visibility, connectivity, ranking and the overall impact of an Internet service on business performance.
- Web rating methods work by comparing a particular Internet service with other similar services and with the Internet as a whole;
- Link analysis methods. Link analysis studies the topology of Internet services, assuming that the

quality of a Web page depends on its links. There are two main methods that use link analysis: PageRank and Webometrics. The PageRank tool was invented together with the Google search engine by its creators L. Page and S. Brin. Google PageRank is a link analysis algorithm, named after Page, that assigns a numerical weight to each hyperlink, and each page has a calculated PageRank based on the number and quality of links pointing to it. [Мутигуллин, Прасолова, 2018, с. 43]. It is worth noting that Google takes more than 100 factors into account when analysing links, but PageRank is the most important one when ranking search results. This tool is a reliable source of information about popular and long-established Internet services.

Speaking about the methods of determining the efficiency of the use of Internet services, which include identifying the place of these services in the web space, which implies, for example, an assessment of the degree of their coverage of the audience, consumers, etc., it should be noted that such tools for determining the efficiency of use of Internet services as automatic evaluation of Internet services and web analytics play an important role in the implementation of these methods.

Tools for automatically evaluating web services include W3C validators and link popularity checkers, software that automates the collection of interface usage data and identifies potential web problems. Their data can be used indirectly as some basis for monetary valuation. However, for evaluation purposes, only automated tools for evaluating internet services cannot be used, as they cannot be considered effective [Perell, 2018].

The most popular web analytics tools are Google Analytics and Alexa. Alexa is a metric system for internet services and websites that calculates traffic rank by analysing web page usage by Alexa toolbar users over three or more months as a combined measure of page views and number of visitors to the internet service.

O.V. Lebedev and L.Kh. Gabidullina identify the following web analytics tools that can be used to collect data to determine the effectiveness of using internet services, which are presented in Table 2 [Lebedev, Gabidullina, 2017].

In this case, the efficiency of the use of Internet services should be considered from two points of view:

– in terms of the financial benefit, in monetary terms, of using the services in question;
– from the point of view of creating a positive image of the organisation, which in turn will contribute to increasing its efficiency in the Russian market.

The efficiency of the use of Internet services can therefore be measured using different methods and tools. The research carried out enables us to distinguish among these methods, such as methods of cash flow assessment (ROI), which allow us to determine the efficiency of

Table 2
A number of web analytics tools that can be used to collect data in order to determine the effectiveness of the use of Internet services

Group of tools	Tools
Counters	LiveInternet, «Рейтинг@Mail.ru», OpenStat, HotLog и др.
Log analysers	Webalizer, AWStats и др.
Internet statistics systems (counter trackers)	GoogleAnalytics, «Яндекс.Метрика» и др.
Marketing tools	Cy-pr, Linkpad, Pr-cy и др.

Source: compiled by the authors based on: [Lebedev, Gabidullina, 2017, p. 100].

investing funds in the development and implementation of Internet services; a method of analysing the costs and risks associated with the use of Internet services; expert methods using tabular data; web assessment methods, which involve identifying the place of internet services in the web space, etc.

In order to assess the value of Internet services for pharmaceutical market participants in e-Pharma, this study uses methods for assessing cash flow (ROI), assessing the impact of Internet services on the achievability of business goals (COBIT) and expert methods.

Such tools for determining the efficiency of the use of Internet services, such as Google Analytics, Alexa, etc., play an important role in the implementation of methods that involve identifying the place of Internet services in the web space.

When determining the efficiency of using Internet services, it is advisable to evaluate the cost of their development, creation and implementation into operation, as well as subsequent maintenance, taking into account the human and software resources involved, covering the databases, network equipment, etc. It is also necessary to identify potential information security risks, the likelihood of which is significantly increased by the use of the Internet (e.g. using the ALE method of expected losses).

3. Case analysis

3.1. Brief description of pharmaceutical companies and their internet services

All three selected pharmaceutical companies and their Internet services Apteka.ru, Zdravcity.ru, Evalar have been operating in the e-Pharma market for more than 5 years and are in demand by consumers.

Apteka.ru - a domestic internet service that allows customers to order the medicines and cosmetics they need

Table 3
Indicators of web-based evaluation of the effectiveness Internet services under study in the Russian pharmaceutical market

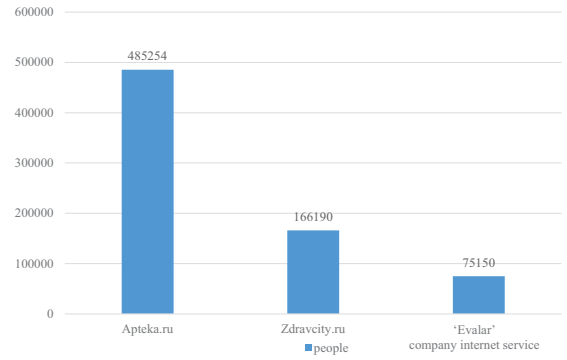
Web evaluation metrics	Apteka.ru	Zdravcity.ru	'Evalar' company internet service
Monthly visits (people)	485254	166190	75150
Annual visits (people)	6001880	2055525	929500
Monthly views (number)	1941007	664750	300615
Annual views (number)	24007390	8221974	3718169
Estimated value (USD)	3262606	189352	22975
Quality score (out of 100)	51	37	44
Monthly ad revenue (USD)	5823	1994	901
Annual advertising revenue (USD)	72022	24665	11154

Source: compiled by the authors based on https://parsesite.ru/.

without leaving home, with the customer choosing the point of sale where they want to collect their order.

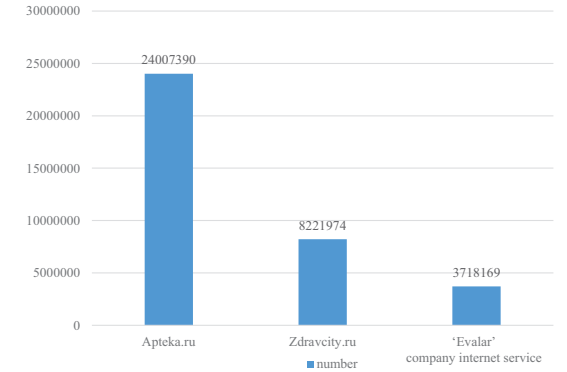
Apteka.ru offers a wide range of pharmaceutical products at the best price. The service also offers a policy of discounts on certain goods and for regular customers. For example, a customer receives a 10% discount on their first order and can use the loyalty programme for subsequent purchases.

Fig. 1. Monthly visits to the Internet services studied (people)



Source: compiled by the authors based on https://parsesite.ru/.

Fig. 2. Yearly views of the Internet services studied (number)



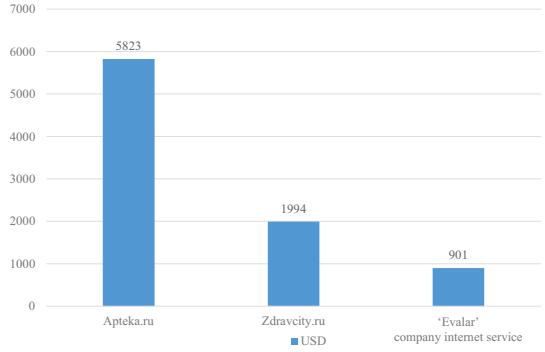
Source: compiled by the authors based on https://parsesite.ru/.

At the same time, the service allows you to search the database for the medicines you need by name or by category, including: cosmetics, basic care, vitamins and supplements, joint disorders, vision, etc. To familiarise themselves with the product, consumers can go to the relevant page on the site. Here they can select the quantity of the product to be ordered, its form factor and specify the price. The site also provides detailed information about the product: composition, indications and contra-indications, method of use, storage conditions, etc. The consumer can also compare the drug with its analogues and leave a review about the product. The consumer can also compare the drug with its analogues and leave a review about the product.

Zdravcity.ru. Just like Apteka.ru, Zdravcity.ru is an online service that allows the client to order delivery of medicines, medical products, hygiene products, dietary supplements, cosmetics and other health and beauty products. The service offers more than 46.000 certified products.

The difference with this Internet service is that you can place an order for delivery by courier. At the same time, it allows you to search for the products you need and classifies them into categories: medicines, dietary supplements, medical devices, medical equipment,

Fig. 3. Monthly income from advertising of the Internet services studied (USD)



Source: compiled by the authors based on https://parsesite.ru/.

Table 4
Findings from an expert evaluation of the effectiveness of Internet services for pharmaceutical market participants

Evaluation criteria	Apteka.ru	Zdravcity.ru	'Evalar' company internet service
Lowest costs	–	–	–
Highly qualified staff	+	–	+
Order execution control	+	–	–
Timely execution	+	–	+
Assessment of the problem	+	–	–

Source: compiled by the authors.

hygiene, mother and baby, cosmetics and healthy food. Like Apteka.ru, Zdravcity.ru allows you to view detailed information about a product, place an order in the 'shopping cart', and also participate in the loyalty programme. The 'ZdravsitiPlus' loyalty programme allows customers to accumulate bonuses for purchases of 100 roubles or more and spend them on up to 70% of their next purchase. Thus, Zdravcity.ru is an Internet service similar to Apteka.ru, the difference being the possibility of courier delivery of the order to the customer's address, which makes the purchase of pharmaceutical products even easier.

'Evalar' - this Internet service offers the same possibilities as those mentioned above, including the possibility of familiarising oneself with the characteristics of the product, placing an order with delivery to the customer and a discount policy. In addition, the site hosts and regularly updates the 'Fitodoctor' blog of the 'Evalar' company, which publishes articles on health and beauty, further attracting consumers.

In order to assess the demand and efficiency of the specified Internet services for pharmaceutical market participants, E-Pharma used web evaluation methods that allowed the determination of service traffic, number of hits, estimated costs, advertising revenue, etc. (Table 3).

The analysis of web evaluation indicators of the studied internet services on the Russian pharmaceutical market shows that the Internet service Apteka.ru has the

Table 5
Findings from an expert evaluation of the effectiveness of Internet services for pharmaceutical market participants

Answers	Number of respondents (people)	Percentage of responses as a proportion of the total number of respondents (%)
Which online pharmaceutical service do you use?		
Apteka.ru	1768	33.4
Zdravcity.ru	1527	22.9
'Evalar' company internet service	598	17.3
Other internet service	1009	17.8
I don't use internet services	192	8.4
What features of online pharmaceutical services attract you?		
Ease of search	1614	70.4
Speed of service	1480	67.8
Ability to receive products without leaving home	1727	75.3
Availability of product information	1368	59.6
I find it difficult to answer	49	2.1
Other	13	0.6
What do you think about the quality of service provided by online services that offer pharmaceutical products?		
Products and services meet my expectations	1324	57.7
Products and services partly meet my expectations	728	31.7
Products and services do not meet my expectations at all	242	10.5
Are you satisfied with the work of online services offering pharmaceutical products?		
Yes, in full	1991	86.8
Not at all	206	8.9
I find it difficult to answer	97	4.3

Source: compiled by the authors on the basis of the survey results.

Table 6
Statistical sample from June 2021 to May 2023

Period (t)	Traffic (y) (million users)	Order processing speed (x_1)	User friendly interface (x_2)
June 2021	9.3	3.2	2.5
July 2021	9.4	3.5	2.6
August 2021	9.3	3.6	2.6
September 2021	11.5	3.4	2.8
October 2021	11.4	3.8	2.3
November 2021	11.1	3.5	2.5
December 2021	11	3.4	3.1
January 2022	9	3.3	3.5
February 2022	10.8	3.7	3.4
March 2022	9.3	3.7	3.5
April 2022	9.2	3.7	3.7
May 2022	9.5	3.5	3.4
June 2022	5.2	3.8	3.8
July 2022	9.7	3.8	3.4
August 2022	9.7	3.8	3.6
September 2022	9.9	4	3.3
October 2022	10.7	4	3.2
November 2022	10.9	4.2	3.7
December 2022	11.7	4.5	4.4
January 2023	8.2	4.6	4.2
February 2023	11.2	4.5	3.3
March 2023	12.4	4.7	3.8
April 2023	12.6	4.8	4.2
01.05.2023 - control sample	12.6	4.9	4

Source: compiled by the authors on the basis of the survey results.

highest value among them, which is demonstrated by monthly and annual traffic, number of views, estimated costs, advertising revenues, etc.

For example, monthly visits and annual views of the Apteka.ru internet service exceed similar indicators of the Zdravcity.ru Internet service by 34.2%, and the Internet service of the 'Evalar' company by 15.5% (Figs. 1, 2). The monthly advertising revenue of Apteka.ru also exceeds the similar indicator of Zdravcity.ru and 'Evalar' (Fig. 3.).

In order to assess the effectiveness of the specified Internet services for pharmaceutical market participants, E-Pharma also used the expert assessment method. For this purpose, a survey was conducted among experts (professional participants in the pharmaceutical market, including pharmacy managers - 10 people) on such evaluation criteria as the cost of maintaining the Internet resource, the availability of qualified staff, etc. These criteria allow us to determine the value of internet services from the point of view of companies offering

Table 7
Estimated least squares model using the LINEST function

R26C2 =ЛИНЕЙН(R[-24]C:R[-2]C;R[-24]C[1]:R[-2]C[2];ИСТИНА;ИСТИНА)

	1	2	3	4
1	Period (t)	Traffic (y) (million users)	Order processing speed (x_1)	User friendly interface (x_2)
2	June 2021	9.3	3.2	2.5
3	July 2021	9.4	3.5	2.6
4	August 2021	9.3	3.6	2.6
5	September 2021	11.5	3.4	2.8
6	October 2021	11.4	3.8	2.3
7	November 2021	11.1	3.5	2.5
8	December 2021	11	3.4	3.1
9	January 2022	9	3.3	3.5
10	February 2022	10.8	3.7	3.4
11	March 2022	9.3	3.7	3.5
12	April 2022	9.2	3.7	3.7
13	May 2022	9.5	3.5	3.4
14	June 2022	5.2	3.8	3.8
15	July 2022	9.7	3.8	3.4
16	August 2022	9.7	3.8	3.6
17	September 2022	9.9	4	3.3
18	October 2022	10.7	4	3.2
19	November 2022	10.9	4.2	3.7
20	December 2022	11.7	4.5	4.4
21	January 2023	8.2	4.6	4.2
22	February 2023	11.2	4.5	3.3
23	March 2023	12.4	4.7	3.8
24	April 2023	12.6	4.8	4.2
25	01.05.2023 - control sample	12.6	4.9	4
26		-1.466806707	2.42661415	5.638351991
27		0.708682624	0.875813186	2.497805721

Source: compiled by the authors.

pharmaceutical products through them. The results of the expert evaluation are shown in Table 4.

The survey of experts also showed that the Apteka.ru service is the most valuable of the Internet services mentioned for pharmaceutical market participants in the e-Pharma sector.

In order to assess the quality of service, usefulness and satisfaction of consumers with Internet services offering pharmaceutical products, a sociological survey was carried out through social networks, where respondents were asked to answer a series of questions. 2294 people participated in the survey, the results of which are presented in Table 5.

The sociological survey showed that the majority of respondents (75.6%) use the internet service Apteka.ru to purchase pharmaceutical products. 55.8% of consumers who took part in the survey use Zdravcity.ru, and only 17.3% use 'Evalar'. At the same time, 8.4% of respondents do not use online services to purchase pharmaceutical products.

The most important functionality that determines the attractiveness of the internet services studied for consumers is the possibility of obtaining medicines without leaving home (75.3%). At the same time, consumers are also attracted by the ease of finding a product (70.4%) and the speed of service (67.8%).

The vast majority of respondents (86.8%) are satisfied with the work of internet services offering pharmaceutical products, while 4.3% found it difficult to answer this question as they do not use Internet services to purchase pharmaceutical products.

Table 8
The 2nd Gauss - Markov assumption. The Goldfeld - Quandt test

				The Goldfeld - Quandt test		
June 2021	9.3	3.2	2.5	–2.358901	4.9479107	–0.364968517
July 2021	9.4	3.3	2.6	1.07042109	2.80653955	7.418202454
August 2021	9.3	3.4	2.6	0.37958265	0.89705602	#Н/Д
September 2021	11.5	3.4	2.8	2.44727297	8	#Н/Д
October 2021	11.4	3.5	2.3	3.93868762	6.43767602	#Н/Д
November 2021	11.1	3.5	2.5			
December 2021	11	3.6	3.1			
January 2022	9	3.7	3.5	GQ	0.29196757	Random residuals are homoscedastic
February 2022	10.8	3.7	3.4	GQ^{-1}	3.42503791	
March 2022	9.3	3.7	3.5	Fkr	3.43810123	
April 2022	9.2	3.8	3.7			
May 2022	9.5	3.8	3.4			
June 2022	5.2	3.8	3.8	–1.8917539	4.53231808	–2.007865363
July 2022	9.7	3.8	3.4	1.51494508	1.60836901	6.13492392
August 2022	9.7	3.8	3.6	0.50092158	1.66016883	#Н/Д
September 2022	9.9	4	3.3	4.01477257	8	#Н/Д
October 2022	10.7	4	3.2	22.1307156	22.0492844	#Н/Д
November 2022	10.9	4.2	3.7			
December 2022	11.7	4.5	4.4			
January 2023	8.2	4.5	4.2			
February 2023	11.2	4.6	3.3			
March 2023	12.4	4.7	3.8			
April 2023	12.6	4.8	4.2			

The analysis of the web evaluation indicators of the studied Internet services on the Russian pharmaceutical market shows that the internet service Apteka.ru has the highest value among them, which is demonstrated by the monthly and annual traffic, number of hits, estimated costs, advertising revenues, etc. These results were confirmed by a survey of experts and a sociological survey of consumers.

3.2. Assessment of the relationship between satisfaction level, service quality and functionality of an internet service and its performance

In order to analyse the impact of service quality, functionality and consumer satisfaction with internet services on the efficiency of their work, correlation and regression analysis was used, which allowed us to construct an econometric model.

It is necessary to build a specification of the model of dependence of monthly traffic on order processing speed and user-friendly interface and to test the econometric model for adequacy. As an endogenous variable in the model, we use the monthly traffic of the internet service, and the remaining variables are explanatory or exogenous: x_1 is the order processing speed and x_2 is the convenience of the interface.

Let us present the statistical information required for the next stage[1]. We will take a monthly statistical sample from June 2021 to May 2023, with a volume of 24 units. May 2023 has been chosen as the control sample (y) (Table 6).

For the analysis we use a linear econometric model with multiple regression (with several regressors - exogenous variables).

Let us denote y_t as the monthly traffic of the internet service, x_{1t} as the order processing speed, x_{2t} as the convenience of the interface, and create a linear dependency :

$$\begin{cases} y_t = a_0 + a_1 x_{1t} + a_2 x_{2t} + u_t \\ a_0 > 0 \\ E\left(\frac{t}{u^{X1t,X2t,X3t}}\right) = 0 \\ E\left(\frac{2t}{u^{X1t,X2t,X3t}}\right) = \sigma^{2u} \end{cases} \quad (1)$$

The model estimated by the least squares method using the linear function in Excel is as follows (Table 7):

$$\begin{cases} y_t = 5{,}638 + 2{,}427 x_{1t} - 1{,}467 x_{2t} + u_t \\ (S_{\tilde{a}0} = 2{,}498), \\ (S_{\tilde{a}1} = 0{,}876), (S_{\tilde{a}2} = 0{,}709) \\ (\sigma_{\tilde{u}t} = 1{,}408) \end{cases} \quad (2)$$

The free regression term $a_0 = 5.638$ reflects the value of the dependent variable when the independent variable is zero. The sign of the coefficient a_1 indicates the direction of the relationship between the variables x_t and y_t. In our case a_1 is approximately equal to $2.427 > 0$, which means that a 1% increase in the speed of order processing for the

[1] Megaindex. Premium Analytics. Competitor visibility history. https://ru.megaindex.com/visibility/apteka.ru?ser_id=1,5693,2846&group=url&url=apteka.ru.

period t leads to a 2.427% increase in the monthly traffic of the Internet service.

There are several indicators that characterise the quality of the regression model, i.e. the degree of agreement between the constructed model and the original data. In this paper, the F-test is used to assess the quality of the model[2].

For the model studied in the work F_{fact}=3.869, F_{crit}=3.493 (calculated using the function $F_{INV.RT}$ (with probability 0.95 and degrees of freedom 2 and 20), $F_{crit} < F_{fact}$, therefore the hypothesis of insignificance of the regression equation is rejected and the quality of the compiled model is confirmed.

For an ordinary least squares regression analysis to produce the best possible results, the random term must satisfy the three Gauss-Markov conditions. If these conditions are not met, it is worth returning to the model specification from the beginning.

The first Gauss-Markov condition: $E_{(\varepsilon i)} = 0$ for all observations. To check this assumption, it is sufficient to find the mathematical expectation of the residuals and make sure that it is close to 0. Using Excel, the mathematical expectation of the random residuals calculated earlier is found as their mean value. The mean value u_t is 0.000000000000001429, i.e. it tends to zero. The first condition is fulfilled.

The second Gauss-Markov condition: the random term variance must be constant for all observations.. Sometimes the random term will be larger, sometimes smaller, but there should be no reason why it should cause a larger error in some observations than in others. When we write the model $y_t = a_0 + a_1x_{1t} + a_2x_{2t} + u_t$, the first two Gauss-Markov conditions indicate that the random terms in n observations come from probability distributions with zero mean and equal variance. The probability of ε taking any positive (or negative) value is the same for all observations. This condition is called homoscedasticity.

To check the second condition, the Golfeld-Quandt test is used: it is necessary to rank the observation equations in ascending order of the sum of the absolute values of the model regressors (in our case, we select the regressor x_1 in ascending order), then to evaluate two samples (in our case, the first 11 and the last 11 values: n' = 1/2; n = 23/2 = 11.5) and finally to use the linear function to calculate ESS_1 and ESS_2.

The next step is to determine the statistics GQ = ESS_1/ESS_2 and GQ^{-1} = ESS_2/ESS_1 = 1/GQ. According to our model GQ = 0.292; GQ^{-1} = 3.425

To conclude that the second condition of the Gauss-Markov theorem is fulfilled, it is necessary to check the fulfilment of the system of inequalities: GQ < F_{crit}, GQ^{-1} < F_{crit}.

F_{crit} is calculated in Excel using the formula: $F_{обр.пх}$ (0.05; 11; 11).

F_{crit} = 3.438, so both inequalities are true and the second condition of the Gauss-Markov theorem is satisfied. Thus, the random residuals are homoscedastic (Table 8).

The third condition of the Gauss-Markov theorem: the random deviations u_i and u_j are independent of each other for $i \neq j$. Fulfilment of this assumption requires that there is no systematic relationship between any random deviations. The magnitude and specific sign of one random deviation should not be the cause of the magnitude and sign of any other deviation. The test is performed using the Durbin-Watson test.

Criterion algorithm: (1) find the estimated u_t according to our model, then find u_t^2 and compute $(u_t - u_{(t-1)})^2$; (2) compute DW = $(\sum(u_t - u_{(t-1)})^2) / (\sum u_t^2)$; DW = 1.9598; (3) for k = 2, n = 23 (find the intersection in the Durbin-Watson table) intervals for d_l° and d_u: d_l° = 1.17; d_u° = 1.54; (4) construct intervals M1 - M5 (Table 9) and see which one contains the DW value.

Table 9
The Darbin - Watson criterion

M1	M2	M3	M4	M5
0-1.17	1.17-1.54	1.54-2.46	2.46-2.83	2.83-4

Source: compiled by the authors based on the results of calculations.

DW ϵ M3, i.e. Cov $(u_t; u_{(t-1)}) = 0$ - there is no autocorrelation of the random residuals. Therefore, the third condition of the theorem is also satisfied.

Thus, all the conditions of the Gauss-Markov theorem are fulfilled with respect to random remainders. In the econometric dependency model, the monthly traffic of the Internet service depends on the speed of order processing and the convenience of the interface.

In order for the forecast for which the econometric model is created to be the most accurate, it is necessary for the model to be recognised as adequate. We have divided the statistics into training and control samples. (See Table 10). The second sample included the May 2023 values according to the statistics presented in Table 6.

Using the least squares method through the linear function, we estimate the training sample and use the resulting coefficients (formulae (1-2)) to find confidence intervals for the control period (May 2023).

The confidence interval for the control sample is calculated using the following formula:

$$y_i(-) = y_i' - t_{crit.} \times S(y_i'), \quad (3)$$
$$y_i(+) = y_i' + t_{crit.} \times S(y_i'),$$

where y_i'–y_i rated, $S(y_i') = \partial_u' \times (q_i + 1)0.5$, $q_i = 1/n + (x_i - x_{mean.})^2 / \sum(x_n - x_{mean.})^2$, n = 1, …, 23; $t_{crit.}$ = 2.086 - is the same for all intervals and is calculated in Excel using the STUDENT.INV2X function (0.05; 20); q_{24} = 0.103; $S(y_{24}$ rated) = 1.479; $y_{24}(-)$ = 12.26; $y_{24}(+)$ = 18.43.

The actual value y_{24} = 12.6 belongs to the confidence interval (Table 10).

[2] Byvshev V.A. (2008). Econometrics: a tutorial. M., Finance and Statistics.

Table 10
Econometric model adequacy assessment

x_{mean}	$(x - x_{mean})^2$	q_0	u_t	$(u_t - u_{(t-1)})^2$	u^2
3.33913043	0.70413989	0.10270015	–0.436500502		0.19053269
	0.5463138		–0.917804076	0.23165313	0.84236432
	0.5463138		–1.260465491	0.11741685	1.58877325
	0.29066163		1.71821868	8.87255939	2.95227543
	1.07979206		–0.085830333	3.25459284	0.00736685
	0.70413989		0.635515253	0.52033946	0.40387964
	0.05718336		1.658260692	1.04600823	2.74982852
	0.02587902		0.48764479	1.37034159	0.23779744
	0.0037051		1.17031846	0.46604334	1.3696453
	0.02587902		–0.183000869	1.83147321	0.03348932
	0.13022684		0.010360472	0.03738861	0.00010734
	0.0037051		0.35564129	0.11921884	0.12648073
	0.21240076		–4.085620272	19.7248043	16.692293
	0.0037051		–0.172342955	15.3137394	0.02970209
	0.06805293		0.121018386	0.08606088	0.01464545
	0.00153119		–0.604346456	0.52615415	0.36523464
	0.01935728		0.048972873	0.42682615	0.00239834
	0.13022684		0.497053397	0.20077616	0.24706208
	1.12544423		1.595833847	1.20731848	2.54668567
	0.74109641		–2.440188909	16.2894797	5.95452191
	0.00153119		–0.517653531	3.69614228	0.26796518
	0.21240076		0.930426993	2.0969372	0.86569439
	0.74109641		1.474488261	0.29600266	2.17411563
	7.37478261		0.000000000000001429	77.7312768	39.6628592

Point forecast	
s_0	15.3448086
q_0	0.10270015
sy_{24}	1.47878736
t_{kr}	2.08596345
$y–$	12.2601122
$y+$	18.429505

Source: calculated by the authors.

Thus, the multiple regression model under study is considered adequate, since the y_t control sample fell within the confidence interval.

When analysing the impact of order processing speed and interface convenience on the monthly traffic of an Internet service, the following conclusions can be drawn:

1. The constructed econometric model confirms that the monthly traffic of the Internet service is primarily sensitive to the order processing speed, i.e. a change in the order processing speed will be reflected in the traffic growth after a shorter period of time compared to other factors.
2. The functional value is confirmed, reflecting the usefulness of the Internet service in a practical aspect, due to the influence of the selected factors in the multiple regression model studied.

4. Discussion of the results of the case analysis

4.1. The impact of functionality on business efficiency

In the e-Pharma market we are considering, Russian legislation does not provide for a separate licence to secure the right to sell medicines via the Internet, so despite the online format of such interaction with the customer, this process is recognised as a pharmaceutical service. This means that in order to sell pharmaceutical products via Internet services, an entrepreneur must have a licence to sell goods through retail trade, which in turn

requires the presence of premises and equipment, in effect a bricks-and-mortar pharmacy. Thus, the operation of an Internet service related to the sale of pharmaceutical products without the need for material support of an offline pharmacy seems impossible, and the delivery of medicines itself is illegal, with some exceptions provided by the legislation of the Russian Federation, if the client is a representative of a privileged category of citizens.

Under these conditions, the functional value of Internet services offering products on the pharmaceutical market is reduced, since this problem creates difficulties in their use. The problem here is specifically related to the delivery of medicines to the customer, since throughout the world only pharmacists are allowed to dispense them, while the courier is not in a position to ensure the proper provision of pharmaceutical services. For example, the delivery of medicines would have to be carried out by specialists, which seems impossible due to the high costs and the human and administrative difficulties of providing pharmacies with this process.

At the same time, pharmaceutical companies are trying to solve this problem. As the manager of JSC RPC 'Katren', which owns the Apteka.ru service, notes, they process customer orders via an online service and deliver to a pharmacy convenient for the customer under a standard supply agreement. An important role is played by partnership relations between JSC RPC 'Katren' and pharmacy organisations, on the basis of which the latter undertake to fulfil orders via the Apteka.ru website at special prices indicated on the website. In this case, Apteka.ru only collects information about the customer's intention to buy a certain product, while the sale itself takes place directly at the point of sale of the medicines.

Thus, RPC 'Katren' managed to maintain the functionality of its Internet service, which probably influenced the indicators of its successful development: maximum user traffic, highest advertising revenues, etc.

4.2. The impact of Internet service quality

The quality of service affects customer loyalty and is a function of their emotional attachment to the organisation, regardless of the conditions under which the purchase is made and the efforts competitors make to attract customers to their service. In the cases we studied, managers noted that emotional attachment was strongly influenced by the promotion of internet services through social networks, which created the conditions for informing a large number of consumers about the services themselves, the medicines presented on them, etc. A representative of the company 'Evalar' notes the need to carry out various campaigns to provide information on which social networks, etc. can be used.

The representative of the company 'Protek' (Internet service Zdravcity.ru) notes that the possibility for consumers to leave feedback on the most interesting Internet services influences the improvement of the quality of Internet services for participants of the pharmaceutical market, which in turn creates conditions for conducting market research and determining the directions of further development of pharmacy organisations. It is also necessary to distribute information materials (including thematic booklets and brochures) in printed form through banking institutions, agency groups, consumer advice centres, and to develop a customer loyalty programme for the pharmacy organisation for certain categories of citizens who purchase medicines through an online service.

It is therefore safe to say that the functionality and quality of the services provided by Internet services influence consumer satisfaction and, consequently, the development indicators of a pharmaceutical company.

Заключение

The purpose of this study is to determine how the functionality and quality of services provided by Internet services affect the performance indicators of the companies that develop them.

Our research confirms that the functionality and quality of service provided by internet services has a significant impact on the perception of customer satisfaction and, consequently, on the company's performance indicators.

The value of Internet services to consumers is determined by their functionality, which allows them to better meet the needs of buyers and also encourages them to choose these services. The value structure of Internet services can include components such as traffic and number of views, which in turn affect revenue indicators, advertising revenues and allow companies to expand their activities.

The analysis of web evaluation indicators of the studied Internet services shows that the Internet service Apteka.ru has the highest value among them, which is confirmed by monthly and annual traffic, number of views, estimated costs, advertising revenues, etc. Thus, monthly and annual traffic of Apteka.ru exceeds similar indicators of Zdravcity.ru by 34.2%, Internet service of 'Evalar' - by 15.5%; monthly advertising revenue of Apteka.ru is also higher. The higher value of the Apteka.ru Internet service was confirmed by an expert survey and a sociological survey of consumers. This is explained by the highest functionality of this service and the perceived quality of customer service - ease of finding a product, speed of service.

The most important events for the development of Internet services in e-Pharma are:

- promoting them through social networks, which will increase their social and emotional value;
- increasing public awareness of them;
- developing a loyalty programme that will help increase their functional, social and emotional value.

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The impact of innovation on the performance of small and medium-sized enterprises in Russia: Empirical analysis

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Abstract

The article is devoted to the study of the impact of different types of innovation on the efficiency of Russian SMEs. The purpose of the study is to assess the importance of different types of innovation for Russian SMEs and to determine the impact of types of innovation on the efficiency and competitiveness of SMEs. The research methodology involves a consistent approach combining qualitative and quantitative analysis. As a collection of information, a survey was conducted among owners of small and medium-sized enterprises in Russia on the use of innovations in the course of business activities in the last three years (2020-2023) and their impact on the company's performance. In addition, the experiences of some participants were explored through in-depth interviews. In total, 112 entrepreneurs took part in the survey. The results of the study showed that innovations are used by the vast majority of small and medium-sized enterprises in Russia. There is no stable relationship between the size of enterprises and the innovations they choose, although in some cases we can say that certain companies tend to a certain type of innovation depending on the number of employees. Organisational innovations are the least popular in enterprises innovation, and the greatest marketing; marketing innovations showed the highest percentage of negative experiences during implementation, despite the fact that they are the most popular category of innovations.

The majority of respondents see an improvement in the financial situation of the company according to various criteria and are satisfied with the results of innovation; at the same time, the larger the company, the more goals it pursues trough innovations. The smaller the business, the more interested it is in solving specific problems to increase sales, profits and customer loyalty. The larger the company, the more it follows the 360 strategy: that is, it pays attention to the creation of new goods and services, as well as to the introduction of innovations in production processes.

Keywords: small and medium-sized businesses, innovations, financial results, product innovations, process innovations, efficiency of SMEs, competitiveness of SMEs.

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创新对俄罗斯中小企业绩效的影响：实证分析

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简介
文章研究了各种类型的创新对俄罗斯中小企业（以下简称为中小企业）绩效的影响。研究的目的是评估不同类型的创新对俄罗斯中小企业的重要性，并确定这些创新类型对中小企业绩效和竞争力的影响。研究方法采用了定性和定量分析相结合的连续方法。信息收集通过对俄罗斯中小企业主进行调查，了解他们在过去三年（2020-2023年）中在商业活动中使用创新的情况及其对公司绩效的影响。此外，还通过深度访谈方法研究了一些参与者的经验。研究总共涉及112位企业家，他们参与了调查。研究结果显示，绝大多数俄罗斯中小企业都在使用创新；虽然没有明确的证据表明企业规模与其选择的创新类型之间存在稳定的关联，但在某些情况下，可以看到某些企业根据员工人数倾向于选择特定类型的创新。组织创新在企业中最不受欢迎，而营销创新最受欢迎；然而，营销创新在实施时也表现出最高的负面经验比例。
大多数受访者表示，公司在各项财务指标上都有所改善，并对创新实施的结果感到满意。企业规模越大，实施创新的目标就越多；企业规模越小，越注重解决提高销售和利润、增加客户忠诚度的具体问题。企业规模越大，越倾向于采用360度战略，即不仅注重新产品和服务的开发，还注重在生产过程中实施创新。
关键词： 中小企业，创新，财务结果，产品创新，过程创新，中小企业绩效，竞争力。

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Introduction

Small and medium-sized businesses are traditionally one of the most dynamic participants in market relations. Great competition and changes in industry and consumer demand force companies to look for new solutions and adapt to changing market conditions. In this regard, a special role is played by the innovative activities of firms that, through the development and implementation of specific innovations, can ensure greater competitiveness, improve financial performance and the quality of management decisions, and, in general, ensure their further development. Thus, the innovative practice taking place within the framework of small and medium-sized enterprises (hereinafter referred to as SMEs) is of particular interest.

SMEs in Russia play a very important role in ensuring employment and contributing to the country's gross domestic product, accounting for about 20% (Table 1). For comparison, in Japan this figure is 55%, in the USA - 53%[1].

Table 1
Share of SMEs in Russian GDP (%)

	2017	2018	2019	2020	2021
Share of SMEs in Russian GDP	22	20.4	20.7	20.8	20.3

Source: compiled by the author based on Rosstat data: https://rosstat.gov.ru/search?q=доля+мсп+в+ввп+рф.

To increase the share and development of SMEs, Russian government agencies are taking certain actions. In particular, in 2019, the national project 'Small and Medium Entrepreneurship and Support for Individual Entrepreneurial Initiatives'[2], was launched, which includes a range of measures to support entrepreneurial initiatives. These measures include creating simplified tax conditions for operations, simplifying reporting requirements, offering preferential loan programmes and subsidies, providing support for issuing securities, and creating opportunities for SMEs to participate in a competitive procurement, among other things. As of

[1] http://doklad.ombudsmanbiz.ru/2021/7.pdf.
[2] https://www.economy.gov.ru/material/directions/nacionalnyy_proekt_maloe_i_srednee_predprinimatelstvo_i_podderzhka_individualnoy_predprinimatelskoy_iniciativy/.

Table 2
Statistical information on innovation activities of SMEs (excluding microenterprises)

Type of economic activity	Share of SMEs engaged in innovative activities in the total number of surveyed enterprises (%)		Volume of innovative goods, works, and services (million roubles)		Share of innovative goods, works, and services in the total volume of shipped products (%)	
	2019	2023	2019	2023	2019	2023
Medium-sized businesses						
Cultivation of annual crops	6.4	13.7	3679.8	1449.7	2.2	0.6
Cultivation of perennial crops	4.8	—	—	—	—	—
Cultivation of seedlings	25	—	88	—	4.8	—
Animal husbandry	4.6	6.3	1939.9	1249.9	1.2	0.5
Mixed agriculture	6.1	9.5	205.4	*	3.8	2.1
Auxiliary activities in the field of agricultural crops production	14.3	—	27.4	*	1.7	1.9
Mining	2.6	2.6	32.8	*	0	0
Manufacturing industries	21.2	25.4	62557.8	84596.6	3.7	3.2
Supply of electricity, gas, steam, and air conditioning	7.8	12.2	208.8	*	0.4	0.8
Water supply, sewage, waste collection and disposal	7.1	7.2	368.4	3180.5	0.7	3.5
Construction	6.1	7.2	5908.8	6783.7	0.6	0.9
Transportation and storage	2.1	3.1	2728.9	3553.7	1.3	0.9
Publishing	6.9	19.4	0.8	*	0	0
Telecommunications activities	14.6	8.1	559.9	*	3	2.2
Computer software development and consultancy in this area	24.1	27.6	8688.3	10764.4	21.2	9.4
Information technology activities	8.1	19	781.8	3781.7	3.9	11.2
Legal and accounting activities	6.5	6.3	13.7	*	0.2	2.6
Management consulting	6.5	9.3	11064.8	470.1	6.5	1.3
Architecture and engineering design activities	21.2	19.4	123.1	994.8	0.2	0.8
Scientific research and development	56.6	65.3	5681.9	7654.2	12.8	13.7
Advertising and market research	—	10.3	—	*	—	3.5
Other professional, scientific, and technical activities	—	28.6	—	*	—	1
Activities in the area of healthcare and social services	5.9	9.9	102.7	221.3	0.3	0.3
Small businesses						
Mining	2.7	3.3	1129.9	2395.5	0.9	1.4
Manufacturing industries	6.5	7.6	63638.9	100236.5	2.6	2.7
Supply of electricity, gas, steam, and air conditioning	1.9	2.4	751.9	3568.9	0.7	2.6
Water supply, sewage, waste collection and disposal, pollution remediation	3	3.5	1537.2	12625	0.9	5.4

* Information cannot be disclosed in accordance with Federal Law No. 282-FZ dated 29 November 2007 ‘On Official Statistical Accounting and the System of State Statistics in the Russian Federation’ (art. 4, paragraph 5; art. 9., paragraph 1).
Source: compiled by the author based on Rosstat data: https://rosstat.gov.ru/statistics/instituteconomics.

7 April 2023, under the preferential lending programme, SMEs have concluded 7.3 thousand contracts for a total amount of over 101 billion roubles. (the average loan amount was RUB 13.8 million)[3]. As for innovation activity, according to the information provided by Rosstat, despite the increase in the share of SMEs engaged in innovative activities, the share of innovative products is decreasing in almost all industries (Table 2).

Industry-specific features of innovation activity are evident, which are reflected not only in the degree of firms' involvement in the innovation process and activities but also in the dynamics of the given indicators. For example, medium-sized enterprises engaged in storage and transportation proved to be the least innovative, while within small businesses, companies providing electricity, gas, steam, and air conditioning services were found to be less innovative.

According to statistical data, companies' expenditures during innovation activities are distributed across ten categories: acquiring new machinery and equipment, researching and developing new products and methods of production, marketing, training and staff development, design, engineering, development and acquisition of computer software, purchasing patent and license rights, planning and implementing new business methods, workplace organisation, and external relations.

In 2009 and 2023, medium-sized enterprises spent 25.3 billion roubles and 41.8 billion roubles, respectively, on innovation activities, while small enterprises (excluding micro-enterprises) spent 27.3 billion roubles and 54.4 billion roubles, respectively. Thus, the total expenditure on innovation activities by SMEs amounted to 52.6 billion roubles in 2019 and 96.3 billion roubles in 2023. The almost twofold increase in spending indicates an increased focus of SMEs on innovation.

Expenditure figures for medium and small enterprises, excluding industry-specific features, are presented in Table 3. It is worth noting that the provided data represents average values and do not account for the industry-specific characteristics of SMEs, resulting in the total sum of these values exceeding 100%.

Key categories within innovation activities include research and development of new products and manufacturing methods, as well as the acquisition of new necessary equipment. For some production sectors, expenses in these categories amounted to 80-100%. This situation demonstrates the critical dependency of SMEs on access to new, more advanced machinery and equipment, as well as their focus on improving their production activities. In third place in terms of spending are activities related to the development and acquisition of specialised computer software as part of digital transformation and the implementation of information technologies, a trend in the modern economy. Minimal expenses during innovation activities are related to staff training and development, averaging less than half a percent.

Table 3
Average values of categories of SMP subjects' expenditures on innovation activities (% of total expenditures)

Expenditure category	2019	2023
Research and development of new products and methods of their production	40.68	40.66
Purchase of machinery and equipment	42.18	41.63
Marketing and brand creation	3.35	0.96
Personnel education and training	0.47	0.39
Design	3.32	0.34
Engineering	7.29	3.93
Computer software development and acquisition	19.87	13.78
Acquisition of patent rights	2.33	6.68
Planning, development, and implementation of new business practices, workplace organisation, and external relations	0.47	0.27
Others	11.43	15.72

Source: compiled by the author based on Rosstat data: https://rosstat.gov.ru/search?q=категории+расходов+мсп+на+инновационную+деятельность.

Meanwhile, research confirms that innovation is a key driver of growth and development for SMEs [Expósito et al., 2018]. Studies also claim that small and medium enterprises engaged in innovative activities achieve better results [Vermeulen et al., 2005; Westerberg, Wincent, 2008]. Innovations provide small entrepreneurs with the opportunity to enhance their business efficiency through better market positioning [Expósito et al., 2018], form competitive advantages over rivals, and increase their business competitiveness [Tan et al., 2009].

Small and medium enterprises implement various types of innovations - from new technologies to new products. These products and technologies aim to increase SME efficiency by introducing innovative business methods [Expósito et al., 2018]. Cost reduction, market entry time, and risks, as well as acquiring missing knowledge, are key drivers of innovation adoption in SMEs [Vrande et al., 2009]. Additionally, collaboration with partners, such as suppliers, clients, and research institutes, can significantly boost the innovation potential of small and medium enterprises [Klewitz, Hansen, 2014].

[3] https://www.economy.gov.ru/material/news/maksim_reshetnikov_obem_lgotnyh_kreditov_po_nacproektu_msp_v_2023_godu_prevysil_100_mlrd_rubley.html.

Therefore, this study aims to investigate which types of innovations most significantly influence the efficiency of Russian SMEs.

1. The Impact of Innovations on the Efficiency of SMEs

There is a considerable body of foreign research dedicated to the impact of innovations on the efficiency of SMEs. For instance, the authors of [Bouwman et al., 2019] argue that the necessity of digital transformation inevitably entails the implementation of innovations in SMEs. They note that small and medium enterprises generally lack the resources to adapt their business models to digitalisation, but those who embrace digital transformation achieve better results in their operations. Research focused on British SMEs [Saridakis et al., 2019] demonstrates that innovative SMEs are more likely to engage in international export compared to non-innovative ones. According to this study, innovations in products, services, and processes play a crucial role in the internationalisation of SMEs. Moreover, innovations are a key element for global competitiveness and effectiveness for SMEs [Lee et al., 2017].

[Shashi et al., 2019] empirically prove that the effectiveness of operational and innovative activities positively influences business efficiency in SMEs. The authors argue that achieving efficiency in both operational and innovative activities significantly impacts financial performance and sustainable development. In [Ioanid et al., 2018], data from a survey of Romanian SMEs show the impact of marketing innovations on social networks on the effectiveness of small and medium-sized businesses. Interaction on social networks between business owners, clients, suppliers, and communities supports conditions for open innovations and co-creation of value.

The authors of [Yu et al., 2015] conducted a study of several examples of Chinese SMEs in the manufacturing industry and demonstrated how Chinese firms successfully transition from pure imitation (imitative innovation) to original innovations. The study describes the challenges faced by SMEs during this transition and identifies the skills necessary for a successful shift. This approach, adopted by most Chinese manufacturing SMEs, is a significant factor in enhancing innovation activity and creating radical innovations in SMEs. [Wang, 2018] shows that SMEs in developing countries are often resource-constrained, and implementing innovations is crucial for achieving high results and ensuring competitiveness. Moreover, in response to growing market instability, SMEs should not only develop new skills and competencies but also implement incremental innovations in existing products and services. The author suggests that, in conditions of high turbulence, a key factor determining the success or failure of SMEs is having a relevant technological innovation strategy and maintaining high productivity [Wang, 2018].

Research on the impact of innovations on the activities of Russian SMEs is limited. Therefore, this study aims to explore the role of innovations in the activities of SMEs in Russia and has the following objectives:

- assess the importance of different types of innovations for Russian SMEs;
- determine the impact of innovation types on the efficiency and competitiveness of SMEs;
- investigate whether SME efficiency can be a competitive advantage in the Russian market.

2. Research Methodology

To analyse the impact of various types of innovations on the efficiency of SMEs, a sequential approach combining qualitative and quantitative analysis was employed. Information was collected through a survey of small and medium business owners in Russia regarding their use of innovations in commercial activities over the past three years (2020-2023) and their impact on company performance. The focus of the study was to identify the most frequently used types of innovations (product, marketing, organisational, and technological), as well as to record the reasons for successes and failures in applying selected innovations. Additionally, some participants' experiences were explored through in-depth interviews. The study included 112 entrepreneurs who participated in the survey.

The qualitative analysis involved a survey consisting of 16 questions designed to identify challenges and successes in implementing innovations, specific types of innovations used, and financial metrics - costs of implementation in absolute and relative terms (relative to the firm's revenue). The survey also included questions assessing the effectiveness of implemented innovations based on their impact on key financial indicators: revenue growth, profit growth, average transaction value, market share increase, cost reduction, and others. Respondents were also allowed to provide their own answers.

The categorisation of enterprises was based on Federal Law No. 209-FZ dated 24 July 2007 (as amended on 29 December 2022) 'On the Development of Small and Medium Entrepreneurship in the Russian Federation.' The law defines two criteria for classifying a firm as a small or medium enterprise - average number of employees and the firm's revenue for the previous calendar year. For small enterprises, these criteria are set at 16-100 employees and up to 800 million roubles in revenue. The law also identifies a special category of microenterprises with up to 15 employees and annual revenue of up to 120 million roubles. For medium enterprises, the criteria are 101-250 employees and up to 2 billion roubles in annual revenue. The law also includes provisions for classifying firms with larger employee numbers as medium-sized under

certain conditions outlined in Government Resolution No. 1412 dated 22 November 2017, and other regulatory documents. For research purposes, it was not possible to account for the annual revenue of companies in the sample due to respondents' refusal to provide such information. Therefore, categorisation of respondents was based on the average number of employees. The firms that agreed to participate in the study were categorised into five groups:

1) firms with up to 15 employees (microenterprises);
2) firms with 16-100 employees (small enterprises);
3) firms with 101-300 employees (first category of medium enterprises);
4) firms with 301-500 employees (second category of medium enterprises);
5) firms with more than 500 employees (large enterprises).

The distinction between the two groups of medium enterprises is due to the variability in the size of firms agreeing to participate in the study. This distinction is somewhat arbitrary, and in some cases, both categories of medium enterprises will be considered as a single cluster in the presentation of research findings.

The general initial data are as follows. About 68% of companies have fewer than 100 employees: up to 15 employees - 26.9%, 16-100 employees - 42.3%. An additional 3.8% and 7.7% are relatively large firms with 101-300 and 301-500 employees, respectively. The third largest representative group consists of owners of large companies with over 500 employees - 19.2%. Despite the study's focus, the author considered it important to include the innovation practices of larger businesses, as this would allow for comparative insights into innovation practices among firms of varying sizes and enhance the current study's findings.

60% of firms operate in Moscow and the Moscow region, about 27% in St Petersburg and the Leningrad Region, with the remainder based in various cities across Russia, predominantly (80%) concentrated in the Central Federal District.

The survey included enterprises providing various services and producing different goods. The number of service-providing firms (53%) is roughly equal to the number of enterprises engaged in production and direct product sales. For the purposes of this study, the sector of activity is irrelevant, although it plays a role in innovation implementation, as determined during data processing. However, operationalising the influence of the sector on innovation usage is not feasible within the scope of this research.

It is worth noting that some firms participating in the study identified themselves as start-ups focused on creating new technologies or solutions in their field. Consequently, additional comments will be provided where they may affect the overall conclusions on specific research questions. Overall, the number of such firms is not substantial in the sample (less than 4%), allowing them to be treated as a general group without specific clustering in the overall statistics.

Subsequently, in-depth interviews were conducted with some respondents from each identified category of firms that agreed to participate in the study. That way, in-depth interviews were conducted with five representatives from small and medium enterprises and larger businesses. These interviews followed a set of thirty questions divided into six thematic sections.

The survey and in-depth interviews aimed to identify the following elements:

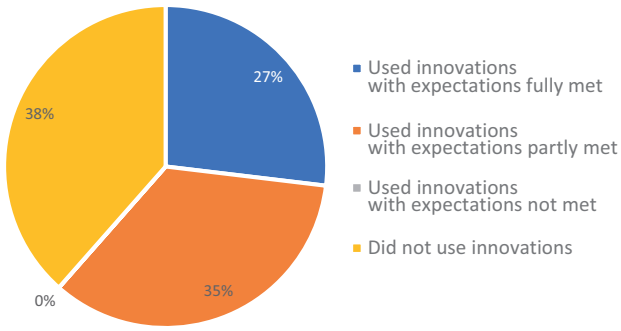
1) what innovations are primarily used by SMEs;
2) what challenges do SMEs face when implementing innovations;
3) how SMEs overcome barriers to innovation implementation;
4) what are the key success factors for implementing innovations in SMEs?

Quantitative analysis included regression analysis of the impact of innovation implementation in small and medium businesses in Russia on their performance indicators.

3. Qualitative Stage of the Study

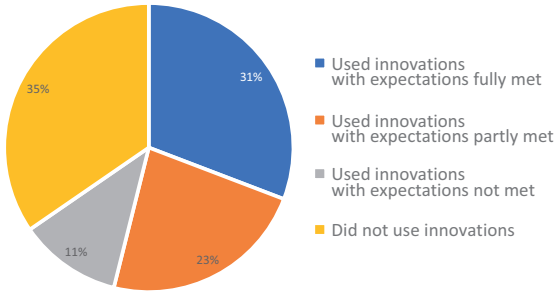
To some extent, innovations were used by almost all respondents - 96%. Organisational innovations, such as implementing supply quality control, outsourcing, employee training activities, new workplace organisation, new systems of responsibility and delegation of authority, were applied by 62% of respondents (see Figure 1). However, these innovations were the least popular among those surveyed. Moreover, businesses with more than 300 employees used organisational innovations on average less than other categories. This is partly due to established business processes and commercial relationships with partners and clients. A larger share of innovations in this category was used by businesses with 16-100 employees (75% of companies in this category).

Fig. 1. Use of organisational innovation (% of respondents)
Source: compiled by the author.



Technological innovations ranked second in frequency of use. 65% of participants worked on implementing these innovations (see Figure 2). ons. No specific dependency in the use of technological innovations across different business categories was identified. On average, the use of this type of innovation is related to the specific characteristics of the business. Due to the focus of technological innovations on improving productivity and using modern technologies in product creation, companies providing services in rapidly developing sectors in Russia (e.g., online education and medical services) are the most frequent users of these innovations. It is worth noting that 11.5% of respondents in this category reported significant challenges in using technological innovations.

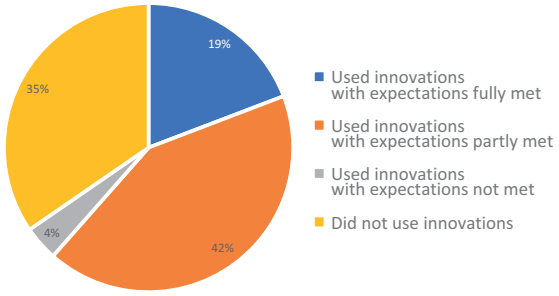
Fig. 2. Use of technological innovation (% of respondents)



Source: compiled by the author.

Product innovations share second place with technological innovations (see Figure 3). Respondents provided specific examples such as innovations aimed at improving the quality of previously released products based on up-to-date information about changing consumer needs and preferences. Other examples included shifting to the production of goods in a different product classification group, often intended for different consumers and the launch of entirely new products. In the latter case, this included both a new product category for the specific company and a new product category for the market in general. It is noteworthy that compared to technological innovations, the number of product innovations where the implementation goals were fully

Fig. 3. Use of product innovation (% of respondents)

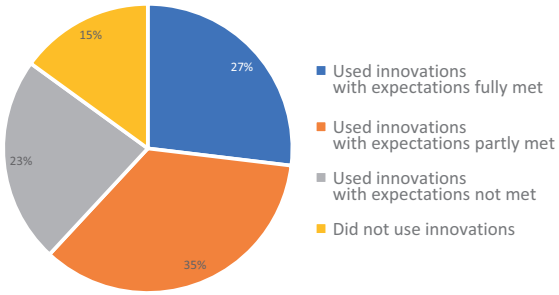


Source: compiled by the author.

met drops significantly. Based on the interview data, this is attributed to higher expectations for the new product and the difficulties associated with introducing a new product to the market, despite prior hypothesis testing and trials.

Marketing innovations were the most popular type, with 85% of respondents utilising them, the highest among all categories (see Figure 4). Respondents cited specific changes that can be grouped as follows: changes in product design that do not affect functional or consumer characteristics, new sales methods or product presentation techniques, new pricing strategies (excluding seasonal and regular ones), and new strategies aimed at expanding the customer base or market reach. As shown in Figure 4, this category of innovations has the highest proportion of negative experiences among all mentioned. Despite the apparent clarity of marketing technologies and the wide range of available tools, respondents identified the main issue as the difficulty in predicting results. They also noted certain limitations related to the company's field of activity. For example, opportunities such as using social media for positioning and advertising sometimes fail due to the inability to effectively reach the target audience. This was particularly noted by firms with B2B (business-to-business) clients.

Fig. 4. Use of marketing innovation (% of respondents)



Source: compiled by the author.

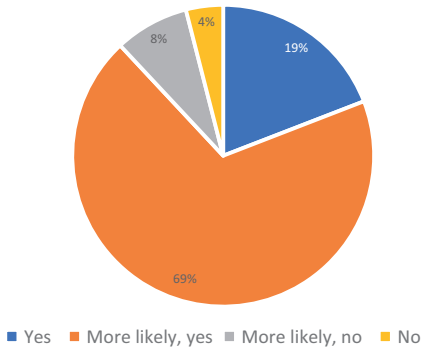
The primary goals of implementing innovations were to increase sales (58% of respondents) and improve company control (54%). These were followed by gaining a competitive advantage (38%), increasing customer loyalty (34%), reducing costs, and speeding up the production process (30% each). Rounding out the list were creating new products for the market (27%) and developing new products that are novel to the specific production process of the firm (15%).

At the same time, 19% of respondents cited increasing sales as their sole goal. This choice was predominantly associated with developing firms with 16-100 employees. The remaining 81% of respondents viewed innovation implementation as a solution to complex business development issues, including not only increasing profit and average transaction value but also optimising internal business processes. This situation is typical for companies

that have either recently entered the market and are trying to grow rapidly or are facing competition that requires them to address multiple aspects simultaneously.

Overall, respondents rated their experience with innovation implementation positively. 19% of respondents reported achieving all their goals, while 69% achieved partial but satisfactory success. Only 8% felt they had expected better results from their innovations, and 4% reported a failure in applying innovations (see Figure 5).

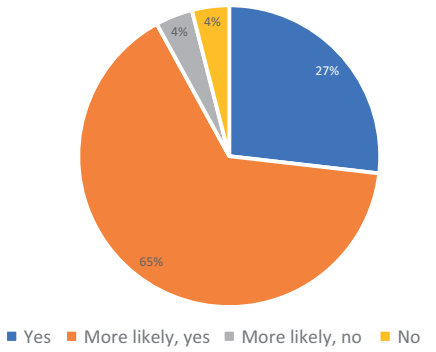
Fig. 5. Answers to the question: 'In general, has the application of your selected innovations achieved the objectives originally set for them?' (% of respondents)



Source: compiled by the author.

27% of respondents unequivocally confirmed an increase in financial indicators following the implementation of innovations (see Figure 6). An additional 65% agreed that there was a certain increase in financial indicators. The remaining 8% of respondents did not notice significant improvements or explicitly stated that there were none. These assessments were predominantly given by managers of small firms with up to 15 employees.

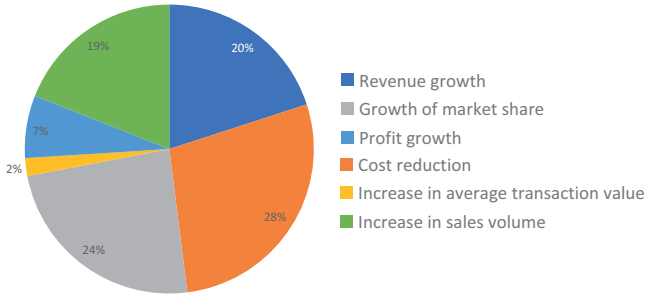
Fig. 6. Answers to the question: 'Did the introduction of innovations affect the increase in the company's financial performance?' (% of respondents)



Source: compiled by the author.

Among the assessments of the effectiveness of innovation implementation, the most notable are profit growth, an increase in sales volume, and an increase in the average transaction value (see Figure 7). Thus, firms primarily associate innovation implementation with improvements in commercial performance indicators, while they are less likely to define the success of innovations by cost reduction parameters. It is also worth noting that the increase in market share was the least frequently mentioned criterion for determining the success of innovation implementation.

Fig. 7. Answers to the question: 'What is the main criterion you have chosen to assess the positive effect of innovation implementation?' (% of respondents)



Source: compiled by the author.

Respondents were also asked to evaluate the impact of innovation implementation based on the percentage change in their chosen key performance indicator. The distribution of responses is shown in Table 4. Overall, the survey indicated that the innovations implemented have a significantly positive effect on the financial and other metrics of SMEs. On average, financial indicators increased by 1% to 5%. The second group of indicators varied from 6% to 10%. Interviews with respondents revealed that a 6-10% increase in profit growth and sales volume was considered good, while anything above 10% was considered excellent. Some respondents achieved significant results from the implementation of innovations, with more than 20% growth in revenue and profit over a certain period.

Let's consider the overall level of satisfaction with the implementation of innovations. The results are similar to the financial outcomes: 20% of respondents stated that the innovations fully met the objectives set for them, 69% agreed that innovations addressed most of the tasks, and another 12% noted that the innovations had a very limited impact or did not meet expectations at all.

The implementation of innovations across different categories of small and medium-sized enterprises (SMEs) has its own characteristics. Let's track certain dependencies and positions on the implementation of innovations in small and medium-sized enterprises based on the size of the company.

Microenterprises. Enterprises with up to 15 employees made up 27% of the respondents. For 57% of such enterprises, the average costs of implementing innovations amounted to up to 100,000 roubles over the past few years. Another 28% spent between 100,000

Table 4
Distribution of answers to the question: 'To what extent have the indicators used to assess the impact of innovation implementation changed?' (% of respondents)

Key indicator changes	Revenue growth	Profit growth	Increase in average transaction value	Growth of market share	Cost reduction	Increase in sales volume
< 1%	9	15	5	—	13	15
1–5%	42	35	32	—	71	31
6–10%	33	29	38	—	16	33
11–15%	9	13	21	—	0	15
16–20%	6	5	4	—	0	6
> 20%	1	3	0	—	0	0

Source: compiled by the author.

and 300,000 roubles. The remaining respondents were represented by start-ups with significant investments for small businesses, exceeding 1 million roubles. The innovation costs for 42% of respondents in this business category amounted to less than 1% of their revenue, for 28% - 2-5% of revenue, and for 14% of respondents - 6-10% of revenue. The remaining respondents, whose activities are conducted in relatively technological and competitive sectors of the economy, spent over 30% of their revenue on implementing innovations. In terms of the specific allocation of these expenses, 70% were related to investments in new forms of firm representation and marketing campaigns. Another 40% of the costs were associated with the purchase of new equipment or transitioning to new computer programmes and software, primarily CRM systems.

For 71% of respondents, the main goal of implementing innovations was to increase sales and improve enterprise control. The latter involved enhancing awareness of the current operational activities of the firm and identifying bottlenecks to develop additional solutions for their elimination.

86% of respondents used marketing innovations, although only 16% of them fully met their expectations for this category of innovations. Product innovations were the least commonly applied, chosen by 58% of respondents. Overall, about 70% of enterprises in this category used various combinations of technological, organisational, product, and marketing innovations. The average satisfaction with the results was 3.8 points on a 5-point scale.

The key problem with implementing innovations was the unpreparedness of personnel for the changes. About 90% of all respondents noted that the firm's employees often did not have sufficient competencies to immediately cope with changes in their work processes. Innovations, even if they were not directly related to current operational activities, caused disruptions in the usual work processes of 40% of enterprises. Despite the widespread issues with personnel during the implementation of innovations, only a few mentioned conducting training for employees. Predominantly, this problem is overcome either as employees adapt to the innovations and develop the necessary skills in everyday practice, or through personnel decisions. The second problem was unexpected additional costs for companies, as noted by 55% of respondents. This situation was generally associated with financial planning errors or changes in the firm's operating conditions. Additional costs were also linked to attempts to revive the ongoing innovation processes with additional financial investments in the hope of justifying the already spent time and resources.

Small enterprises: 42% of the surveyed companies fall into those whose staff size ranges from 16 to 100. 45% of such enterprises spent over 1 million roubles on implementing innovations; another 18% spent between 600,000 and 1 million roubles, and between 300,000 and 600,000 roubles, while the rest spent 100,000-300,000 roubles; the proportion of investments relative to the revenue amount significantly increased compared to the previous category. If 42% of small companies with up to 10 employees spent up to 1% of their revenue on innovations, then in the presented category, there were twice as few - 20%. 18% of respondents noted that they spent about a third of their revenue on various improvements; 9% of enterprises spent 21-30% of their revenue; 27% - 11-20% of revenue; and the remaining 26% - 2-10% of revenue. In other words, companies that feel relatively confident in the market and can generate sufficient income are willing to invest significant funds in implementing innovations. Such expenditures bring tangible results. For instance,

one respondent reported that with expenses of about 500,000 roubles, the implemented innovation brought benefits of more than 5 million roubles over two years and increased the company's recognition by 80% and the average transaction value by 25%.

As with the previous category, the primary type of innovation used was marketing, mentioned by 90% of firms. Organisational and product innovations came second (72% each), and technological innovations were last (54%). The average level of satisfaction with implementation was 4.3 points on a 5-point scale.

The main goal of implementing innovations remains to increase sales (55%), but the same percentage of respondents also noted tasks related to improving enterprise control. 70% of firms set very broad goals for innovations, ranging from already mentioned financial performance and organisational improvements to gaining a competitive advantage (45%), reducing costs (36%), speeding up production (35%), and increasing customer loyalty (19%). 36% sought to use innovations to create a new product or service for their market. It can be stated that within this business category, innovations acquire more complex and comprehensive goals and, judging by the amount of investment, are viewed as a natural tool for conducting commercial activities. Furthermore, such firms are in a stage of active growth and, as a rule, try to gain competitive advantages through innovations by creating new products and speeding up production and distribution. To achieve this, they address the issue of speeding up feedback collection. However, this is not to say that such behaviour is uncharacteristic for other SME categories, but in this segment, it is most pronounced.

The issue of personnel and their receptiveness to innovation remains a serious challenge, although it manifests much less frequently (46% versus 90% in firms with up to 10 employees). It is also notable that 56% of firms in this category reported conducting regular training and retraining of employees. This is a direct result of the personnel issue. During the interviews, it became clear that the complexity of employee training for organizations is not primarily due to additional financial costs (most interviewees - owners or general directors - noted that education expenses usually pay off quickly), but rather because it disrupts the established procedures of the firm's operational activities. As the company enters the market and develops, the management inevitably institutionalises (formalises) key processes. This concerns interactions with clients and contractors, internal communication between departments, production processes, sales, etc. When facing challenges related to implementing innovations, enhancing employees' competencies is closely linked to changes in the firm's routine operations, necessitating a revision of established business practices. In this regard, not all managers and other decision-makers are willing to review formalised procedures, causing the innovation implementation process to drag out. This, in turn, generates psychological resistance to innovations and, importantly for the firm's budget, reduces financial performance. Thus, professional development courses and other human capital investments are effective only when combined with flexible thinking among managers and require parallel changes in the company's internal 'routine' conditions.

40% of firms noted the need for additional expenses during the innovation implementation. In addition to the costs of retraining employees, respondents mentioned allocating additional funds to attract new contractors if the previous one did not meet expectations. Additional expenses for purchasing extra equipment due to calculation errors were also cited. Another 36% reported technical difficulties in operating and managing new equipment or software.

An additional category of difficulties during innovation implementation was the increased time needed for implementation. Overall, this affected 63% of respondents. This is because firms did not anticipate the potential difficulties and challenges associated with implementing innovations.

This business category also includes companies that received government support for innovation implementation, accounting for 17% of the sample. This mainly concerned receiving tax benefits as residents of technology parks and innovation centres, and in some cases, obtaining grants or interest-free loans for company development. It is worth noting that half of the participants in cooperation with government structures in this area mentioned the complexity and length of bureaucratic procedures associated with obtaining the necessary benefits. However, their average satisfaction with innovation implementation was 4.5 points, which is slightly higher than the overall average for this category of businesses. Overall, the sample does not allow for a specific conclusion about the role of government support in the success or failure of innovations implemented by enterprises in this category.

Medium-sized enterprises. Companies with 101 to 300 and 301 to 500 employees represent 4% and 8%, respectively. The sample for each category is not representative, as these enterprises generally do not differ significantly in their indicators, so they are combined and considered together. Thus, 75% of medium-sized firms used marketing, technological, and product innovations with equal frequency. Organisational innovations were the least used. According to the interviews, this is related to well-established internal processes, which are considered sufficient for continued operations in their current form. The experience of using organisational innovations by firms in this category shows that they find it difficult

to restructure already established systems of processes and relationships, as they have previously gone through the need to reorganise the company structure and found clear and effective forms of personnel management and external communication.

According to respondents, there is a noticeable decrease in the number of successful cases, where the objectives of innovation implementation were fully achieved. With the overall satisfaction rating of 4 points on a 5-point scale, there were no cases where innovations fully met expectations after implementation.

As with other cases, a major issue highlighted by almost all respondents was the unpreparedness of staff for innovations. Typically, such companies have some system in place for staff development, but the scale of changes implemented by firms of this size is often large enough to make the transition difficult. Respondents were not unanimous about the significance of the personnel training issue. An indirect confirmation of its seriousness is that, alongside personnel problems, respondents also cited technical difficulties, which included challenges in operating and configuring equipment and coordinating actions of staff in new conditions.

The average costs for innovation in this category generally range from 601,000 to 1,000,000 roubles (50% of respondents), which constitutes 2-5% of their revenue (78% of respondents).

Large enterprises. The final category of enterprises includes companies with more than 500 employees. The results of the analysis of their innovation activities do not significantly differ from the previous group.

The same goals for innovation implementation are observed (increasing sales, improving company control), along with the same problems (staff unpreparedness, unexpected technical challenges, and additional time and cost expenditures). The cost of implementation is somewhat higher, ranging from 1,000,000 to 1,500,000 roubles, which for most (60%) companies amounts to up to 1% of their revenue.

In summary, the following can be stated:

the innovative activity of SMEs is still in a formative stage. The proportion of firms participating in the innovation process in 2023 increased compared to 2019, but the share of innovative products relative to the total amount of goods, services, and works remains low and is growing only in specific sectors.

There is a significant variation in innovation activity and expenses depending on the economic sector.

On average, key areas of expenditure during innovation activities include costs for acquiring new equipment and machinery, developing and implementing new products and production methods, and creating or acquiring software.

According to respondent evaluations, medium-sized firms that are already established in the market and can allocate sufficient funds for successful innovation implementation achieve the most significant effects. Such firms have not fully formalised their internal processes, which makes them more receptive to changes.

A major issue in implementing innovations, as noted by respondents, is staff unpreparedness, as well as the need for additional costs related to retraining or technical complications.

The main goal of implementing innovations is to increase the firm's profit and sales. As the number of employees grows, improving company management becomes increasingly important.

The main criteria for evaluating the results of innovation implementation are profit growth, higher average transaction value, and revenue growth.

Implemented innovations, on average, allowed one-third of SMEs to increase profit, average transaction value, and revenue by 6-10%.

As firms grow, the problems they aim to solve through innovation become increasingly complex.

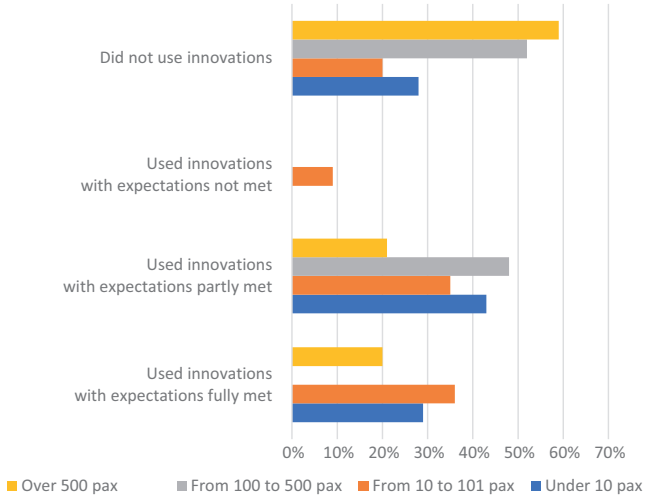
4. Quantitative Stage of the Study

The survey and in-depth interview data allow for a quantitative analysis of the impact of various types of innovations on the performance of SMEs.

According to these data, organisational innovations were used by almost all categories of SMEs (see Figure 8). Larger companies paid increased attention to staff training and, in some cases, reorganised workflow control through the implementation of CRM systems.

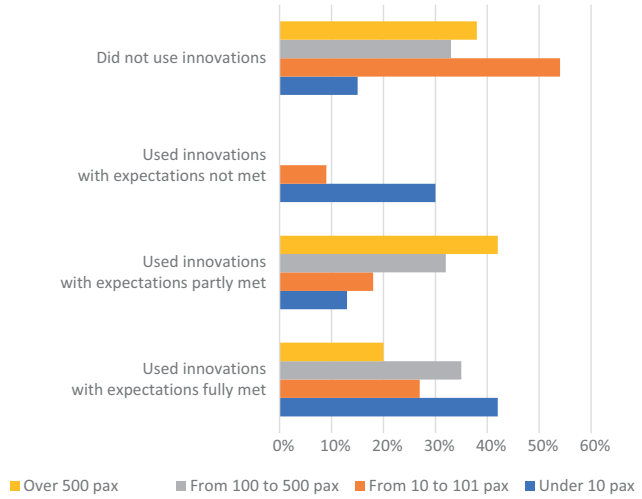
Medium-sized companies with 16-100 employees were the most successful in this category of innovations. In their growth phase, they actively implement organisational innovations to find the optimal organisational and management structure.

Fig. 8. Use of organisational innovation depending on firm size (% of respondents)



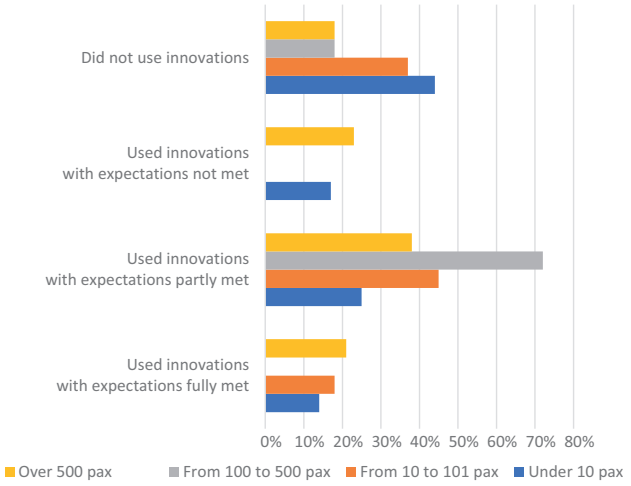
Source: compiled by the author.

Fig. 9. Use of technological innovation depending on firm size (% of respondents)



Source: compiled by the author.

Fig. 10. Use of product innovation depending on firm size (% of respondents)



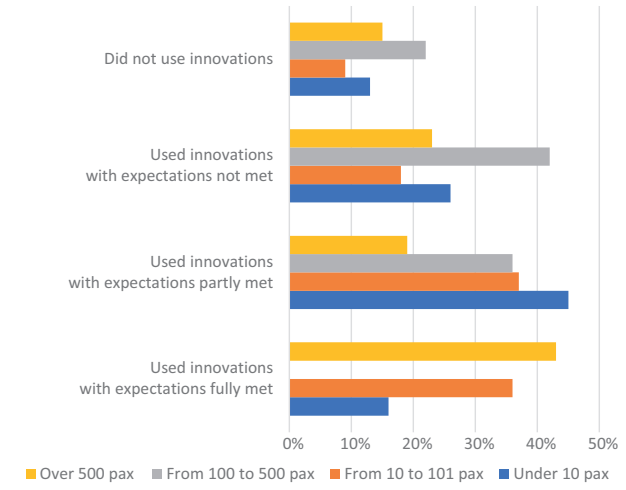
Source: compiled by the author.

Technological innovations (see Fig. 9) were predominantly successful for small firms. Successful experiences are primarily characterised by the creation of websites for selling their products, transitioning to new software, and, in some cases, changing production technology with the use of new equipment. The latter is primarily related to identifying and addressing bottlenecks in production.

It is striking that more than half of medium-sized firms did not use this type of innovation in their activities. This is partly due to the relative stability of the production process and the significant costs associated with acquiring equipment and software in specific cases.

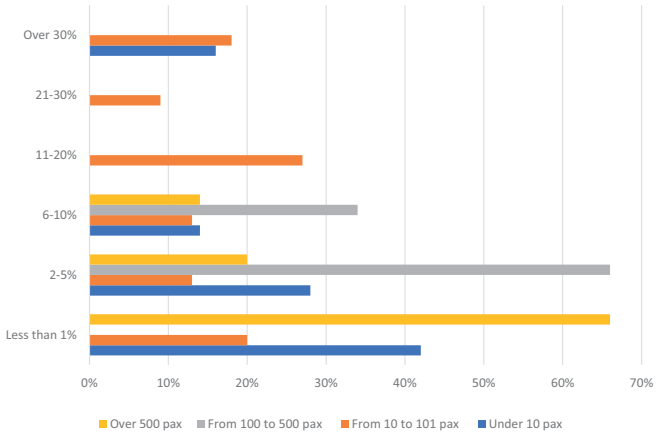
Product innovations (see Fig. 10) were comparatively rarely used by small and medium-sized enterprises. This was mainly related to improving product quality through obtaining timely information about its condition from customers. Large firms, in this case, were the leaders. It is worth noting the relatively low level of fully achieving goals in this area of innovation, which rarely exceeds 20% across all SME categories. As interview results show, this type of innovation is quite difficult to model in terms of potential outcomes. Low satisfaction with results is partly related to high expectations, especially when creating a product that is fundamentally new for the market or the company. Additional elements of the assessment include difficulties encountered in bringing a product or service to market, so this may be the case of a comprehensive evaluation of the work done in the commercialisation of new products.

Fig. 11. Use of marketing innovation depending on firm size (% of respondents)



Source: compiled by the author.

Fig. 12. Distribution of firms' innovation costs vs. annual revenue by number of employees (% of respondents)



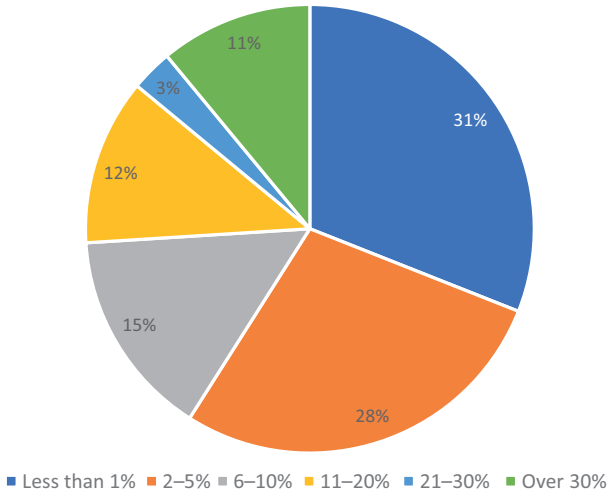
Source: compiled by the author.

The final category of innovations implemented by enterprises was marketing innovations (see Fig. 11). They showed the highest percentage of implementation - along with the highest level of negative evaluations among all other types of innovations. The first aspect is explained by the relatively low cost and variety of available tools that firms can use to promote their products or maintain contact with their audience. The latter, particularly characteristic of medium-sized firms, has several reasons. Firstly, in some cases, failures are related to the performance of the firms' promotion departments - in other words, the qualifications of employees in specialised departments are insufficient to handle the tasks. Secondly, a portion of respondents misjudged demand and therefore proposed wrong pricing strategies for consumers, mistargeted the audience for marketing campaigns, or incorrectly allocated the budget across specific sales channels.

After considering specific types of innovations, it is worth paying attention to the costs incurred by firms, the data on which are shown in Fig. 12.

Based on the data provided, it can be concluded that the majority of respondents (30%) allocated up to 1% of revenue to innovations. For firms of up to 10 people, there is a clear reduction of expenditure on expensive innovations. A certain surge in expenditure - over 30% of revenue - in this case is associated with the initial position of the company as a startup under development. The same is true for companies where the number of employees does not exceed 100 people. All categories of firms tend to decrease their innovation expenditure as its cost increases relative to revenue. The majority of firms (59%) spent less than 5% of revenue on innovations (Fig. 13). It appears that this value is the most acceptable for SME firms.

Fig. 13. Distribution of firms' innovation costs depending on revenue (% of respondents)



Source: compiled by the author.

The ratio of funds spent and satisfaction with the innovations used is shown in Table 5.

Table 5
Relationship between money spent and satisfaction with innovations used (score on a 5-point scale)

Cost of innovation compared to revenue	Degree of satisfaction with the introduction of innovations
< 1%	4.125
2-5%	4.142
6-10%	3.75
11-20%	4.6
21-30%	4
> 30%	3.9

Source: compiled by the author.

The regression analysis revealed, however, that there is no relation between these indicators (coefficient $R^2 < 0.5$). The regression analysis data are shown in Table 6.

Table 6
Regression analysis of the dependence of innovation costs on the level of satisfaction with the implemented innovation

Expenditure on innovation to revenue share	Share of companies (%)	Assessment of satisfaction from the introduction of innovations (score on a 5-point scale)
Input data		
< 1%	30.7	4.125
2-5%	26.9	4.142
6-10%	15.4	3.75
11-20%	11.5	4.6
21-30%	3.8	4
> 30%	11.7	3.9
Regression statistics		
Multiple *R*	0.06201011	
R^2	0.00384525	
Normalised R^2	-0.24519343	
Standard error	11.3817083	
Observations	6	

Source: compiled by the author.

This further supports the thesis revealed during the in-depth interviews: it is relatively unimportant what resources a company invests in innovation implementation; what matters are the skills for implementing innovations, which are associated with employee qualifications and the selection of specific solutions to improve particular processes.

In absolute terms, the costs of implementing innovations were distributed as follows (see Table 7).

Table 7
Absolute costs of SMEs for innovation implementation

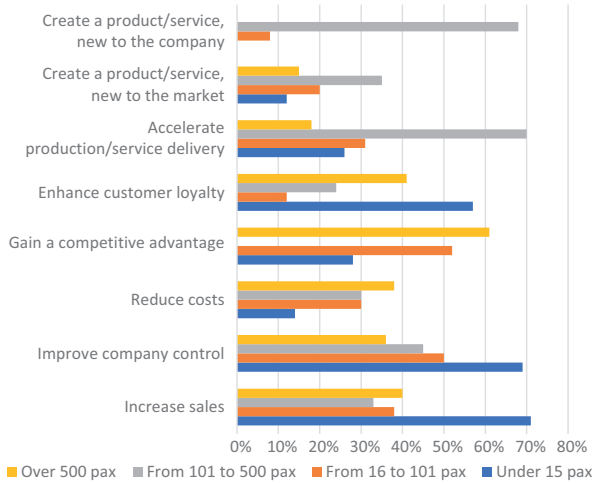
Absolute cost of innovation (thousand roubles/year)	Share of SMEs (%)
Up to 100	15.4
101-300	23
301-600	3
601-1000	15.4
1000-1500	38.3
Over 1500	5

Source: compiled by the author.

Overall, the breakdown of absolute costs for firms falls into two ranges: up to 300,000 roubles (38.4%) and from 601,000 roubles to 1.5 million roubles (53.7%). It is clear that in relative terms (as a share of total revenue), these costs may vary depending on the category of SMEs and the specific sector of activity. However, the data provided allows for an estimation of the approximate amounts SMEs require to finance their innovation activities.

A significant difference was identified in the approaches to the innovation process concerning the stated goals of implementing innovations (see Figure 14).

Fig. 14. Declared goals of innovation implementation (% of respondents)



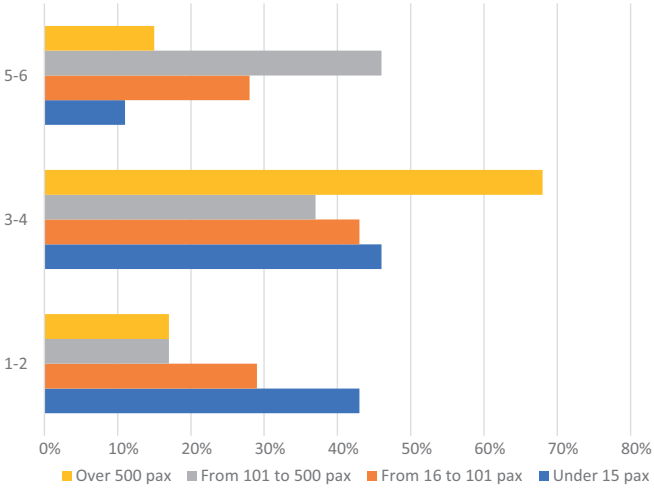
Source: compiled by the author.

Depending on the size of the firm, their approach to implementing innovations varies somewhat. Microenterprises primarily focus on increasing sales, improving enterprise control - reflecting an overall understanding of core business processes - and enhancing customer loyalty. Interviews revealed that this is often linked to these companies' unstable market positions and the need to improve financial performance. As these firms grow and expand, they aim to develop their product range and differentiate themselves from competitors. Consequently, their innovations will be directed towards gaining a competitive advantage while maintaining the importance of other innovation areas.

For businesses with 101 to 500 employees (with categories 101-300 and 301-500 considered together due to the small sample size), a notable focus is on accelerating service delivery and creating products or services that are new for the enterprise. This heightened focus on these goals is related to the nature of their internal operational processes: such firms are generally stable, have acceptable cash flows from their product sales, and have somewhat reached the limits of expanding their market presence. In this context, competitive advantage may be achieved through increased production efficiency, such as reducing time costs and introducing new product or service categories.

Another interesting observation is the complexity of the primary goals set by enterprises implementing innovations (see Figure 15).

Fig. 15. Number of goals stated by enterprises when introducing innovations (% of respondents)



Source: compiled by the author.

Notably, there is a certain dependency: the smaller the company, the more specific goals it sets for itself when implementing innovations. Conversely, the larger the company, the more complex the tasks it aims to solve through innovation. Interviews revealed that this is related to the company's successes and experience in innovation activities. Larger amounts of funds that entrepreneurs are willing to invest in innovation motivate decision-makers to actively seek innovative solutions across different areas of operational activities. This is especially true if the company has developed an innovation-friendly environment and the management understands the necessity of implementing innovations.

Thus, the empirical analysis leads to the following conclusions: innovations are used by the overwhelming majority of small and medium-sized enterprises (SMEs) in Russia.

There is no strong correlation between the size of the business and the chosen types of innovations, although in some cases companies tend to adopt certain types of innovations depending on their number of employees.

Organisational innovations are the least popular among SMEs, while marketing innovations are the most popular.

Marketing innovations show the highest share of negative experiences in implementation (expectations were not met for 23.1% of respondents), even though they are the most frequently used category of innovation.

Most respondents manage to implement innovations successfully. The vast majority notice improvements in the company's financial position based on various criteria and are satisfied with the results of innovation implementation.

Regarding the financial aspect of innovation activities, 30% of SMEs spend up to 1% of their annual revenue on innovations. Overall, 59% of firms spend no more than 5% of their annual revenue on innovations. Yet, there is no clear connection between the resources spent and the level of satisfaction with innovation implementation.

The typical amount of funds used by SMEs for innovation ranges from up to 300,000 roubles (38.4%) to between 601,000 and 1.5 million roubles (53.7%).

The larger the company, the more goals it pursues by introducing innovations.

The smaller the company, the more interested it is in addressing specific tasks to increase sales and profits and enhance customer loyalty. The larger the company, the more attention it pays to the creation of new goods and services, as well as the acceleration of production processes.

Conclusion

The results of the study of 112 Russian small and medium-sized enterprises allowed us to draw the following conclusions: innovations are used by the overwhelming majority of small and medium-sized enterprises (SMEs) in Russia. There is no strong correlation between the size of the business and the chosen types of innovations, although in some cases companies tend to adopt certain types of innovations depending on their number of employees. Organisational innovations are the least popular among SMEs, while marketing innovations are the most popular. The latter show the highest share of negative experiences in implementation (expectations were not met for 23.1% of respondents), even though they are the most frequently used category of innovation. Most respondents manage to implement innovations successfully. The vast majority notice improvements in the company's financial position based on various criteria and are satisfied with the results of innovation implementation.

Speaking about the financial side of innovation, it is worth noting that 30% of SME firms spend up to 1% of their annual revenue on innovation. Overall, 59% of firms spend no more than 5% of their annual revenue on innovations. Yet, there is no clear connection between the resources spent and the level of satisfaction with innovation implementation. The typical amount of funds used by SMEs for innovation ranges from up to 300,000 roubles (38.4%) to between 601,000 and 1.5 million roubles (53.7%).

The problems faced by enterprises when introducing innovations are complex in nature. None of them can be solved in isolation and require consideration of the innovation implementation process in the framework of a comprehensive plan. The issue of personnel training in innovation implementation is not only related to the qualifications of specific employees but also to the qualities of decision-makers, who must understand and find resources to address it. The innovation implementation process is closely linked to the company's ability to finance its preparation and execution. Thus, the company needs to have free capital available for investment in its development. However, solving the funding problem is not an end in itself. It is intricately woven into the overall innovation activity framework and concerns not only funds allocated for purchasing new equipment or organising marketing campaigns but also costs related to employee training, maintaining material incentives, and other expenses. Another challenge for companies during innovation implementation is the difficulty in forecasting its execution and risk management.

Overall, recommendations for improving innovation activities within SMEs can be summarised as follows: it is necessary to ensure a higher quality informational space for sharing the latest achievements in innovation activities, improve financial literacy and planning skills of decision-makers, enhance mechanisms for targeted government financial support for SMEs and simplify the procedure for obtaining it, form a pool of potential government tools for targeted assistance, and develop a mechanism for their application using big data to increase efficiency. Additionally, it is recommended to include criteria for supporting the company's innovation activity in employee KPI structures and to develop measures for material incentives based on these criteria.

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Improving the user experience of financial technology IT services based on UX/UI research

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Abstract

In today's dynamic fintech environment, user requirements are constantly changing, and digital services need to be developed and adapted to meet their expectations and needs. UI/UX research technologies and methods provide rich opportunities to study user preferences and identify problems and shortcomings in existing digital services. The main aspects of improving the user experience of the mobile bank were reviewed. Recommendations were made for the further development of the IT service. The purpose of this article is to examine the main aspects of improving the user experience and to formulate recommendations for the development of IT services in the banking sector. Research methodology - at the first stage, an analysis of user behavior in fintech was carried out: a study of user expectations and preferences in the field of digital financial services. Then user experience was analyzed and UI/UX studies were conducted for the 'Notification Center' of the bank's mobile application. The final stage of the study was to evaluate the effectiveness of the redesign project of the Notification Centre section of the bank's mobile application and to formulate recommendations for the further development of the mobile application.

The research conducted has shown the practical importance of improving the user experience of the bank's mobile application, which consists of improving usability, increasing customer satisfaction and improving the overall impression of banking services. This leads to increased conversion, customer retention and increased loyalty to the bank.

Improving the user experience of the bank's mobile application makes it possible to increase the efficiency of the bank's employees, reduce the burden on the customer support department and reduce the number of errors when performing routine operations or actions. This not only optimises the bank's internal processes, but also helps to improve the overall quality of service, which has a particular impact on the bank's reputation, competitiveness and financial performance.

Keywords: UI/UX research, mobile application, fintech, UX design, A/B testing, banks.

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基于UX/UI研究的金融科技领域IT服务用户体验优化

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简介
在当今动态的环境中，金融科技用户的需求不断变化，必须发展和调整数字服务，以满足他们的期望和需求。 UI/UX研究技术和方法为了解用户偏好以及发现现有数字服务中的问题和不足提供了广泛的机会。本文旨在研究优化用户体验的主要方面，并提出银行业IT服务发展的建议。首先，分析了金融科技领域用户行为，研究了用户对数字金融服务的期望和偏好；接着，对银行手机应用的"通知中心"部分进行了用户体验分析和UI/UX研究；最后，对银行手机应用"通知中心"部分重新设计项目的有效性进行了评估，并提出了进一步发展手机应用的建议。
研究表明，优化银行手机应用的用户体验具有实际意义，包括提高使用便捷性、客户满意度和整体银行服务体验。这将导致转化率增加、客户留存率提高以及对银行的忠诚度提升。
优化银行手机应用的用户体验可以提高银行员工的工作效率，减轻客户支持部门的负担，并减少执行日常操作或任务时的错误数量。这不仅能优化银行的内部流程，还能提升整体服务质量，从而提高银行的声誉、竞争力和财务表现。
关键词： UI/UX研究、移动应用、金融科技、用户体验设计、A/B测试、银行。

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Introduction

In the modern world, information technology services are playing an increasingly important role in various fields. One of these areas is financial technology or FinTech. Fintech means using the latest technologies to provide banking and other financial services.

Financial technology products facilitate traditional banking processes and provide a better quality of user service. Most fintech applications are designed to meet the needs resulting from user frustrations. Another important factor influencing the introduction of fintech technologies in different regions and age groups is the perceived ease of use. However, quality assurance is impossible without involving users in the development of these products [Cordeiro, Weevers, 2016, p. 34].

User experience (UX) refers to the overall assessment of a user's perception and satisfaction when using a product or service. In the context of IT services, UX is a key tool for attracting and retaining customers on a platform. A good UX ensures ease of use, high task completion speed, and positive emotions from using the product [Dietz et al., 2016].

By the 1980s, UX design had become more systematic and methodical. Several models and methods were developed to consider user needs and preferences in product development. For example, the User-Centred Design (UCD) model proposed by D. Norman was popular at that time. In the 1990s, with the advent of the Internet and the emergence of websites, UX design became even more relevant. Web designers began to realise the importance of usability, information architecture, and navigation. The term 'user experience' became widely used in the context of internet products. In the 2000s, with the development of mobile technologies and the arrival of smartphones, UX design gained even greater significance. Companies and organisations began establishing dedicated departments for user experience development. Additionally, specialised courses and educational programmes in UX design began to appear [Cordeiro, Weevers, 2016]. In the 2010s, with the emergence of new technologies such as artificial intelligence, virtual reality, and the Internet of Things, UX design became even more diverse and complex. A large number of tools, methods, and frameworks were developed to improve the user experience.

Today, UX design is an integral part of product development in various industries, such as web design, mobile applications, gaming, the automotive industry, and more. Companies are increasingly recognising the importance of user satisfaction and are investing in UX design to achieve competitive advantages and success in

the market [Barquin, Vinayak, 2016]. The importance of UX in the fintech industry is particularly significant, as the financial services sector has traditionally been considered conservative and has not always paid sufficient attention to developing user-friendly and intuitive interfaces. With the emergence of fintech startups, this situation began to change. New companies actively study customer needs and develop services that provide a high level of UX [Aliyu et al., 2014]. One of the key aspects of UX in fintech is the simplicity of service use. Customers want to access their finances without the need to fill out numerous forms or undergo lengthy identity verification procedures. Fintech companies strive to make registration on their platforms as quick and easy as possible. This helps attract new customers and increases the likelihood that they will become active users [Akinwale, Kyari, 2020].

The goal of this article is to explore the main aspects of improving user experience, as well as to develop recommendations for the development of IT services in the banking sector, which has led to several research objectives: analysing user behaviour in fintech-expectations and preferences of users in the field of digital financial services; analysing the user experience of a selected digital financial service, conducting UI/UX studies; developing recommendations for improving the UI/UX of the digital financial service and assessing the effectiveness of the implemented changes in user experience.

1. Literature Review

User experience optimisation is the process of enhancing user satisfaction with websites and applications. This involves improving usability, increasing accessibility, and boosting the effectiveness of user interactions with the site or app. The goal of optimisation is to make the site or app user-friendly and valuable, avoiding any confusion for users [Alexander et al., 2017]. User experience design focuses on how customers use a product [Barquin, Vinayak, 2016]. In this context, a product is not just a commodity or service; it also includes the content offered to customers.

There is a wide range of research methods in the field of user interaction, from laboratory studies of user interface usability to more recent methods, such as unmoderated online UX assessments (see Fig. 1). Each measure helps distinguish research in terms of the questions they address and the goals for which they are best suited.

To better understand when to use which method, it is helpful to consider them within a three-dimensional framework with the following criteria:

– evaluative and behavioural;
– qualitative and quantitative;
– context of use [Mohamed, Ali, 2018].

The difference between evaluative and behavioural metrics can be characterised by contrasting what people say versus what they do, with these metrics often differing significantly. The goal of evaluative research is to understand or measure people's stated subjective assessments. This is why evaluative studies are widely used in marketing departments.

Most usability research should rely more on people's behaviour, but methods in which users directly report information can often be quite useful for designers. These methods focus on studying what people say and can be presented in the following forms:

– card sorting: provides insight into users' cognitive models of how they perceive an information space and can help choose the best information architecture for a product, application, or website;
– surveys: assess and classify opinions or gather data based on users' responses; they can help identify or track important issues that need to be addressed;
– focus groups: generally less useful for studying user interface usability for various reasons but offer the most important insight into what people think about a brand or product concept in a group setting.

Fig. 1. Common research methods

There are also methods that evaluate user behaviour. These aim to understand what people do with the product or service being studied [Banker et al., 2006]. Such methods include:

– A/B testing: shows changes in website design to a random sample of visitors, aiming to keep everything else constant to observe the impact of different design variants on behaviour;
– eye-tracking: focuses on understanding how users visually interact with interface designs.

Combining these two completely opposite metrics provides a mix of the most popular methods: usability testing and field research [Ofodile, 2019]. These methods combine user-reported data and information about their behaviour. They may lean more towards one of these metrics, but it is generally recommended to prioritise the behavioural side.

Another approach involves qualitative and quantitative metrics. Qualitative and quantitative metrics have substantial differences that go beyond the narrow view of qualitative metrics as 'open-ended,' such as opinion surveys with open-ended questions [Perry, 2017]. Qualitative research gathers data on behavioural patterns or evaluations based on direct observation. In turn, quantitative research relies on the indirect collection of data on the observed behaviour or evaluations through surveys or analytical tools [Stewart, Jurjens, 2018].

For example, in field studies and usability testing, the researcher directly observes how people use (or do not use) technology to meet their needs. This allows for asking questions, exploring behaviour, or even adjusting the study protocol to better fit its goals. Such data analysis is usually not mathematical. On the other hand, quantitative methods typically rely on mathematical analysis, as the data collection tool (e.g., a survey or web server log) covers vast amounts of data that are easily programmable into numbers.

Since qualitative and quantitative methods are fundamentally different in nature, the questions they answer also differ [Storvang et al., 2020]:

– qualitative methods are much better suited to answering questions about why and how to solve a problem;
– quantitative methods are much better at answering questions that begin with 'how much' and 'to what extent.'

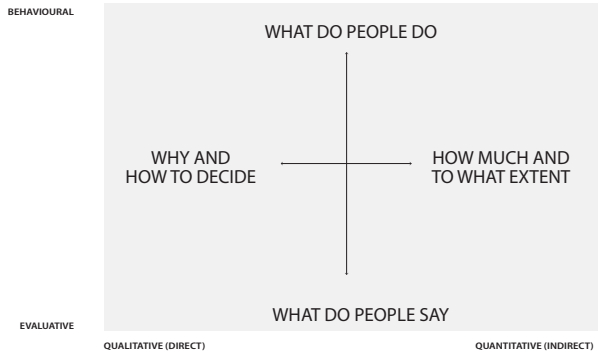
Having these criteria helps prioritise resources, such as focusing on issues that have the greatest impact.

Figure 2 shows how the first two metrics influence the types of questions asked.

The context of use relates to how and whether the study participants use a specific product or service. It can be described as follows:

– use of the product in a natural or near-natural environment;

Fig. 2. Questions for research methods in a three-dimensional structure



– use of the product according to a scenario;
– non-use of the product during the study;
– a combination of the above [Sue, Ritter, 2022, pp. 122-148].

Studying the use of a product in a natural environment aims to minimise research interference to understand user behaviour or judgement as close to reality as possible. Using a product in a natural environment ensures greater credibility but less control over the research subjects [Oyefolahan et al., 2019]. Many ethnographic field studies attempt to use this indicator, although there are always some observational errors. Quantitative examples of this indicator include random surveys, data analysis, and other analytical methods.

Scenario-based product use studies are conducted to focus on specific aspects of use, such as a newly designed process. The accuracy of the scenario can vary significantly depending on the research goals. For example, usability comparative analysis typically has a very strict scenario, and it is more quantitative, thus providing reliable indicators of interface usability.

Studies in which the product is not used are conducted to explore issues beyond use and usability. These include studying the brand or broader cultural traditions [Varga, 2017].

Method combinations involve a mix of product use methods to achieve specific goals. For example, co-design methods allow users to interact with and move design elements to discuss which solutions best meet their needs and why they made such a choice. Such interaction with design elements can also become an experience with the product.

Concept testing methods apply a rough approximation of a product or service, where the essence is (without knowing the details) to understand whether users want such a product or service and whether they need it.

Most methods in the scheme can move along one or more indicators, sometimes within a single study, usually to achieve multiple goals.

For example, field studies can focus on what people say (ethnographic interviews) or what they do (extended observations); preference assessment and card sorting

have both qualitative and quantitative versions; eye-tracking can be conducted with or without a scenario.

In conclusion, it can be noted that user experience plays a key role in improving IT service efficiency. The approaches, tools, and technologies discussed in this section will help companies enhance user experience and achieve greater results in their activities.

2. Research Methodology

In today's digital age, a mobile banking app is essential for banks to remain competitive and meet their customers' needs. Mobile banking is no longer considered an additional feature but an integral part of banking and financial service provider operations. With a mobile app, banks can improve overall customer service quality, attract and retain customers, and gain valuable analytics.

The following methodology was used to answer the research questions: in the first stage, an analysis of the issues was conducted, and a product passport was created, which included the 'Business,' 'Users,' and 'Product' sections. An expert assessment of the current user experience of the bank's mobile app was then conducted. In the second stage, UX/UI research of the mobile app was carried out, including qualitative and quantitative studies, based on which hypotheses regarding the mobile app's functionality were created. In the third stage, benchmarking was conducted to identify best practices, processes, or methods and apply them to improve features and achieve a high competitive advantage for the client. In the fourth stage, recommendations for product improvement based on user experience research were developed; in the final stage, feedback collection and effectiveness evaluation were conducted.

To create the 'Business' section of the mobile app passport, several key questions need to be answered: What problems is the business currently facing, and why is the product needed? What goals is the business currently setting to solve these problems? What numbers does the business want to see in the future? What currently generates the main revenue for the business? What should become the revenue source for the future product? What is the business currently spending on? What does it plan to spend on when developing the product? After answering these questions, the first section of the bank's mobile app passport is formed (see Fig. 3).

Next, the 'Users' section was considered - it allows us to define the target audience of the product, its needs and problems that the product should solve, analyse behavioural patterns and preferences of users, describe user scenarios of product use and key functional requirements (Fig. 4).

The final section of the product passport is the 'Product' - it includes the main features and functionality

Fig. 3. Product passport – 'Business' block

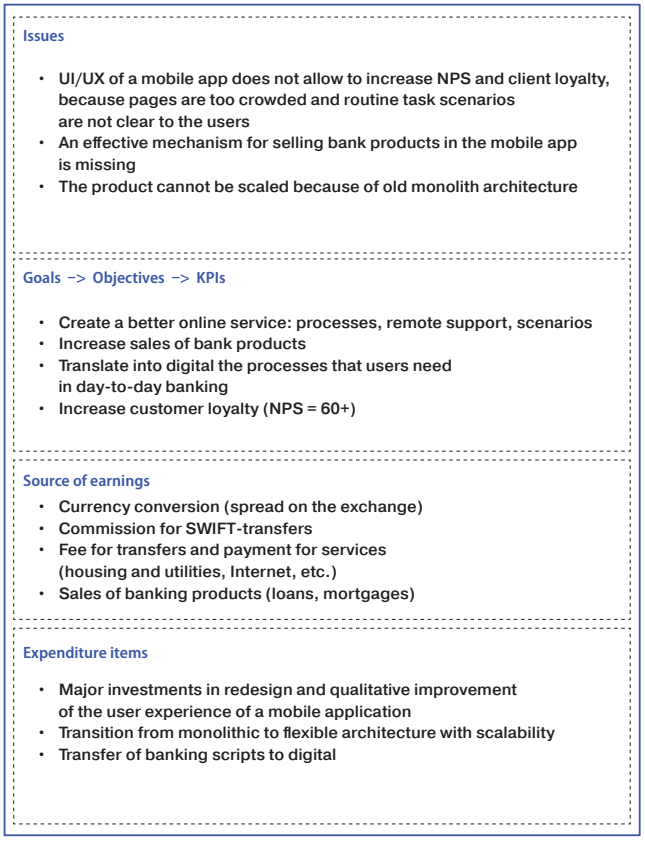
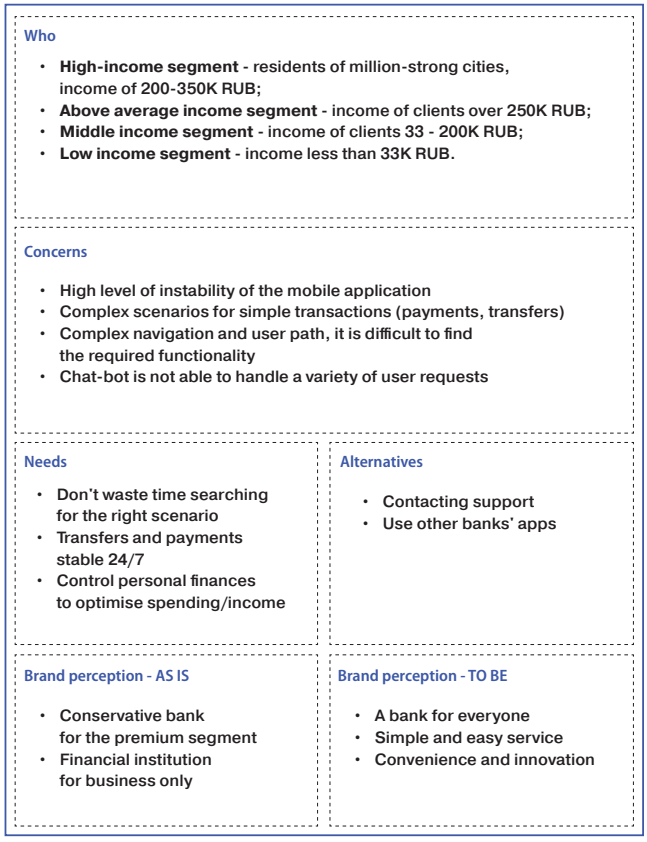


Fig. 4. Product passport – 'Users' block



of the mobile application, technical specifications and requirements for the product, as well as the product development plan, its life cycle and monetisation strategy (Fig. 5).

An expert assessment of the current user experience of the bank's mobile application was then conducted (Table 1). The table presents the criteria, a description of the current state, and an evaluation on a five-point scale, where: 1 - low level (of maturity/development of the criterion); 2 - satisfactory; 3 - average; 4 - good; 5 - high.

The average user experience rating of the bank's mobile application is 2, which indicates a low level of user experience maturity and can significantly affect customer satisfaction and the effectiveness of app usage.

Complex navigation, long wait times for operations, outdated design, frequent errors and crashes, lack of personalised recommendations, and limited options of communication with the bank can create a negative impression for users. This can lead to a loss of trust in the bank, a deterioration in user experience, and even loss of clients to competitors.

To improve the user experience, it is necessary to conduct a thorough analysis of the app's problems and shortcomings, develop a strategy for enhancing user experience, and implement the necessary changes [Bano, Zowghi, 2014]. Only by doing so can the bank increase the maturity level of the user experience, ensure customer satisfaction, and attract a new audience.

Fig. 5. Product passport – 'Product' block

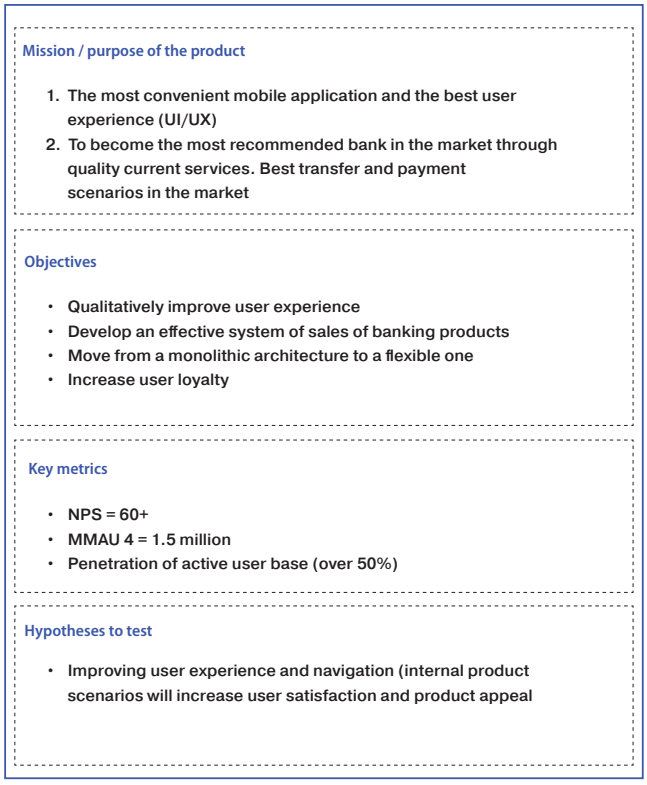


Table 1
The current state of mobile banking user experience

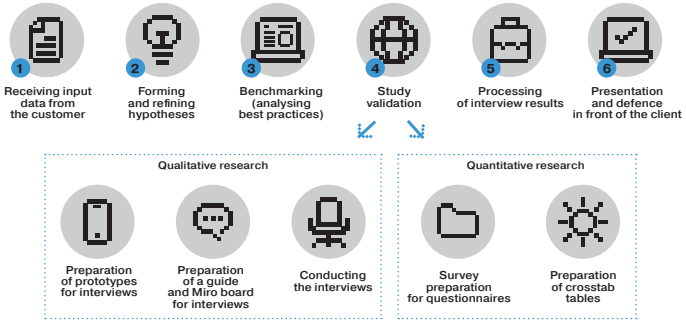
Criteria name	Current state of AS IS
Ease of use	
Easy navigation and intuitive interface	Complicated navigation, overloaded application screens, for example, the main screen has too many banners that make it difficult to access the card, the card and account are displayed separately, which confuses the user
Brevity and clarity of textual information	Errors in the texts on banners and messages, the user has access to basic information about banking services and operations
Ease of access to the main functions of the application	Complex scenarios, additional time required to find the necessary functionality. For example, personal information is located in the 'More' section, where the user expects to see rare operations
Overall expert rating of usability	2
Speed at which tasks are completed by the user	Long wait times when performing operations in the application
Accuracy and completeness of the information provided	Too many steps and unnecessary actions needed to complete simple transactions, such as housing and communal services payments, transfers between own accounts, etc.
Overall expert rating of effectiveness	2
Attractiveness	
Design and visual design of the application	Outdated design, components of varying sizes, and no consistent style throughout the mobile application.
Using colours, fonts, and graphics	Insufficient use of graphic elements and colour solutions
Emotional impact and creation of a positive mood	Lack of positive visual impact on the user, such as the absence of high-quality graphic elements and illustrations. The entire application is designed in dull tones, with a bright yellow colour as the only contrast, and there are no smooth transitions between screens.
Overall expert assessment of attractiveness	1
Reliability	
Absence of errors and failures in the operation of the application	Errors occur when performing standard operations
Quick bug fixes and app updates	Fixing bugs and updating the application takes a long time because of the old architecture, which does not allow for quick changes
Overall expert rating of reliability	3
Personalisation	
Consideration of user preferences and interaction history	No consideration of user preferences
Offering personalised content and recommendations	Personalised recommendations and content are absent
Ability to customise the interface and functionality for specific needs	Limited customisation options for the app's interface and functionality (minimal set of filters, all interface elements are static), for example, on the main screen, you can hide the card/product.
Overall expert rating of effectiveness	2
Overall rating on all the criteria	2

3. Methodology of UX/UI Research of Mobile Application: Case Study on Notification Centre Functionality

The goal of any UX/UI research is to create a product that is intuitive, easy to use, and meets user needs.

The subject of this article is the process of managing user experience and developing IT services in the banking sector. To obtain more accurate results, banks conduct UX/UI research for each functional block of the mobile application separately. Such research requires a comprehensive approach to analysing user experience, which focuses on user needs and expectations, the effectiveness of each function, and interface details. The stages of the research process are demonstrated in Figure 6.

Fig. 6. Stages of UX/UI research



Let's consider conducting a UX/UI study using the example of the 'Notification Centre' functionality in the bank's mobile application.

The Notification Centre is a key point of contact between the bank and the customer, where users can receive notifications and special offers related to various products. This section of the mobile app stores all notifications and push alerts. Users have access to different types of notifications: marketing, informational, transactional, and service-related. The bank also offers products with personalised terms for each client. The basic pattern for displaying the entry point to the notification centre is a bell icon located in the top right corner of the main screen.

The bank continuously collects feedback on the functionality within the mobile application, which has revealed several shortcomings affecting usability and informativeness for users. Users have noted that the current notification mechanism is inconvenient due to the lack of categories and colour indicators, making it easy to lose important notifications among the large number of marketing messages. Furthermore, most users paid little attention to recommendations where personalised bank products were featured, as the offers were not sufficiently informative, and the product cards in the old design were not compelling enough to encourage users to click through for more detailed information.

It became necessary to define the development trajectory for the notification functionality in the mobile bank to increase sales conversions through the Notification Centre.

To achieve this goal, the following tasks need to be completed:

- determine which types of notifications should be displayed in the Notification Centre;
- revise the structure of notifications to make them more informative;
- categorise the notifications in a way that is clear to users;
- propose scenarios for opening new products through notifications;
- compare competitor solutions and identify patterns applicable to the bank.

The quality of the research depends on the expertise of the participants, so it is important to plan the role model for the project in advance (Table 2). The number of experts for each role depends on the scope of the functionality being studied. For the study of the Notification Centre, one specialist per role is sufficient. The key role in the research is played by the methodologist, who is responsible for building all processes within the team, ensuring the outcome, and possessing high expertise in the subject area being studied [Pals et al., 2008].

Table 2
Role model on the research stream

Role name	Area of responsibility
Methodologist	Formulating and tracking research methodology Deciding on the timing and methods of research in the project Communicating with the bank's team regarding methodology and research results/ conclusions
Researcher	Conducting the entire research cycle (business briefing with the bank, hypothesis formulation, interview guide preparation, etc.) Analysing data and preparing/presenting results (conclusions)
Business Analyst	Supporting the research process Analysing the competitive market, gathering benchmarking data Analysing product metrics and aligning them with research objectives
Designer	Researching and engineering design layouts Preparing a working prototype Adjusting design layouts for the delivery of results

Next, it is important to form the entire list of hypotheses that will be tested in the interviews. For UX/UI studies, a qualitative research format is used, where respondents are shown a modified prototype based on the proposed hypotheses [McLeod et al., 2007].

The global hypothesis regarding the redesign of mobile application sections is that improving the user experience will significantly increase satisfaction metrics, such as NPS (Net Promoter Score), MAU (Monthly Active Users), and CES (Customer Effort Score).

Other hypotheses for the new screens of the 'Notification Centre' functionality:

1) users know what types of notifications from the bank they will see in the app's notification centre;
2) users do not need notifications older than a month;
3) users want important notifications to be separated from others so that when viewing new notifications, they immediately know what to focus on;
4) when users enter the notification centre, they want to see a simple list of notifications from the bank (without filters and search), as it is important to see only new notifications;
5) when users need to use an offer from the bank received a month ago, they will not search for this notification in the bell icon but will contact the bank manager through chat or check the product showcase;
6) when users need to find a personal offer from the bank, they look for it in the product showcase;
7) users expect the total number of all notifications (counters) in the app to match the number displayed on the app icon.

Benchmarking is conducted based on created hypotheses. Benchmarking is a process of comparing the performance, practices, or characteristics of an organisation with best benchmarks, typically with other companies or industries. The goal of collecting benchmarking data is to identify best practices, processes, or methods and apply them to improve features and achieve a competitive advantage for the client [Ongwae, Duncombe, 2021]. Benchmarking is a comparative table that contains the results of competitive and functional analyses (Table 3).

As seen from the analysis the main pattern across all banks is to put the notification centre on the home page in the top right corner as a bell icon.

Tinkoff integrated the notification centre (bell icon) with the chat. The entry point is hidden within the section, but the icon is still familiar to users. Alfa-Bank, following Tinkoff, moved notifications to chat in newer app versions (bottom navigation menu). Most banks use message categorisation within the 'Bell' section, typically into transactional and informational notifications from the bank, as well as promising proposals. If a bank displays all notifications in one list, this list opens by default. If no general list is available, the first tab in the section is usually for promotional offers. Generally, banks store promotional, transactional, and informational notifications in the notification centre. Search functionality for notifications is mostly absent in banking apps.

Another pattern for receiving specialised bank offers: users receive product notifications in a special tab within the notification centre. It's worth noting that the indication resets when entering the section. However, only Bank N requires entering each specific notification to clear the counters. Other banks update the count after viewing the notification list.

Based on the insights, patterns, and hypotheses gathered, the researcher forms a guide that includes several parts:

- introduction - greeting and interview instructions;
- first set of questions about the value of notifications, presentation of the notification list, types of tasks associated with notifications, and entry points for resolving them (e.g., what types of notifications do users expect to work with? Can users name (list) types of notifications? How do users categorise messages?)
- second set of questions about user tasks, typical scenarios, and notification centre functionality (e.g., when users open the notification list, what tasks do they want to accomplish? What form of presenting the notification list would help users achieve their goals?);
- third set of questions focused on notifications about new products and personal offers (e.g., how do users respond to notifications about new products and personal offers? What motivates users to take advantage of the offer? What stops them?);
- conclusion and acknowledgements.

The designer creates a prototype and key scenarios based on the guide, which the respondent will go through [Veilleux et al., 2020].

The search for respondents takes place simultaneously with the prototype design. Respondent sample parameters for qualitative testing:

– 7 men and 9 women, aged 28-40;
– 8 persons from Moscow and 8 from St Petersburg;
– 4 respondents with high income (over 220,000 RUB), 4 with above-average income (180,000 RUB+), 4 with average income (100,000 RUB+), 4 with low income (60,000 RUB+);
– not working in IT;
– 8 clients of Tinkoff, Alfa-Bank, Sberbank, VTB;
– 8 clients of Bank N.

Each interview lasted 2 hours; respondents received instructions on setting up the prototype in advance so that they could complete tasks as if they were using the mobile app. The researcher asked all questions and gave all

Table 3
Analysis of Russian banks' mobile applications

Criterion/Banks	Bank N (bank under study)	Tinkoff	Alfa-Bank	Sberbank
Availability of a notification centre	Yes Entry point: Main → Upper right corner → Bell icon	Yes Entry point: Bottom navigation menu → Chat → Upper right corner → Bell icon	Yes Entry points: Main → Upper right corner → Bell icon Chat	Yes Entry point: Home → Upper right corner → Bell icon
Notifications divided into types	We recommend: – Credit rating – Personal offers (loans) Notifications: – List of messages from the bank Charges: – Fines, taxes, utilities	There is no division into different lists depending on the type inside the bell icon. Each message in the general list is marked with an icon corresponding to the type of notification. Transactional notifications from individuals are stored in chat as messages	Segmented: – notifications (not displayed, informative message 'Notifications moved to chat') Offers - Personal offers	Segmented within the bell icon: – My notifications – Joint notifications – Deductions – Credits – Cash – Transfers – Savings
Types of notifications stored in centre	Notification types: – Promotional – Transactional – Authorisation – Informational – Debt Collection	Notification types: – Promotional – Informational	Notification types: – Promotional – Transactional – Authorisation (one-time passwords) – Informational	Notification types: – Promotional – Transactional – Informational
Search and notification filters	No search or filter at the notification centre	No search or filter at the notification centre	No search or filter at the notification centre. While viewing notifications filters available in chat: – Deductions – Credits – Issued invoices – Loan Messages – Bank Messages – Other Notifications	Search available (by keywords without suggestions)
Special offers in notification centre	Home → Top Right Corner → Bell Icon → Recommendations	Home → Open New Account/ Product Home → 'Pre-approved Loan' in user product list	Home → Top Right Corner → Bell Icon → Offers Banner display points for new products are available on the home page and in the 'Showcase' section	Home → Upper right corner → Bell icon
Notification retention period	3 months	2 months	3 months	6 months
Notification counter reset method (what action should the user take to reset the '+1')	To reset the indicator, each unread notification must be opened, and the notification centre revisited	Unread message indication resets upon opening the notification centre and scrolling through the message list	Unread message indication resets upon opening the notification centre and clicking on each offer. Indication in chat resets upon entering the scenario	Unread message indication resets upon opening the notification centre

clarifications, and the analyst recorded the respondents' answers verbatim.

Recording responses in detail (always asking 'why?') is crucial to avoid guessing the meaning during analysis. Moreover, a good guide is not a guarantee of good answers. The business analyst should not add their thoughts when recording respondents' answers; it is better to record direct speech. The more detailed the quote, the more valuable it will be for the research.

After completing all interviews, the final stage includes transcription and interpretation of the interview results. This stage involved:

- crouping notes by logical blocks (general information about respondents, comments on entry points, etc.);
- processing notes within each group (looking for commonalities, trends, or deviations);
- structuring the results as prepared by the researcher;
- formulating conclusions about the confirmation/rejection of hypotheses;
- delivering recommendations for functional development.

Two hypotheses were not confirmed during the study:

- When a user needs to locate a personal offer from the bank, they look for it in the product showcase.
- Users expect the total number of all notifications (counters) in the app to match the number displayed on the app icon.

Respondents noted that all personal offers are either stored in the notification centre or they expect to see them on the main screen as a banner or story. If they previously received an offer but cannot locate it, they will check with the chat.

Respondents did not understand the logic of how bank notifications are displayed on the app icon. If users could customise and select which counters to display on the icon, they would expect 'highlighting' only selected types of notifications. They would calmly accept a situation where the notification bell icon in the app shows more notifications than the app icon itself.

4. Results of the study: improving the user experience of a mobile application

The results of the UX/UI studies indicated that the notification centre, along with the overall mobile application of Bank N, requires a redesign and improvement of the user experience.

Based on the results of the in-depth interviews, the following conclusions can be drawn regarding the shortcomings of the user experience in the current 'Notification Centre' section of the mobile application.

1. Respondents did not choose layouts in the old design or with elements of the old UX/UI when completing tasks.

Table 4
Results of UX/UI research

Hypotheses	Result of the study
Users know what types of notifications from the bank they will see in the notification centre of the bank's app.	Confirmed. Comment: respondents intuitively understand that they can find notifications from the bank in the notification centre, although they are not 100% sure about what specific notifications are stored there. This is because different types of messages are delivered through different channels (push notifications, SMS, chat), and due to how they perceive transactional messages: users also consider them as 'Bank Notifications' (even though they will look for them in the transaction history).
The user doesn't need notifications received more than a month ago.	Confirmed. Comment: most respondents did not think about the retention period for notifications in the notification centre, so some respondents suggested that all bank messages should be stored for as long as possible. However, after a detailed review of examples and tasks in the message list, only cashback information and personalised offers from the bank remained for long-term storage. Respondents assume that offers are valid for about a month, but emphasise that such messages should remain in the notification centre for the entire duration so that they can use them at any time.
The user wants important notifications to be separated from others, as it is crucial to immediately identify what to pay attention to when viewing new notifications.	Confirmed. Comment: users paid attention to filters and noted that this allows them to quickly find the needed message. Respondents emphasised the need for colour coding to simplify navigation in the message list.
When a user enters the notification centre, they want to see a simple list of bank notifications (without filters and searches), as it is important to see the new notifications.	Confirmed. Comment: When users enter the notification centre, they want to see a simple list of bank notifications (without filters and searches), as it is important to see the new notifications.
When a user needs to use a bank offer received a month ago, they won't look for it in the notification centre; they will contact the bank manager via chat or check the product showcase.	Partially confirmed Comment: Respondents will scroll through the notification centre to find the message or write in the chat. However, they won't visit the showcase to search for personalised offers.
When a user needs to find a personalised offer from the bank, they look for it in the product showcase.	Not confirmed. Comment: respondents noted that they are accustomed to seeing bank offers in the form of banners, where products with personalised conditions can expand their options. The 'Showcase' section is not currently perceived by users as a place to store individual offers.
The user expects the total number of notifications (counters) in the app to match the number displayed on the app icon.	Not confirmed. Comment: Respondents did not understand the logic by which bank notifications are displayed on the app icon. Users want to see only the number of important notifications on the icon. Respondents wanted the following notifications to be counted as '+1' on the app icon: – readiness of certificates and statements; – document flow: the bank sent a document for signature; – new charges: utilities, taxes, fines, etc.; – message in the chat from a bank employee

2. Users failed to notice and missed important notifications due to the absence of indicators or colour highlights.
3. The majority struggled to complete tasks, such as finding previously sent specialised banking offers, on the first attempt.
4. Respondents noted the complex structure of notifications in the old design and the lack of separation by the date of receipt.
5. Most users failed to understand the logic behind the counters (the quantitative indicator of new notifications), what is included in the count at the entry point, and the types of notifications.
6. The notification settings scenario was complex, requiring navigation through the 'Profile' or 'More' sections.
7. Most users mentioned that they rarely visit the 'Notification Centre' section due to the inconvenient interface and cluttered screen.
8. Furthermore, the banking offer cards appeared sparse and uninformative; users also noted the lack of adaptation to individual needs-personalisation.

Most of the hypotheses were confirmed, and users liked the prototype with the new functional design. Let's take a closer look at the processed responses within each hypothesis (Table 4).

Based on the tested digital solution (prototype), the bank needs to pay attention to the following recommendations for refining the UX/UI of current solutions in the mobile app [Kola-Oyeneyin et al., 2020].

1. Develop an indication for key notifications in the notification centre - highlight categories that are important to users so they stand out from other notifications. It is recommended to highlight no more than two or three categories related to payments, issued invoices, cashback, and security.

2. To save space, place the date in the upper right corner of the card. For notifications received today, display the time. For messages received within a week - 'Thursday, 12:45.' For older notifications, display only the date, for example, 'December 12.'

3. Separate messages into 'Recommendations' and 'Notifications.' Respondents noted that they are not bothered by promotional banners in the notification feed - it has become a habit to skip banners and continue reading. Advertising notifications can be moved to a separate section and shown by default when entering the notification centre; this way, the entry point for personalised offers remains, helping users quickly navigate the opportunities provided by the bank.

4. It is necessary to review the structure of the banking offer cards and conduct A/B testing.

As a result of the UX/UI research of the notification centre, user scenarios were clarified, entry points and user navigation were refined, and the digital solution was qualitatively tested for implementation.

The new structure includes dividing the section into two tabs: 'Recommended' and 'Notifications.' The 'Notifications' tab provides users with a complete list of notifications, which have colour indications. The colour indication is available for important notifications, including service notifications from the bank. For example, the user needs to update the app, update passport data, or the bank notifies the user when certificates or other documents are ready.

The notification structure includes the following parameters:

– date (sendAt);
– title;
– notification body;
– a link to go to certain screens inside the mobile application (deeplink).

The 'Recommended' tab contains all information about personalised offers and general recommendations from the bank. By default, this tab opens first when entering the notification centre.

Bank offer cards have different parameter structures. The new format standardises the display of information about bank offers for the bank's main products:

1) consumer loans (productType = listLoanOffer):
   – loan name (nameLoan),
   – interest rate (rate),
   – term (term),
   – loan amount (initialAmount),
   – illustration (display according to design);
2) credit cards (productType = listcreditCard):
   – card name (nameCreditCard),
   – interest rate (rate),
   – credit limit (creditLimit),
   – illustration (display according to design);
3) debit cards (productType = debitCard):
   – card name (cardName),
   – card type (cardType),
   – cashback (cashback),
   – illustration (display according to design);
4) savings account (productType = savinAccount):
   – account name (accountName),
   – interest rate (interestRate),
   – deposit and withdrawal conditions (depositWithdrawalConditions)
   – illustration (display according to design);
5) mortgage (productType = mortgage):
   – mortgageprogramname(mortgageProgramName),
   – interest rate (interestRate),
   – mortgage term (mortgageTerm)
   – down payment (downPayment),
   – illustration (display according to design);

6) insurance (productType = insurance):
   – insurance name (insuranceName),
   – type of insurance (insuranceType),
   – coverage amount (coverageAmount),
   – insurance conditions (insuranceConditions),
   – illustration (display according to design);
7) investment management (productType = investment):
   – investment product name (investmentProductName),
   – type of investment (investmentType),
   – minimum investment amount (minimumInvestmentAmount),
   – investment conditions (investmentConditions),
   – illustration (display according to design);
8) management of mutual investment funds (productType = uif):
   – fund name (fundName),
   – fund type (fundType),
   – minimum contribution (minimumContribution),
   – illustration (display according to design);
9) asset management (productType = assetManagement):
   – asset management service name (assetName),
   – service type (serviceType),
   – management structure (managementStructure),
   – illustration (display according to design).

Next, event tracking was implemented in the notification centre, as it is important to collect and analyse data on user behaviour. Event tracking allows monitoring user actions within the app, such as button clicks, screen views, and interactions with various interface elements [Bano et al., 2017]. This data helps understand how users interact with the new functionality structure of the 'Notification Centre' mobile app and which actions they perform most often.

5. Assessment of the Effectiveness of User Experience Improvement

Financial efficiency will be achieved through the enhancement of the user experience, leading to increased user satisfaction and growth in sales of banking products [Bano, Zowghi, 2013].

Based on actual data and a specialised tool in the form of a BI system for product analytics provided by the bank, the following calculations were made:

– Net Promoter Score (NPS);
– Monthly Active Users (MAU);
– Conversion to a target action rate (transition to detailed bank product cards through the notification centre);
– Number of blank screens (error screens) [Oshodin et al., 2019].

To calculate the Net Promoter Score (NPS) for the 'Notification Centre' section, feedback surveys were used. Before the redesign of the mobile app, the NPS was 45%. The NPS is calculated using the formula:

$$NPS = \% \text{ promoters} - \% \text{ detractors}. \quad (1)$$

After the redesign of the mobile app, 350 customers were surveyed by the bank, yielding the following breakdown:

– Promoters who rated 9-10: 245 people (70%);
– Passives who rated 7-8: 71 people (20.29%);
– Detractors who rated 0-6: 34 people (9.71%).

Thus, according to formula (1):

NPS = 70% promoters - 9,71% detractors = 60,29%.

Next, the MAU value for the month following the mobile app redesign was determined using data from the BI system. Before the redesign, the MAU on iOS and Android platforms was 275,000 users, and after the redesign, it increased to 316,250 users, representing a 15% increase.

The conversion rate to detailed bank product cards through the notification centre was calculated using the formula:

$$Conversion = \frac{X_1}{X} * 100\%, \quad (2)$$

where X_1 is the number of users who actually transitioned to the detailed product cards in the 'Recommendations' tab, and X is the total number of users who visited the 'Notification Centre' section.

Before the project to improve the user experience of the notification centre, the total number of users who visited this section was 840,877, of which only 42,044 users transitioned to detailed product cards, resulting in a conversion rate of no more than 5% with the old design. After the redesign, the BI system was used to extract data on section visits and internal scenario transitions. According to formula (2):

$$Conversion = \frac{104\,575}{941\,588} * 100\% = 11,11\%.$$

User experience effectiveness is also influenced by the presence of blank screens (error screens or zero screens) in the mobile app in the 'Notification Centre' section. Blank screens can lead to negative impressions among users, causing confusion and disappointment, which in turn can lead to user loss and reduced conversion rates. Before the redesign, the total number of blank screens was 487, and after the redesign, it was reduced to 162 (a threefold reduction). The number of blank screens was measured using the bank's product analyst and BI system reports.

The results of the calculation of changes in bank N's metrics are presented in Table 5 - before and after the mobile app section redesign.

Table 5
Changing metrics to improve user experience

Metric name	Before redesign	After redesign
MAU (mber of users)	275 000	316 250
NPS (%)	45	60
Conversion to target action (transition to detailed bank product cards through the notification centre) (%)	5	11,11
Blank screens (number of errors/ blank screens)	487	162

After completing the redesign of the notification and recommendations centre within the bank's mobile app, significant improvements in the user experience were noted, as reflected in the project's key metrics. The first significant change was the increase in the monthly active audience (MAU) from 275,000 to 316,250 users, indicating more appealing and engaging content and functionality after the changes were implemented. The increase in the Net Promoter Score (NPS) from 45% to 60% is another indicator of the project's success. The increase in user satisfaction suggests that the new app design and functionality are positively received by the bank's customers, providing an opportunity to attract new target audiences. Moreover, the significant jump in the conversion rate to a target action (transition to detailed bank product cards through the notification centre) from 5% to 11.11% indicates a high-quality structure of the bank's personalised offer cards and the engagement of users in important actions, providing an opportunity to increase sales of the bank's products and services. The reduction in the number of blank screens by three times - from 487 to 162 - also plays a crucial role in enhancing the user experience. The error-free state of the screens helps prevent negative impressions among users and provides them with a smoother and more informative interaction process with the app.

Thus, the redesign of the bank's mobile app 'Notification Centre' functionality has indeed contributed to the improvement of the user experience and the enhancement of the app's key performance metrics.

Conclusion

Improving the user experience in the bank's mobile app plays a crucial role in establishing long-term relationships with customers and ensuring a high level of user comfort and satisfaction. By creating a convenient, personalised, and secure service, the bank aims to provide its customers with innovative solutions that meet modern requirements and expectations [Nugraha et al., 2019].

This study has thoroughly analysed the state of the research object - Bank N and the process of managing the IT service user experience. Benchmarking and a full cycle of UX/UI research were also conducted for the 'Notification Centre' functional block of the mobile app. Based on the analysis of the research results, deficiencies were identified, and suggestions for improving the user experience with the mobile app were made.

As a result, a decision was made to implement a project to develop and redesign the bank's mobile app, which will ensure:

- Improvement of the user experience (increasing the NPS that reflects customers' willingness to recommend the brand to others);
- Increase in the retention rate of the app users;
- Increase in the MAU and improvement in the rate of conversion of users into bank customers.

Directions for future research were also formulated:

- Create information tips for users, where in the app they can view cashback statistics by month;
- Analysis of best practices in fintech shows a trend towards developing banking apps without notification centres or moving the functionality to chats;
- Implement AI tools for generating illustrations in personalised banking products.

Within the project to improve the user experience of the mobile app's notification centre, key system requirements were formulated and grouped according to the FURPS+ methodology. Target mock-ups for the redesign of the notification centre were also developed, key project stages were defined, and the development team was established. The redesign of the mobile app section resulted in positive changes in key performance indicators, demonstrating the feasibility of implementing the project at Bank N. The increase in the active audience, improvement in NPS, growth in conversion, and reduction in blank screens are key indicators of the project's success. The increase in user satisfaction and improvement in metrics following the update indicate the success of the changes made and a more appealing app for users. This may also contribute to user retention and revenue growth.

The project results emphasise the importance of focusing on the user experience and the company's readiness to implement changes to improve service quality. Further monitoring of metrics and user feedback will help continue to improve the app and strengthen its market position.

In developing the notification centre and other functional capabilities of the mobile app, the bank is recommended to:

– Continue to enhance the user experience for sections such as 'Transaction History,' 'Main Screen,' 'Payments and Transfers,' and 'Product Showcase,' based on qualitative testing (UX/UI research);
– Develop user scenarios for the 'Financial Health' functional block to improve users' financial well-being, increase their financial literacy, and make the app a more valuable tool for personal finance management;
– Create an AI assistant to improve customer service, increase user satisfaction, and make interaction with the bank more convenient, efficient, and personalised.

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