



INFLUENCE OF FINANCING INNOVATIONS ON INFORMATION SYSTEMS MANAGEMENT IN THE DIGITAL ECONOMY

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ABSTRACT

In this article, we elaborated on the features and effectiveness of financial support for innovations, which are connected with the improvement of information systems management in the digital economy. We considered the key aspects of the influence of funding for innovation on this process on the example of the leading companies in the sphere of innovative technologies (German SAP and Canadian Celestica). We established approaches of each studied company to the management of these processes and revealed characteristics and opportunities for achieving economic effectiveness within the directions for funding for innovation.

The purpose of this research was to determine the character of the influence of financial support for innovations on the level of the management of information systems of the subjects. For this, we analysed the financial reporting of the companies and utilised the methods of comparative analysis, factor analysis, and correlation analysis.

The novelty of this research lies in establishing the directions for the improvement of financing of innovations to raise the level of the management of digital information systems.



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1. INTRODUCTION

Information systems management became very widespread in the age of the digital economy, for the latter influenced the expansion of their potential, coverage of data flows, and materials of different categories. Digitalisation introduced new types of information needs of consumers (companies, population, and public authorities), the provision of

which became the top-priority task of the IT sphere subjects. The use of information systems in the digital economy allows operating of large arrays of data, creating new advantages for products (services), which further influences the growth of its value-added. Accordingly, this process allows the opportunity and perspective for the transition of companies from an extensive to an intensive economy which is focused on the preservation of resources and the creation and

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application of innovations that create new value and competitive advantages for products (services) and the brand.

The considered process of digital informatization can be effective in the conditions of sufficient funding for innovation, which makes it unique. Financial support for new technologies and processes in the management of various information systems can be provided by the government, public-private partnerships, and private companies. Certain countries and companies are drivers of implementing innovations of certain types and categories, the effectiveness of commercialisation of which is achieved due to the digital economy. The availability of financial capabilities is a mandatory precondition for the creation of new types of management, including in the sphere of information systems.

The goal of this paper was to identify the character of the influence of financial support for innovations on the level of the management of information systems of subjects. For this, we endeavoured to establish the connection between funding for innovations and improvement of the management of information systems of companies of various sectors; and find the features of innovations management in the improvement of the management of information systems in the conditions of the digital economy.

2. EXPERIMENTAL SECTION

The research hypothesis is the statement that stable growth of funding for innovation is a factor in the change of information systems management in the digital economy at the level of companies. The experimental basis of the research is the leading companies in the sphere of the management of information systems in the world.

To reach the designated goals, we used the methods and data on the innovative and financial & economic activities of the leading companies in the considered sphere. Among these data, the key role belongs to reporting and analytical information.

The method of analysis of financial reporting of companies was used to find the indicators of funding for innovation. The comparative analysis was utilised to find the state of the management of information systems of companies within various periods. The factor analysis was applied to find the influence of funding for innovation on the management of the companies' information systems. The correlation analysis was used to find the impact of the indicator of the volumes of funding for innovation on the indicators of effectiveness of digital information systems management (revenues and profit of companies).

The literature review demonstrated the following. Pohlisch (2020) studied the experience of a German company SAP in the sphere of open innovations management, connected with the effective remote interaction of the personnel of an innovative department, digital tools, and information systems that facilitate such practice of R&D.

Xu and Li (2022) dwelt on the possibilities for stimulation of the effectiveness of the influence of implementing innovations and digitalisation on the improvement of the municipal development and structure of territories' industry. The authors showed that a range of stimulators allows achieving an effect from innovations even in the conditions of their limited financing.

Xiong et al. (2023) assessed the capabilities of digital inclusive financing as a stimulus for ensuring the implementation of innovations with limited capital. The provisions of this research are especially valuable for raising the level of the effectiveness of small companies' innovative development.

Li et al. (2023b) studied the financial limitations of innovative development faced by small and medium companies and established the necessity for creating a favourable environment of support for small companies that are focused on the implementation of innovative solutions in various spheres and sectors, including through the capabilities and tools of the digital economy.

Li et al. (2024) identified the list and characteristics of small companies' capabilities in receiving the required funding for innovations with the use of non-traditional sources. Rainatto et al. (2021) elaborated on the features and problems of the protection of intellectual property for R&D, including in the sphere of using the open innovation model.

Li et al. (2023a) provided empirical evidence of the direct connection between digital financing and an increase in the level of implementation of technological innovations, which, in turn, allow ensuring the growth of value-added products (services). The results of the research showed that digital financing can facilitate the growth of the economic activity of regions and territories. Silin et al. (2023) assessed the connection between the components of the innovative development of regional infrastructure, the digitalization of companies, and the growth of the implementation of innovations by entrepreneurial subjects. In the conditions of the current level of two given factors, high indicators of innovativeness are ensured, which leads to the emergence of new offers in the market. This work's important contribution is the empirical justification of the low effectiveness of financing innovations in regions with a high level of the financial and credit market. It was shown that technological investments

might be more profitable in the conditions of certain financial limitations.

Liao et al. (2022) considered the drivers of the growth of digital financing of cities' innovations (by the example of China), distinguishing active business environment, which ensures constant turnover of financial capital; technological level of territories' infrastructure; dissemination of digital financial services in the city. The authors revealed that the simultaneous growth of these components allowed for a high level of opportunities and advantages in financing of cities' innovations. Differences in these factors led to a lack of proportionality in financing innovations in China; in particular, such cities as Guangzhou, Shenzhen, Shanghai and Beijing demonstrate the best results. Other cities of the country have fewer capabilities in this sphere due to insufficient concentration of high-tech business in their territories.

Thus, we see the need to consider effective approaches to funding innovation in the sphere of digital informatization of the economic activities of companies.

3. RESULTS

The influence of funding for innovation on information systems management in the conditions of digitalisation

is considered by the examples of municipal, regional, and national management and within the economic activities of companies (Xu and Li, 2022). The existing arguments in favour of the influence of the two components show that the environment of the digital economy creates new opportunities for technological support and new solutions in the sphere of communications and governance.

We considered the successful experience by the example of the leading companies in various spheres. Attention should be paid to the formation of digital information systems by the German company SAP, which was founded in 1972. It produces corporate software. The company's innovative products are in demand in Europe, Asia, Africa, the USA, and South America. The company is the European leader in the production of this type of IT products and holds 4th position in the world (SAP, 2024a). Table 1 presents the indicators of the influence of funding for innovation on the effectiveness of digital information systems management. In this case, innovations are R&D in the development and improvement of information systems management, which ensures corporate software for various sectors. We considered the total volume of financing R&D, provided in the integrated corporate reports for 2014-2023 as the total volume of investments in the development of information systems.

Table 1. Indicators of the influence of funding for innovation on the effectiveness of digital information systems management in SAP.

	Indicator of the company's activities	Value of the indicator, description
1	The volume of funding for innovation	2014 – EUR 2.3 million 2015 – EUR 2.85 million 2016 – EUR 3.04 million 2017 – EUR 3.4 million 2018 – EUR 3.62 million 2019 – EUR 4.29 million 2020 – EUR 4.45 million 2021 – EUR 5.3 million 2022 – EUR 6.1 million 2023 – EUR 6.33 million
2	Structure of the management of digital information systems, produced and used by the company	Corporate applied software in 2014-2016 was presented by the following: 1) Packages of transition to digital management, including messaging services in corporations; information support for corporate management of the new generation; packages of services of applied management of market cost; 2) Packages of transformation of digital organisation: options for digital space management at the local levels of departments and corporations on the whole; packages for the new realisation of products (services) in the conditions of the selected digital spaces; packages of digital trade spaces management. In 2017, this direction of economic activities included the following: - 26 packages of information systems management, which were classified into three categories: 1) Software for constant support for customers' success (market and financial & economic); 2) Services on the management of the provided software; 3) Software for managing the systems of premium liabilities (for consumers of various categories and sectors); 4) New types of service packages: SAP Data Hub (application for remote management of information flows); SAP S/4HANA (application for the management of financial information with the help of the Machine Learning function); SuccessFactors for effective digital management of labour resources; SAP Fieldglass Live Insights, which allows consumers (companies and recruiting services) to forecast results and variants of achievement of talented employees and applicants. In 2018: 30 packages, 5 of which were completely new. Innovative solutions that were in high demand were applications for the management of start-ups of SAP technology with the

		<p>use of various types of software.</p> <p>In 2019: 22 packages, of which 6 contained new types of services based on innovations developed within the innovative architecture. These were mostly applications for processes of business analytics operations and quick collection, systematisation, and processing of data.</p> <p>In 2020: 31 packages, including 3 completely new ones (applications based on SAP Fieldglass (digital support for the optimisation of HR policy), SAP Ariba (digital organisational & financial support for the functioning of digital trade platforms), and SAP Concur (digital application for corporate and individual management of expenditures (for business events and trips).</p> <p>In 2021: 20 packages (including 3 new ones based on innovative solutions for the control of the digital space of companies).</p> <p>In 2022: 20 packages, including ones focused on services in the sphere of creation and support for digital trade platforms.</p> <p>In 2023: 20 packages, with the main direction being digital solutions in corporate management and implementation of technologies for the reduction of CO2 emissions.</p>
3	Quantitative indicators of the effectiveness of funding for innovation in the management of digital information systems that are manufactured and used by the company	<p>Indicators of effectiveness:</p> <p>- Number of customers:</p> <p>1) Growth of 500,000 over 2014-2016; the number of customers was 2.5 million in 2016;</p> <p>2) Growth of 47.5 million over 2016-2017; the number of customers was 50 million by the end-year 2017;</p> <p>3) Annual growth of 10% over 2017-2023.</p> <p>- Number of services in the sphere of digital information systems management:</p> <p>1) Growth of 1,000 over 2014-2015; the number of services was 5,400 by the end-year 2015;</p> <p>2) Growth of 2,500 over 2015-2016; the number of services was 7,900 by the end-year 2016;</p> <p>3) Growth of 10-15% over 2017-2023.</p>
4	Economic indicators of the effectiveness of funding for innovation in digital information systems management, produced and used by the company	<p>Total revenue (IFRS):</p> <p>2014 – EUR 17,560 million;</p> <p>2015 – EUR 20,793 million;</p> <p>2016 – EUR 22,062 million;</p> <p>2017 – EUR 23,461 million;</p> <p>2018 – EUR 24,708 million;</p> <p>2019 – EUR 27,553 million;</p> <p>2020 – EUR 27,338 million;</p> <p>2021 – EUR 26,953 million;</p> <p>2022 – EUR 29,520 million;</p> <p>2023 – EUR 31,207 million.</p> <p>Profit after tax:</p> <p>2014 – EUR 3,280 million;</p> <p>2015 – EUR 3,056 million;</p> <p>2016 – EUR 3,629 million;</p> <p>2017 – EUR 4,046 million;</p> <p>2018 – EUR 4,088 million;</p> <p>2019 – EUR 3,370 million;</p> <p>2020 – EUR 5,283 million;</p> <p>2021 – EUR 5,376 million;</p> <p>2022 – EUR 1,708 million;</p> <p>2023 – EUR 5,964 million.</p>
5	Pearson correlation coefficient (the connection between the indicator of funding for innovation and Total revenue (IFRS))	<p>0.9467 (high value).</p> <p>We see the positive role of funding for innovation in the growth of the company's revenues.</p>
6	Pearson correlation coefficient (the connection between the indicator of funding for innovation and Profit after tax)	<p>0.2796 (low value).</p> <p>Since there were unpredicted expenditures fur to the influence of external factors, the connection between funding for investments and profit is low.</p>

Source: Prepared by the authors using the materials of SAP (2024a); SAP (2024b), SAP (2024c), and SAP (2024d)

In the course of the analysis (Table 1), we revealed the influence of the indicator of financing of investments on the level of the effectiveness of information systems management in the conditions of the digital economy, by the example of the company SAP. The level of the company's sales revenues directly depends on an increase in the level of innovative development of the offer. The considered company demonstrated trends in the sphere of digital information systems management.

The presented lists of packages of services, produced and sold by the company, were improved as per international trends, support for demand, and attraction of new customers. Though there is a low correlation dependence between funding for innovations and profit, the latter was not the strategic target benchmark of the company.

Analysis of the materials by Pohlisch (2020) showed that the organisation of the development and implementation of innovations in digital information systems in SAP is built according to the model that includes two directions:

- 1) Creation of completely new packages of services by attracted organisations and specialists. The innovation pool of the company is comprised of 100,000 employees working in SAP;
- 2) Improvement of the existing packages of services.

The innovation pool studies market trends and capabilities of the digital economy and develops and implements improved service packages. This direction also includes open innovation management, the development and implementation of which involves the participation of the employees as full owners of the patented solutions. Participation in this model of innovation creation involves a range of organisational

and registration procedures connected with the protection of intellectual property rights (Rainatto et al., 2021).

Further on, we studied the features and effectiveness of financing investments to improve information systems management in the digital economy by the example of a Canadian company Celestica. Celestica is a multinational company. Its main economic activities are focused on the sphere of project support, production and maintenance of hardware digital platforms, and electronics for various sectors of industry. The company has branches in fifteen countries of the world, it works on 50 trade digital platforms (Celestica, 2024d). Table 2 presents the assessment of the influence of financial support for innovations on the effectiveness of improvement of information systems management in Celestica in the conditions of the digital economy.

Table 2. The influence of funding for innovation in information systems management in Celestica in the conditions of digitalisation

	Indicators	Description
1	Types of innovative solutions in information systems management	2013: 1. The use of new technology at automatized lines of the assembly of electronics. 2. New technology in the system of quality control of electronics. 2014: 1. Complex solutions for equipment assembly in the processing industry. 2. Digital application for remote control of the quality of multi-layer printed circuit boards (remote control system). 3. Technology of technical modules production. 4. Modification of automatized assembly lines for electronics. 5. Digital application of project testing of the introduction of electronic products in the market. 2015: 1. Modification of automatized lines of electronics assembly. 2. Technology of testing of automatized lines of electronic assembly. 3. Digital applications for the optimisation of spending of materials and resources in pharmaceutical production (based on AI). 4. Digital solution for quality control and material intensity of construction blocks at the stage at which defects can still be detected and eliminated. 5. Technologies of industrial packaging production, which conform to the requirements of sustainable development. 2016: 1. Technology of logistics procedures management at companies that produce electronic products. 2. Digital solutions for control over the adaptation of R&D in various sectors of industry. 3. Digital solution for modelling the introduction of a new type of products of electronic industry in the market. 4. Digital solution for adapting the design of products and packaging as per set final parameters. 5. Digital solutions for the management of service departments around the world. 2017: 1. Improvement of automatized lines of electronics assembly. 2. Implementation of innovative components of technological lines of storing products of the pharmaceutical industry. 3. Digital solution for the search for partners in the sphere of logistics. 4. Technologies of primary processing of products and raw materials of the food industry. 2018: 1. Innovative solutions for communication of remote employees of company branches. 2. Digital solutions for materials science management. 3. Digital solutions for the management of trade processes at the level of several trade platforms. A chatbot technology is used in this solution, for processing orders and communication. 4. Modification of the automatized lines of waste processing (including installation of CO2 traps. 2019: 1. Digital solutions for the management of change in materials and resources in production and components for the communications sphere. 2. Digital applications for transfer and analysis of data in special formats. 3. Improvement of automatized lines of the assembly of electronic products. 2020:

		<p>1. Technology of full-system assembly of ten types of electronics that are used in industry. 2. Technology of production of complex mechanical components for large automatized complexes (processing and chemical industries). 3. Improvement of ten types of automatized lines of the assembly of electronic products due to the implementation of quick testing components. 4. Digital application for remote testing of products in the sphere of ICT.</p> <p>2021: 1. Technologies for large centres of data processing of the IT sector. 2. New-generation routers. 3. Digital app for automatized remote connection of customers. 4. Digital app for automatic processing of messages from social networks.</p> <p>2022: 1. Digital app for the management of projects in the sphere of electronic production and further logistical support for the system. 2. Technology of remote processing of messages and information flows. 3. Automatic controllers of product quality (processing and pharmaceutical industries).</p>
2	Share of the volume of funding for innovation in total revenue, including	
2.1	Forecasted	2013 – 0.3 % 2014 – 0.3 % 2015 – 0.4 % 2016 – 0.4 % 2017 – 0.4 % 2018 – 0.5 % 2019 – 0.4 % 2020 – 0.5 % 2021 – 0.7 % 2022 – 0.6 %
2.2	Factual	2013 – 0.3 % 2014 – 0.35 % 2015 – 0.41 % 2016 – 0.41 2017 – 0.41 % 2018 – 0.51 % 2019 – 0.48 % 2020 – 0.52 % 2021 – 0.7 % 2022 – 0.64 %
3	Revenue	2013 – USD 5,796.1 million 2015 – USD 5,639.2 million 2016 – USD 6,016.5 million 2017 – USD 6,110.5 million 2018 – USD 6,633.2 million 2019 – USD 5,888.3 million 2020 – USD 5,748.1 million 2021 – USD 5,634.7 million 2022 – USD 7,250 million
4	Funding for innovation	2013 – USD 17.4 million 2014 – USD 19.7 million 2015 – USD 23.2 million 2016 – USD 24.9 million 2017 – USD 25.1 million 2018 – USD 33.6 million 2019 – USD 28.4 million 2020 – USD 29.9 million 2021 – USD 38.4 million 2022 – USD 46.3 million
5	Gross Profit	2013 – USD 389.5 million 2014 – USD 405.4 million 2015 – USD 391.1 million 2016 – USD 427.6 million 2017 – USD 417.8 million 2018 – USD 430.5 million 2019 – USD 384.7 million 2020 – USD 437.6 million 2021 – USD 487 million 2022 – USD 636.3 million

6	Pearson correlation coefficient (the connection between the indicator of funding for innovation and Total revenue (IFRS))	0.6846 (medium level of influence).
7	Pearson correlation coefficient (the connection between the indicator funding for innovation and Profit after tax)	0.8683 (high dependence).

Source: Prepared by the authors using the materials of Celestica (2024a), Celestica (2024b), and Celestica (2024c)

The above analysis showed that Celestica, unlike SAP, is peculiar for the high influence of the growth of funding for innovation on such indicator of the effectiveness of digital information systems management as Gross Profit. In this case, there was no goal of covering the large share of the market, but there was a focus on Gross Profit. This strategy allowed the company to effectively function in the conditions of the changing trends of the digital economy. At that, new strategic priorities enabled the situation when the growth of funding for innovation (which is in high demand) led to the growth of the volumes of Total revenue (IFRS) and an increase in the company's market share.

4. DISCUSSION

We proved the hypothesis on the direct dependence of two considered indicators and showed that the capabilities of innovative development in the conditions of digitalisation are connected with an increase in financing. It also conforms to the provisions of scientific studies on the direct connection between the implementation of leading innovations and financial capabilities (Li et al., 2023b). The conditions of the digital economy lift off the barriers that hindered companies' entering markets in the past and slowed down the growth of demand for their products (Xiong et al., 2023).

A comparison of the strategic approaches of the leading companies in the IT-sphere demonstrated the effectiveness of using the market (focus on the growth of sales revenues and an increase in the market share) and financial approaches (focus on the indicator of sales profit). The research on the activities of Celestica showed that at the current stage it, similar to SAP, demonstrates an inclination towards the market approach. The focus on such an approach is primarily shown by large companies, while small and medium companies have to take fewer risks to support a sufficient level of profitability. If there are no sufficient offers in the sphere of investing, it is possible to ensure

a positive business image, which would allow receiving non-traditional funding. This requires the achievement of such advantages as growth of productiveness, reduction of external financial dependence, reduction of the level of operational risks, transparency and openness of corporate information (Li et al., 2024), and the strategy of adapting to the new conditions of digitalisation of the main economic spheres (Galoyan et al., 2023). The realisation of these advantages can become a precondition for the first stage of implementing innovations with the help of financing from non-traditional sources, allowed by national law. Further stages will enable such subjects of entrepreneurship to raise their potential and ensure financing at the level of the banking system.

5. CONCLUSION

We studied the connection between the growth of funding for innovation and an increase in the effect of their implementation at the level of digital information systems management in the leading companies in the IT sphere. It is possible to state that entrepreneurial subjects' striving towards the achievement of corporate goals is the key driver of progress in the sphere of innovative development in the conditions of the digital economy. Strategic goals (growth of revenue, market share and sales profit) drive the companies' striving towards the search for new innovative solutions. Digitalisation and its tools help find new models of innovative growth, and digitalisation's capabilities allow avoiding barriers connected with financial limitations and territorial barriers. Dealing with the latter allowed many companies to preserve business and ensure consumer demand in the conditions of forced distancing measures during the COVID-19 pandemic.

Financing innovations could be ensured with the help of traditional sources (bank credits, own funds) and new digital finance. The use of the latter provides new opportunities for small and medium companies that desire to introduce new products (services) in the markets.

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