Innovation as a Success Factor in IT – the Role of Software Supporting Digital Transition

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Abstract

The article presents the specificity of innovativeness in software development companies in Europe from the perspective of its connection with Industry 4.0/5.0 technologies and closed versus open innovation methods, as well as its role in innovation systems. Empirical research in 142 European computer programming companies shows that they are involved in the development of software supporting the digital transition. The findings also show that high innovation in collaboration with external partners as well as closed innovation are success factors for the software industry. Consistent strategic management and wastage reduction are also important. Further promotion of the software industry as an intermediary in innovation systems is recommended. The methods used were literature review, web survey and statistical and econometric analysis.

Keywords: software industry, digital innovation, innovation system, knowledge intensive business services, strategy

1. Introduction

The aim of this paper is to analyse the impact of innovativeness on the success of computer programming companies in Europe and the role of software supporting digital transformation in the innovative efforts of IT companies. We present the results of a survey of 142 European software development companies.

Computer programming (CP) is a high-tech industry that is crucial for today's innovativeness. It is innovative itself and supports the innovativeness of other industries. As such, it belongs to the sector of knowledge-intensive business services (KIBS), which are an important component of innovation systems, but are not included in the existing concepts of triple, quadruple and quintuple helix innovation models. These models show the helixes of science, business, administration, as well as users and the natural environment, represented by environmental activists and other actors [1,2]. We show an additional helix in the innovation system model that includes intermediary institutions such as KIBS, clusters, pro-innovation infrastructure (technology parks, incubators, technology transfer centres) (Fig. 1). CP companies are an example of advanced KIBS that support the innovative capacity of all other types of companies and the entire economy undergoing digital transformation. The digital transformation of industry is visible in the use of digital innovations associated with Industry 4.0/5.0 technologies. Digital technologies supporting digital transformation are technological process innovations according to the OSLO

Manual [3]. Progress in the implementation of digital technologies drastically changes products, processes and business models, i.e. innovations [4]. Digital technologies related to Industry 4.0 and 5.0 include the Internet of Things, big data analytics and cloud computing, artificial intelligence, robotic process automation, augmented and virtual reality, blockchain, digital twins of factories and people, autonomous vehicles, sensors and cybersecurity or green IT [5].

The following research questions are examined in this article:

RQ1. What is the innovation intensity of CP companies in Europe, RQ2. Whether computer programming firms in Europe are involved in the development of software that is the basis of digital innovations related to Industry 4.0/5.0, RQ3. Whether this type of software is an important part of IT companies' innovation efforts, RQ4. What type of innovation, closed or open, based on collaboration with external partners, is characteristic of CP enterprises, RQ5. Can CP firms be considered as intermediaries in the innovation system? We also test the hypothesis H1 that innovation is a crucial factor that increases the probability of good and very good development prospects of firms, accompanied by specific strategic and wastage management. Strategic objectives are often associated with firms' innovative efforts. In an era of hypercompetition, cost efficiency is as important as creating new value for customers. Strategies aimed at swimming in a "blue ocean" without competitors, i.e. aimed at radical innovation, are based not only on adding some new features to products/services, but also on reducing some of the standard features, thus allowing cost optimisation [6]. In IT, lean management is becoming a dominant management concept [7].

On 12 April 2024, we found 35 articles in Web of Science with the title "innovation", among which we searched for those with the terms "software" and "digital transition". We analysed articles related to the field of economics and computer science. However, their topic is often not related to the software industry. The articles found analysed innovation supported by innovation management software; digital innovation but from the perspective of companies implementing digital technologies; digital business model transformation; data-driven innovation; analysis of specific digital technologies such as those related to the future internet, social robots or green innovation supported by digitalisation. In Scopus on 14 June 2024, we found 25 articles containing innovation and digital transition in the title, abstract or keywords, among which we found those containing the term "software". However, none of them referred to the CP industry.

In fact, only two of the articles found in the bibliometric analysis were related to innovation and digitalisation from the perspective of IT companies. In [8], the authors analyse the changes in the business models of software vendors in the light of the digital transition and the use of cloud computing technology for digital innovation, which changes the business processes of software vendors. Cloud computing has changed the business processes of user companies, but it has also changed the activities of the software industry. In [9], the strategic behaviour and collaboration in digital innovation ecosystems involving digital innovation firms is considered [9]. Thus, our article fills the gap in the analysis of the innovation process in IT companies and its links with digital technologies.

2. Literature review

Innovation is a new or significantly improved product or business process, but also social innovation, eco-innovation, systems innovation and public innovation. Innovation is new value that satisfies human needs and, in the case of business, generates revenue. The recent OSLO Handbook on Innovation [3] provides new recommendations for measuring innovation, changing and adapting the definitions to include a broader vision of innovation-generating entities, now including social and public organisations, and emphasising the systemic nature of innovation. However, business innovation remains the basis of innovation systems and the main source of growth of economies.

The reductionist approach to innovation implies closed innovation. In the closed model, innovation is based on human resources, in-house R&D and self-financing by firms aiming to be first to market with new products for which they secure intellectual property rights [10]. In this model, producers view R&D as covering the value chain from design to technology. Thus, in-house R&D substitutes for any potential contribution from users as innovators [11]. The concept of open innovation (OI) relies on extensive collaboration between external entities and the firm, integrating external and internal knowledge [12]. The OI concept implies that both knowledge and skills can be created or used outside the boundaries of the firm. For example, internal research may be complemented by external research. It is not necessary to be the first in R&D in a particular field to achieve positive results. For a company to benefit from open innovation, it must have a business model that integrates external and internal knowledge and thus values collaboration with external partners [12]. The OI concept is based on absorptive capacity, that is, the ability of organisations to recognise the value of external knowledge, assimilate it and use it to create new value [10]. In this article, we examine how closed and open innovation models are related to the innovation intensity and development prospects of CP firms.

The sextuple helix model of the innovation system [13] takes into account the role of intermediary institutions, which has been omitted from previous models of the innovation system (triple [1], quadruple and quintuple helix models [2]). Brokers facilitate the diffusion of knowledge as well as independently generate innovations. Intermediaries and pro-innovation infrastructure facilitate contacts between science and business. These are such organisations as technology transfer centres, technology parks and clusters, as well as knowledge-intensive business services (KIBS) - such as computer programming companies.

The development of the Internet has made it possible to involve users more closely in the innovation process and to create social networks and initiatives. Public administration has started to support and manage the development of innovative systems and is now becoming an active entity inventing new solutions in the field of social and public innovation (participatory budgeting, new solutions in the field of road systems in terms of autonomous vehicles, smart cities, etc.). Environmental organisations and movements are now also agents of innovation systems representing the natural environment [13]. In the most advanced innovation systems, co-creation and interdisciplinary efforts are crucial. The aim is to connect different units of innovation systems so that they develop new solutions to societal challenges. Moreover, current technologies and knowledge are too complex and extensive to be known by individual entities, so networking is often required in innovation processes. The sextuple helix requires appropriate conditions, such as a pool of skills provided by an education and training system, so that society can generate and/or use new solutions. It also relies on funding at the idea stage. In addition, transport and telecommunications infrastructures are important for the exchange of knowledge. Regulations facilitate the implementation of innovative activities. Finally, innovation systems are rooted in a specific culture and history, which influence their development path (Fig. 1). We used this concept of innovation system to indicate varied potential partners of CP firms in innovation processes as well to check their intermediary role in the innovation system.

KIBS are commercial enterprises that operate at the interface between science and industry and can therefore be regarded as knowledge brokers. They are also innovators themselves. Interaction with KIBS is particularly important for companies that develop radical innovations, such as the bundling of services with products [14]. KIBS are often high-tech service providers. They have stronger links to science than traditional sectors, while interaction with KIBS promotes innovation in traditional companies. KIBS are companies that provide services with high intellectual added value, mainly to other companies [15]. The first type of KIBS are traditional professional services that are intensive users of new technologies (marketing, advertising, etc.). The second type is KIBS based on new technologies, such as software and other computer-related activities. KIBS are knowledge-intensive services with a consulting - problem-solving function that is highly interactive and individualised for the client. The activities of KIBS can be described in terms of a knowledge cycle involving KIBS and their clients. It comprises three basic phases: the acquisition of new knowledge, the recombination of knowledge and the transfer of knowledge to the client. Knowledge acquisition is based on interaction with customers through learning in the process of solving customer problems. In the second phase, the previously acquired knowledge is processed, partly through codification, and the newly created knowledge is refined. This allows KIBS to create its own market to a certain extent. Finally, the application of knowledge in the form of new and improved services allows a partial transfer of knowledge to customers. The dissemination of knowledge is linked to new opportunities for interaction and knowledge creation, thus creating a feedback loop.

The relevance of KIBS for the innovation system is twofold: directly, through the innovativeness of KIBS as a provider of new knowledge, and indirectly, through the impact on the innovativeness of customer companies [15, 16, 17]. For example, CP firms become more innovative through the implementation of digital technologies, such as cloud computing, and their innovation also includes the development of software for these digital solutions, which are later implemented as digital innovations by their customers.

The latest changes in industry and the economy as a whole are linked to digital transformation. The terms used are Industry 4.0 or 5.0. However, these changes are driven by computer programming companies that respond to their customers' needs by developing software that supports digital transformation. This software and the innovations resulting from its use can be called digital innovations. In the era of Industry 4.0, digitalisation encompasses a wide range of data operations, digital interfaces, automation and connectivity [18, 19]. Firms' growth and innovation increasingly depend on their ability to analyse large amounts of data from systems, business processes and products in real time. Methods for analysing big data sets turn the collected data into information for decision making.

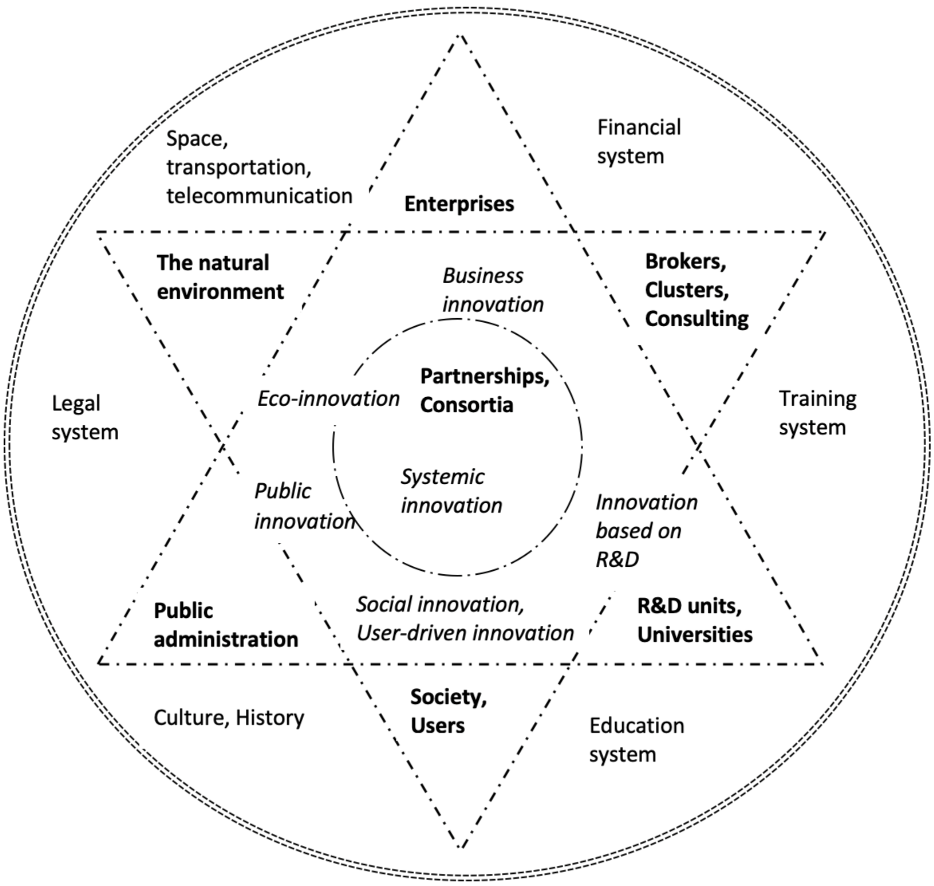

Fig. 1. Innovative system according to the sextuple helix model. Source: [13]

Cloud computing is the use of shared IT resources made available over the Internet. In virtual reality (VR), users are transported into a virtual world, usually with a set of headsets and goggles, while in augmented reality (AR) applications show the illusion of layers of graphical information superimposed on a particular part of the user's field of view. The combination of both technologies is mixed reality. In smart factories, cyber-physical systems monitor physical processes, create a virtual copy of the physical world and make decisions. Based on the Internet of Things, cyber-physical systems communicate and cooperate with each other and with humans in real time [20].The Internet of Things is the direct communication between machines and things. Industry 4.0 is also about the extensive use of artificial intelligence, and therefore robots. Examples include autonomous vehicles and drones. The data and information shared as part of Industry 4.0 solutions must be protected by cybersecurity solutions. Blockchain technology is a new business-to-business settlement system and proof of identity. New digital solutions are based on wireless connectivity and sensors [7]. Quantum computers currently exist as experimental models, but business applications are being developed. They are based on the principles of quantum physics for information processing, enabling much faster performance than conventional computers [22].

Businesses must digitise to remain competitive. Sustainability requirements to reduce waste and pollution are also driving the development of new digital technologies. The fourth revolution is related to mobile technology, machine learning and artificial intelligence. It is characterised by widespread access to the internet, a decrease in the cost of digital storage, portable devices, smart sensors, the use of renewable energy sources and artificial intelligence [21, 23]. The Fifth Industrial Revolution is about the combination of humans and machines. It also emphasises clean industrial technologies that promote sustainability and conserve natural resources [24, 25].

Innovation is not only technological development driven by competition, but also a range of strategic options that enable a firm to maintain and develop a particular form of production [26]. Entrepreneurial strategies are those that enable people to be innovative, creative and accountable for their decisions. Therefore, the diffusion of strategic capabilities throughout the firm and the empowerment of individuals to actively participate in the strategic management process are critical to the development and implementation of strategies [27]. Innovating actors engage in discursive strategies to create and manipulate the meaning of modern technologies, products and services. In doing so, they seek to change formal and informal institutional environments such as norms, practices, knowledge and relationships [28]. Strategic intelligence [29] relates to top management, teams and the organisation. Organisations with different levels of strategic intelligence can be identified by the impact of their strategic behaviour in a particular business ecosystem. Strategic behaviour is the result of strategic decisions made by members. Strategic thinking is a dynamic process that continuously influences mission, strategy and operations in relation to customer and market needs [30]. Strategic thinking needs to be integrated with the context of action [31]. In the research, we asked the computer programming companies whether their strategy takes different forms, from more formalised to more informal and emergent. We examined which forms of strategic behaviour, in addition to innovativeness, are associated with better development prospects for firms.

3. Data and Methods

In December 2023-January 2024 we sent an online questionnaire to about 20 thousand computer programming firms in Europe and received 142 responses. We sent the survey to all computer programming companies registered in the Orbis database[1] that have an e-mail address. The questionnaires were sent by the IT Centre of the University of Gdansk. Questionnaires were sent to companies in both English and the native language. Questionnaires were sent to Polish companies in Polish only. We received responses from Poland, Estonia, Hungary, Lithuania, Bulgaria, Slovenia, Slovakia, Romania and the Czech Republic, which we define as Central and Eastern European (CEE) countries. From the Western European (WE) countries, we received responses from Portugal, Finland, Germany, the United Kingdom and Norway. The highest number of responses came from Poland - 40, followed by Portugal - 20, Finland - 20 and Germany - 17. Of the respondents, 115 were CEOs or directors or owners, while the rest were IT project managers or IT specialists. Low response rate causes that the results may be treated only as opinnions of the respondents about their organisations and we cannot generalize them to the whole CP industry in Europe. Moreover Polish companies are overrepresented.

In the survey we asked respondents about the perceived innovation level: the percentage of software development projects that are innovative in nature (development of software that is significantly different from existing software on the market or significant changes to your own software).

[1] https://login.bvdinfo.com/R0/Orbis

We also asked whether the software developed by the firms is related to the following areas: virtual/augmented reality, blockchain and/or cybersecurity, autonomous vehicles and drones, smart factories, reduction of environmental impact, wireless communication, quantum computers and big data or cloud computing. In this article, we analyse whether the CP companies surveyed are developing software related to the digital transformation of industry and the economy. We took into account both relatively widely used technologies as Wireless communications as well as emerging such as Quantum computers. We believe the latter could be the source of a new industrial revolution. We wanted to check which of the digital technologies are the subjects of CP firms' software development projects.

We then aksed with which partners from the six helixes of the innovation system the respondents cooperate. We asked precisely about cooperation with 1. Firms: a. customers multinational corporations, other customers, b. technology suppliers, c. competitors: other IT companies, d. companies from other industries other than customers; 2. Administration, 3. Academia: a. universities, b. individual experts from science or outside science, 4: Society: non-governmental organizations, 5. Intermediaries: a. KIBS – consulting firms, b.organizations such as technology transfer centers, clusters, technology parks; 6. Other… We also asked about closed innovation. The responets could choose the option "We do not cooperate, we implement them internally".

The respondents answered also how the company's strategy is created and implemented. We analysed the following options: strategy as a formalised action plan, strategic goals and measures of success are formulated only by the CEO of the company, strategic plans are strictly implemented in business practice, the path of implementation of the strategy is defined only piecemeal, the strategy is a market improvisation, the strategy is formed in the course of operations in the market, the strategy is oriented towards the exploitation of emerging opportunities.

In the questionnaire we also asked about the causes of wastage in companies such as poor communication within the project team, poorly diagnosed customer requirements, overly ambitious schedule, execution of several projects simultaneously, poor distribution of tasks among project team members, lack of effective monitoring and control, overly ambitious customer requirements, excessive tasks of the project manager, too small project budget, insufficient staff qualifications and use of outdated technology. We also asked about development prospects of the companies.

We conducted a statistical analysis of the significance of the differences in the proportions. We used the two-sample test for large samples, depending on the proportion and size of the population in question. In addition, the two-sample z-test for significance of differences in means was performed based on population size and standard deviation [32]. We also estimated logistic regressions to assess whether the development of digital innovation software by enterprises increases the probability of high innovation activity of companies. We also tested whether collaboration in the innovation process increased the odds of high innovation. We also estimated whether innovation and its specific type and form of strategic management, as well as waste, affect the development prospects of firms. Logistic regressions are used to determine which factors increase the likelihood that an explained variable has a certain character. They determine the probability that the explained variable will be 1 or 0, given the parameters and values of the explanatory variables. An odds ratio was calculated to indicate how much more likely it is that a company with a given characteristic will excel in innovation and stand out in terms of development prospects [33].

We also used a path model, which can capture direct and indirect relationships. In a path model, variables in the model are substituted once as explained variables by other variables and a second time as explanatory variables, depending on the concept of the relationships. The result is a set of paths that illustrate the relationships between variables [15].

4. Results

Most of the CP companies surveyed reported that more than 50% of their software development projects are innovative, that is, the software developed is significantly different from existing software on the market or significantly different from the company's own software (42.3%). One in four companies had a share of innovative projects of 31-50% and around 22% of companies had a share of 11-30%. Only about 11% of the enterprises had less than 10% innovative projects. The only significant difference was found between enterprises from CEE and WE, namely a higher share of enterprises with a share of innovative projects in the 11-30% range in CEE. Among the size classes, micro (up to 9 employees) and small enterprises (10-49 employees) had a higher share of companies with more than 50% innovative projects than enterprises with more than 49 persons employed (medium and large). However, the latter had more enterprises with innovative projects in the 31-50 % range. Small enterprises were more likely to have less than 10% innovative projects than the largest enterprises (Table 1).

Table 1. Percentage of innovative software development projects versus type of innovation, good development prospects, company's location and size.

Dimension	**Share of innovative software**				
	More than 50%	**31-50%**	**11-30%**	**Less than 10%**	**n**
The whole sample	42.3%	24.6%	21.8%	11.3%	142
Intensity versus type of innovation and development prospects					
Closed innovation	*3%*	12%**	13%**	6%	(11)
The average number of particular types of innovation partners – open innovation	*2.5*	2.4	2*	1.5*	2.3
Good & vg prospects	*65%*	56%	42%**	38%**	(78)
Differences between firms in CEE and WE countries in innovation intensity					
CEE	38.9%	25%	27.8%**	9.7%	72
WE	45.7%	24.3%	*15.7%*	12.9%	70
Differences between size classes in innovation intensity					
Micro	46.7%*	24.4%	17.8%	11.1%	45
Small	46.6%*	*17.2%*	20.7%	15.5%*	58
Medium and Large	*31.6%*	34.2%**	28.9%	*5.3%*	38
n	60	34	31	16	

Note: n in brackets given for information issues, not used for calculations; ** statistically significant on 0.05 level, * statistically significant on 0.1 level, the statistcaly significant difference of values in the subgroups of a given variable to the value/s of the subgroup in italics. Source: authors calculations in Stata based on the research.

Comparing the types of innovation: closed versus open and the share of innovative projects, only 1 enterprise among the most innovative enterprises did not cooperate with external partners but carried out innovative projects internally. Among the medium innovators, significantly more companies relied on closed innovation. We calculated the average number of the types of partners that the enterprises involved in their innovative projects. Firms with a share of innovative projects above 30% had a significantly higher average number of the types partners than those with a lower level of innovativeness. This means that high innovativeness requires open innovation.

Collaboration with other companies was the strongest: with customers (especially multinationals) and other IT companies as well as technology suppliers and other companies. Another important partner for CP companies is academia: universities and individual experts from academia. This confirms the intermediary role of IT between business and science in the innovation system. Other intermediaries, that is consulting firms and innovation infrastructure, were the third according to intensity of cooperation type of innovation partner for the enterprises surveyed. The fourth-ranked type of partner was administration and non-governmental organisations.

Good and very good development prospects were reported significantly more often by enterprises with more than 50% of innovative software development projects than by those with less than 30% of innovative projects in their project portfolio.

Table 2. Type of software versus innovation, prospects, location and size.

Dimansion	Software, innovation, prospects			Location		Size		
Type of software	**Europe**	**Over 50% innov**	**Good & vg prospects**	**CEE**	**WE**	**Micro**	**Small**	**Medium and Large**
Virtual/augmented reality	*13.8%*	21.7%*	14.1%	15.5%	11.9%	19.1%*	*8.8%*	15.8%
Blockchain and/or cybersecurity	*13.8%*	16.7%	11.5%	15.5%	11.9%	11.9%	17.5%	7.9%
Autonomous vehicles and drones	*5.8%*	8.3%	9%	*2.8%*	9%*	7.14%	5.3%	5.3%
Smart factories	*14.5%*	18.3%	15.4%	*8.5%*	20.9%**	19.1%*	*8.8%*	18.4%
Reducing environmental impact	*18.1%*	21.7%	19.2%	14.1%	22.4%	16.7%	19.3%	18.4%
Wireless communications	*12.3%*	15%	14.1%	11.3%	13.4%	9.52%	17.5%	7.9%
Quantum computers	*2.2%*	1.7%	2.6%	*0%*	4.5%**	7.1%**	*0%*	*0%*
Big data or cloud computing	*34.1%*	33.3%	38.5%	42.3%**	*25.4%*	28.6%	33.3%	42.1%
Management support software	*60.1%*	53.3%**	60.3%	73.2%***	*46.3%*	52.4%	63.2%	65.8%
n	138	60	78	71	67	42	57	38

Note: *** statistically significant on 0.01 level, ** statistically significant on 0.05 level, * statistically significant on 0.1 level, difference to the value in italics. Source: authors calculations in Stata based on the research.

Although management support software is still the main type of software developed by enterprises, software supporting digital transformation is also the area of activity of CP enterprises in Europe (Table 2).

Table 3. Estimations of logistic regressions.

Explained variables	**Over 50% innovative projects**		**Very good and good prospects**	
Explaining variables	Odds ratio(z-statistic)			
Virtual/augmented reality	3.2 (2.10**)	3.2 (2.02**)	.	.
Blockchain and/or cybersecurity	.	1.5 (0.79)	.	.
Autonomous vehicles and drones	.	1.2 (0.24)	.	.
Smart factories	.	1.5 (0.82)	.	.
Reducing environmental impact	.	1.4 (0.75)	.	.
Quantum computers	.	0.28 (-0.88)	.	.
Big data or cloud computing	.	0.9 (-0.26)	.	.
Management support software	.	0.66 (-1.11)	.	.
Cooperation with universities	2.4 (2.06**)	.	.	.
Cooperation with customers	2.2 (2.17**)	.	.	.
Over 49 employees	0.38 (-2.15**)	.	.	.
Number of waste causes	.	.	0.77(-2.24**)	.
Number of innovation partners and over 50% innovative software (interaction)	.	.	1.3(2.14**)	.
Closed innovation – no partners	.	.	15.05 (2.42**)	.
Strategy as a formalized action plan	.	.		1.28 (0.53)
Strategic plans are strictly implemented in business practice	.	.	3.82 (2.31**)	3.35 (2.1**)
The path of implementation of the strategy is defined only piecemeal	.	.	.	1.34 (0.56)
The strategy is a market improvisation	.	.	.	1.09 (0.19)
The strategy is formed in the course of operation in the market	.	.	0.35(-2.54**)	0.44 (-2.01**)
The strategy is oriented to the use of emerging opportunities	.	.	.	1.09 (0.22)
Strategic goals and measures of success are formulated only by the company's CEO	.	.	.	1.12(0.26)
Constant	0.4 (-2.92***)	0.68 (-1.17)	2.4(1.8*)	1.24(0.77)
Pseudo R^2	0.09	0.06	0.14	0.06
n	138	138	137	137

Note: in brackets value of z statistic Chi-square Pearson test, *** - statistically significant on 0.01 level, ** statistically significant on 0.05 level, * statistically significant on 0.1 level. Source: authors calculations based on the research.

CP companies are mainly concerned with big data or cloud computing and software to reduce environmental impact. Several percent of firms develop software related to smart factories, virtual/augmented reality, and blockchain and/or cybersecurity, as well as software for wireless communications. Few companies are working on autonomous vehicles and drones, as well as quantum computing. Among the enterprises that reported the highest share of innovative projects, the share of enterprises dealing with virtual/augmented reality and management support software was higher than in the whole sample. A higher proportion of enterprises in CEE than in WE were involved in the development of management support software and big data or cloud computing. Only in the WE were there enterprises developing software related to quantum computing, and these were only micro-enterprises. More enterprises in WE than in CEE were involved in projects related to smart factories and autonomous vehicles and drones. A significantly smaller proportion of small than micro enterprises were involved in virtual/augmented reality and smart factories.

Specific types of software developed by the enterprises surveyed are, according to the respondents, related to areas such as artificial intelligence, FinTech, EdTech, Internet applications, green energy, paperless, process automation, WAN network acceleration, medical laboratories and psychological and innovation IT systems.

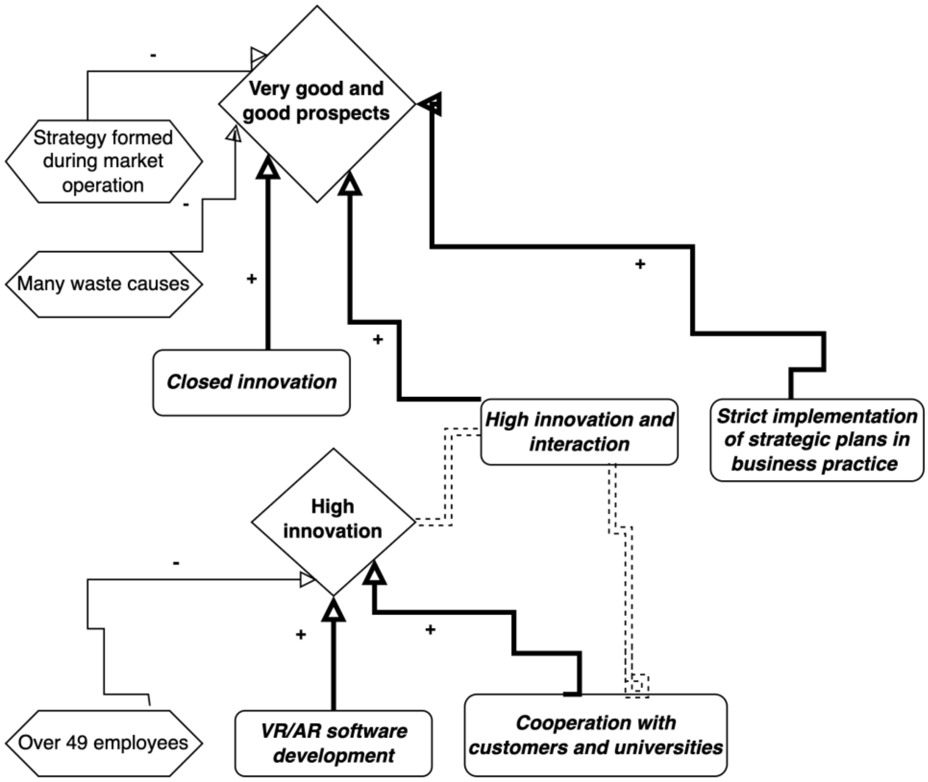

Fig 2. The path of the success factors for the companies surveyed.
Note: + - positive impact, - negative impact; Source: authors based on logistic regressions estimations.

Logistic regression analysis showed that only the development of virtual/augmented reality software increased the likelihood of companies reporting more than 50% innovative projects (Table 3). Other types of technology were not significant. In another model, we included types of partners that in other estimations have been found to increase the odds of high innovativeness, that is, cooperation with universities and customers, as well as the size variable. The results show that there is an increased likelihood of high innovativeness in the case of firms engaged in V/AR, cooperation with universities and cooperation with customers. Being a medium or large firm reduces the probability of being highly innovative.

In another set of estimations, we tested for factors that increase the likelihood of very good and good prospects of the firms reported by the respondents. We created an interaction variable to show firms with the highest innovativeness and the number of innovation partners to reflect the open innovation method used by firms. We also introduced a variable reflecting the number of sources of waste in the firm. We also looked at which types of strategic thinking and management correlate with good prospects for companies. Only the option that reflected consistent implementation of strategic plans increased the chances of an optimistic outlook. The more formal or emergent type of strategy was not important. However, completely unplanned behaviour, in which strategy is formed in the course of operating in the market, had a negative impact on the chances of prosperous development in the future. Finally, we estimated a model which showed that both closed and open innovation increased the likelihood of optimistic prospects as well as the consistency in implementing strategic plans in business practice.

The likelihood of declaring good and very good prospects decreased in the case of strategy formed during market operations and a higher number of causes of waste identified in the organisation (Table 3). Innovation is therefore a success factor for CP companies, as is appropriate strategic management in the form of real implementation of the strategic plan. Furthermore, the elimination of wastage should also lead to better prospects, as more sources of wastage in companies reduce the chances of good development. The multiple regressions carried out in the analysis of the survey data, with the exception of the four presented in Table 3, showed an indirect relationship between the type of digital software developed and cooperation with external partners and the development prospects of enterprises (Figure 2).

The development of V/AR software and cooperation with universities and customers were significant for high innovation intensity in CP enterprises, but insignificant as explanatory variables for good development prospects. However, high innovation intensity, especially when accompanied by a higher number of the types of innovation partners (from customers, suppliers, universities, experts, consultancies, administration, innovation infrastructure such as technology parks) was crucial for good development prospects of the firms. We can conclude that the involvement of CP firms in the development of digital technologies indirectly, through high innovativeness, increases the chances of a prosperous development of the firms. However, high innovativeness requires innovation partners, especially customers and academia.

5. Conlusions

Computer programming companies are high-tech business services that play a crucial intermediary role in innovation systems. This role of software development companies has been confirmed in our research on European enterprises (RQ5). The main innovation partners of the surveyed enterprises are customers, mainly multinational organisations, as well as universities and individual researchers (RQ4). CP companies are highly innovative. None of the respondents reported that their projects were not innovative (RQ1). The software developed by the surveyed firms is often connected with digital innovation, especially big data and cloud computing, software that reduces environmental impact, virtual and augmented reality, and blockchain and cybersecurity (RQ2). However, only software related to VR/AR increased the likelihood of high innovativeness for CP firms (RQ3). High innovativeness further increased the odds of firms having an optimistic outlook (H1).

The intermediary role of CP firms in the innovation system means that when they develop innovative software, they do so mostly for their customers who want to increase their innovativeness. In order to be successful in this, CP companies often establish links with academia. Currently, digital innovation is a critical type of innovation leading to the digital transformation of organisations and the economy.

Both closed and open innovation models have been successful for CP companies. However, external partners are crucial for the highest levels of innovation. Consistent implementation of strategic plans is a success factor for CP firms, along with the ability to innovate. However, strategy formulation during market operations, without prior planning, reduces the chances of very good and good development prospects. Many causes of wastage present in companies, such as poor communication in a project team, multi-tasking, insufficient monitoring in an organisation, also reduce the chances of success for CP companies.

The structure of enterprises engaged in digital innovation software development and, in particular, their growth prospects are largely similar in CEE and WE. Some differences were observed in the shares of enterprises with innovative projects of 11-30%, which were higher in CEE. In CEE, relatively more CP enterprises develop big data or cloud computing and management support software. Firms in WE develop more advanced software related to smart factories, autonomous vehicles and drones, and quantum computing. Smaller enterprises in CP more often have more than 50% of their projects related to the development of innovative software. Micro enterprises mainly develop software related to VR/AR, smart factories and quantum computing.

Our respondents were primarily chief executives, directors and owners of the companies. Therefore, their opinions can be seen as related to the perspective of the whole organisation. However the limitation of the research is the low response rate. The results may be attributed only to the respondents' companies.

Further research on innovation in IT could include types of innovation other than the organisational innovations identified in the research as increasing the efficiency of the intermediary role of CP firms in innovation systems. Perhaps a stronger promotion of innovation networks and innovation infrastructure among CP firms would increase their intermediary role in the innovation process. To some extent this role is visible in the strong involvement of the IT sector in regional innovation strategies in Europe, mostly as a horizontal smart specialisation providing key enabling technologies for other sectors of the economy. As intermediaries in the innovation system, CP companies also need methods to diagnose the digital transition needs of their customers. Such methods would also help to reduce waste in IT projects. In addition, some sort of strategic planning should be present in CP firms, especially in the form of formulating strategic plans that would later be rigorously implemented.

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