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Technological Capital and its Impact on the Level of Innovation Maturity in IT Enterprises: A Quantitative Research in Lubusz Voivodeship in Poland*

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Abstract

In the current turbulent economic environment, innovation is considered a factor ensuring the survival of enterprises. Introducing individual innovations is insufficient; innovations should be developed continuously, and enterprises should improve their innovation activities to achieve subsequent levels of innovation maturity. To achieve this, it is crucial to identify the factors that determine innovation. It turns out that technological capital is one such determinant.
The aim of this study was to examine the relationship between an organization's technological capital and the level of innovation maturity it has achieved.
The research data was collected using two methods: individual interviews, which were supplemented in the second stage with a survey. Seventy IT entities in the Lubusz Voivodeship, Poland, participated in the study.
The study results confirmed the existence of a positive, relatively strong relationship between the technological capital of the surveyed enterprises and their level of innovation maturity.
The study results show that enterprises should take care of the development of the technological capital of the organization, because it can contribute to achieving a higher level of innovation maturity and thus achieving excellence in innovation activities, and thus achieving competitive advantages.

Keywords: technological capital, innovation, innovation maturity.

Introduction

In recent years, many researchers have emphasized the importance of innovation and innovativeness for the development and survival of enterprises. Innovation has become an essential factor enabling enterprises to achieve competitive advantage in constantly changing markets. To meet the expectations of constantly changing markets, enterprises cannot conduct innovation activities incidentally; this activity must be continuous. To achieve this, enterprises must possess appropriate resources, both tangible and intangible, as well as appropriate dynamic capabilities (Inków 2023).

It is worth noting that technological capital is considered one of the ways in which enterprises can implement innovations and contribute to their effectiveness (Ngah et al. 2022, Alazzawi et al. 2018), and the use of technological innovations within organizations particularly supports their innovation activities (Chaoji and Martinsuo 2019). It is also worth emphasizing that technological capital can be a source of both incremental and radical innovations (Klasik and Kuźnik 2019). As early as 1939, Schumpeter (1939) noted that technological change is one of the determinants of change in industry and includes product innovations—the introduction of new products, process innovations—new production processes, and organizational innovations, such as the

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introduction of new management methods in the economic system. In knowledge-based economies, the role of technology is highly valued and is based primarily on information technology. Technological capital is based on both internal and external activities and functions related to the development of products and services in organizations (Mukulu et al. 2016).

The development of technology can be viewed as a kind of Big Bang that has opened up endless possibilities for the world. It is now a crucial tool for achieving excellence in contemporary markets. Furthermore, technology is believed to offer advantages over traditional ways of working, thus delivering innovative products and services. Technology also accelerates operations, thus increasing process productivity (Saleemi 2009, Mukulu 2016).

It is also worth noting that improving an organization's intellectual capital, which includes technological capital, allows enterprises to improve their innovative performance, while poor utilization of intellectual capital leads to poor product and technology quality (Bontis 2000, Narvekar and Jain 2006).
In this study, the author attempts to demonstrate the relationship between technological capital and the level of innovation maturity of IT enterprises.

Technological capital

Technological capital can be defined as a set of intangible assets based on innovations and technical processes, it is based on research and development and IT knowledge (Bueno et al. 2006), it is a combination of knowledge directly related to the development of activities and functions of the technical system of an organization (Martin-de-Gastro et al. 2006), it is derived from technical knowledge and is an intangible asset that is part of the intellectual capital of an organization (Mohtar et al. 2015, Ramezan 201; Ramirez 2010).

McGrattan and Prescot (2009) note that technological capital refers to capabilities and unique know-how accumulated through investments in research and development, organizational capital, and branding. Martın-de-Castro et al. (2006) note that technological capital is a combination of knowledge directly related to the development of the activities and functions of an organization's technical system. As Stachowiak (2017) notes, technological capital can also be understood as a resource of knowledge and skills that leads to a combination of available production factors that allows an organization to improve its production processes and business operations. This is important because it enables the creation of qualitatively new solutions in the field of new products, new processes, technical and technological solutions, and management solutions, which can take both tangible and intangible forms. Ngah and Ibrahim (2011) indicate that technological capital includes information technology, research and development, and innovation. For knowledge to be quickly shared and remain accessible to others, the existence of technological capital is crucial. Collecting, storing and distributing data and information is much easier thanks to technological capital.

Calderón Gómez (2019), in turn, proposes a revision of the concept of technological capital, which he believes can be defined as a subspecies of cultural capital, gaining value in various fields. He proposes treating technological capital as a whole consisting of two complementary dimensions (Fig. 1).

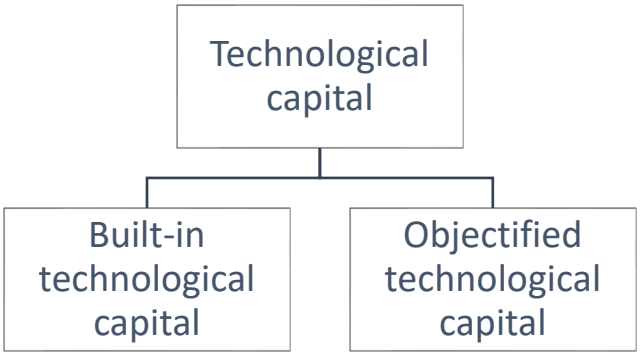

Fig. 1. Components of technological capital

Source: prepared based on (Calderón Gómez 2019).

Embedded technological capital is internalized from the habitat through digital knowledge, skills, and dispositions to use information and communication technologies, developed along the biographical trajectory of the subject.

Objectified technological capital, in turn, materializes through digital devices, equipment, tools, and all physical objects necessary to access the Internet. These objects constitute economic resources in themselves, but they are primarily utilized by people with the ability to use information and communication technologies (Calderón-Gómez, 2019).

To summarize the considerations regarding an organization's technological capital, it can be stated that technological capital is a combination of tangible components, such as devices and equipment providing access to information—i.e., technological resources—and intangible components—the ability to appropriately utilize the tangible portion of technological capital. This is the approach adopted in this article.

It is worth noting that some researchers believe that technological capital is closely linked to the performance of enterprises, as using information technology allows an enterprise to more easily enter the market, streamline product distribution, and improve marketing activities, which in turn should improve the enterprise's performance (Salsabila 2018; Hikmahwati and As Sahla 2022). However, it should be added that developing technological capital and technological know-how in an organization is generally difficult, expensive, and time-consuming. Initial costs are generally very high, but over time, these accumulated knowledge resources become resources for the enterprise, and when they are strategically important, they become distinctive competencies (Kogut and Zander 1996; Inków 2023). It is worth adding that the effectiveness of technological capital requires strong support from top management (Ngah et al. 2022).

Innovation maturity and its measurement

Researchers define innovation maturity as the ability to appropriately utilize available resources, including dynamic innovation capabilities, which are considered a key element of innovation (Niedzielski 2005, Corsic and Neau 2015, Zaleśna 2013, Inków 2023). Innovation maturity can also be understood as the utilization of knowledge for new solutions, as well as autonomy and independence in the implementation of assigned tasks and functions (Morawski 2009). Spoz (2019) stated, however, that innovation maturity is a situation in which an enterprise is aware of the importance of innovation in achieving market success. Innovation is therefore treated here as a permanent element of the enterprise's operational and development strategy. Dewicka (2014), in turn, pointed to the existence of innovation maturity in both employers and employees. An organization's innovation maturity can also be viewed through the lens of its dynamic capabilities, including dynamic innovation capabilities. Higher innovation capability should lead to an increased number of innovations, which in turn leads to a higher level of innovation maturity (Inków 2019).

Tools commonly used to measure innovation maturity are innovation maturity models. These models allow for the assessment of an organization in terms of its level of innovation maturity. A properly constructed model should include a set of levels or stages that describe the development of the entity being studied in a simplified manner.

Description of the research

The study was conducted in the Lubusz Voivodeship, Poland, among IT companies. The research was conducted in the Lubusz Voivodeship because the IT industry is of significant importance to this region. IT companies located in this region offer solutions that are successful not only in the domestic but also global markets. This industry is constantly developing in the region, and its leaders include: Streamsoft, Sygnity Business Solutions (Max Elektronik), Apator-Rector, IMP Poland, HertzSystems, Patents Factory, RTLS (Astec), Meta Pack Poland, SIDIUS, and Rublon (Inków 2023).

The study involved 70 respondents who were owners or members of the management staff of the surveyed entities. The largest group of respondents were the smallest enterprises employing up to nine people (51 respondents), followed by representatives of small businesses (14 respondents), and two medium-sized and three large enterprises. While this structure of the surveyed companies may seem inappropriate, it is nevertheless a result of the significant fragmentation of the Polish market overall.

The study employed two research methods: a structured interview questionnaire, which was supplemented with a survey in the second part of the study. A construct consisting of three statements was used to measure the technological capital of the surveyed companies:

(KT01) The organization has appropriate technological resources to store organizational knowledge and easily retrieve it.

(KT02) The organization has appropriate technological resources to enable continuous connectivity between all organizational members.
(KT03) The organization has appropriate technological resources to promote continuous operation and collaboration with external agents.

Respondents were asked to rate each of these statements on a scale of 1 to 5, where 1 meant "strongly disagree" and 5 meant "strongly agree."

These statements were based on the work of Aramburu et al. (2015). A Cronbach's alpha coefficient of 0.854211201 was achieved during the study.

The author used a model she developed to measure the innovation maturity of the surveyed companies. This model assumes five levels of innovation maturity: Level 1 represents a lack of innovation, while Level 2 represents forced innovation—a company undertakes innovation activities solely because the situation in its environment has forced it. Level 3 represents planned innovation. Companies at this stage begin to recognize the need for systematic innovation work. Consequently, they begin planning these activities, and the foundations for innovative thinking emerge. Level 4 represents innovation management. The company recognizes that its success depends on the success of its innovation activities, has a formally written innovation strategy, strives to build an organizational culture that supports innovation, and creates reward systems for innovation. Level 5 represents continuous improvement in innovation management. Companies that have achieved this level are experienced innovators. The presented model assumes a multi-criteria scoring system for maturity, and companies are classified into specific levels based on the number of points they receive during the study. The study uses a standardized questionnaire consisting of twelve questions. Each question consists of 1 to 16 statements, which respondents rate on a five-point scale, where 1 means strongly disagree and 5 means strongly agree. The first part of the questionnaire concerns the company's innovation activities, the next relates to the company's strategy, knowledge management within the company, organizational culture, and customer relations during innovation development (Inków 2023, Inków 2024).

Study Results

Referring to the technological resources of the surveyed companies (Table 1), it can be seen that they rate the statements regarding technological capital quite highly, indicating that they possess relatively high technological capital. The highest rating was given to the second statement, KT02, with an average rating of 4.4, indicating that the surveyed companies possess adequate technological capital enabling constant connection between all members of the organization. The second highest rating was given to statement KT01, which is also quite high, suggesting that the surveyed companies possess adequate technological resources for storing and easily retrieving organizational knowledge. Statement KT03 received the lowest rating, although this rating is still relatively high. This indicates that the statement that the organization possesses technological resources to promote continuous operation and collaboration with external agents is at least partially true for the surveyed entities.

Table 1. Descriptive statistics for individual items of the technological resources scale, N=70

Variable	Descriptive statistics						
	Mean	Confidence -95,000%	Confidence 95,000%	Median	Variance	Std Dev	Standard error of the mean
KT01	4,028571	3,750351	4,306792	4,000000	1,361491	1,166829	0,139463
KT02	4,400000	4,158468	4,641532	5,000000	1,026087	1,012960	0,121072
KT03	3,814286	3,515167	4,113405	4,000000	1,573706	1,254474	0,149938

Source: (Inków 2023)
KT01-KT03 - individual scale items.

To determine whether there is a relationship between the technological capital of the surveyed enterprises and their level of innovation maturity, the author calculated Spearman rank correlation coefficients for the entire construct of technological capital and the level of innovation maturity of the surveyed enterprises, as well as for individual items of the technological capital and innovation maturity scales. It is worth noting that the correlation coefficient for the entire construct is 0.459339 with $p < .05000$, which is statistically significant and indicates a moderate correlation between the studied variables. Moving on to the analysis of Spearman rank correlation coefficients for individual items of the technological capital scale with the level of innovation maturity, it can be

seen that the highest correlation coefficient was achieved for technological resources used for storing and easily retrieving knowledge (KT01). This coefficient is 0.513345 with p <.05000, indicating the existence of a strong positive relationship between the correlated variables. This result should not be surprising, as the literature has long argued that knowledge and its effective management are very important in innovation activities (e.g., Leszczyńska 2007, Sopińska 2014). It is worth emphasizing that technological resources that help an organization efficiently store and retrieve knowledge are as important as knowledge management, because without them it would be difficult to effectively manage knowledge.

Regarding the correlation between a company's possession of resources enabling constant connection between all company members (KT02) and the level of innovation maturity, there is a moderate positive correlation, statistically significant at 0.406986 p <.05000. This result is also not surprising, as technologies that enable all company employees to be in constant contact significantly improve communication and the flow and exchange of knowledge, which are also indicated in the literature as important sources of innovation.
The lowest correlation coefficient is observed in the correlation between technological resources promoting continuous operation and collaboration with external agents (KT03) and the level of innovation maturity (0.317041). This result is also not surprising; external agents, including external stakeholders, can be an inspiration (e.g., customers) or a source (e.g., scientists from universities and research centers) of innovation, therefore, the ability to maintain constant contact with them seems extremely important.

Conclusion

Summarizing the previous considerations and the results obtained during the study, we can observe a positive, moderately strong relationship between technological capital and the level of innovation maturity achieved by the surveyed companies. Therefore, it can be concluded that technological capital can contribute to the development of innovation activities in IT companies, as well as in other industries, and thus to their achievement of increasingly higher levels of innovation maturity. Although investments in technological capital are costly, companies striving to be innovative should allocate resources for them. As previously mentioned, technological capital not only helps implement innovations more effectively and improves their efficiency, but can also be a source of radical innovations, in addition to incremental ones, which can be of enormous value to the company.

Due to the small sample size, this study provides only some guidance for companies on what they should pay attention to if they want to improve their innovation performance and serves as a starting point for conducting in-depth research in this area in the future.

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