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Model of the impact of intangible resources on the competitiveness of listed companies from the WIGtech index in Poland

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Abstract

Motivation: The complexity of the phenomenon of competitiveness among contemporary enterprises implies the legitimacy of searching for sources of competitive advantages beyond traditional success factors. The concepts of enterprise competitiveness have evolved from classical economics to the present day and theories with a practical purpose such as: the theory of five forces by M.E. Porter and the theory of key competences by G. Hamel and C.K. Prahalad. Nowadays research on the phenomenon of the competitiveness of enterprises seeks answers to the following questions: what is the role of intangible resources in being competitive on the market and what types of intangible resources are the most important from the point of view of the research?

Aim: The aim of the article is to examine the strength and direction of the impact of intangible resources on the competitiveness of listed companies. The article presents a theoretical model of the impact of intangible resources on the competitiveness of listed com-

panies. The case study used for the empirical verification of the constructed model will be joint-stock companies from the Warsaw Stock Exchange selected according to the criteria defined in the article. Statistical data of the tested objects from 2021 will be implemented in the model in order to analyze its stability.

Results: To achieve the aim of the article, the PLS-SEM method of modeling structural equations was used, which allows for the study of relationships between directly unobservable variables. The model consists of two parts: a structural (internal) model and a measurement (external) model. These models are also used in the parameter estimation process — they are interrelated. Two unobservable (hidden) variables were adopted in the constructed model: intangible resources (IR) and competitiveness of companies (CC). Hidden variables were defined based on a potential set of indicators (observable variables). The specification of the PLS-SEM model will make it possible to determine the strength and direction of the impact of intangible resources on the competitiveness of listed companies, based on the theory of key competences. Identification of the most important variables among intangible resources shaping the competitiveness of enterprises will contribute to the determination of theoretical conclusions and practical recommendations for listed companies in Poland.

Keywords: PLS-SEM method; intangible resources; competitiveness of enterprises; high technology enterprises
JEL: C31; E22; G32; O34

1. Introduction

Modeling economic processes requires a comprehensive analysis of internal and external conditions, which are characterized by strong feedback loops. This is particularly important in the context of contemporary circumstances such as: the energy crisis, the economic crisis, galloping inflation, or Russia's aggression against Ukraine. In order to function efficiently, enterprises need stable development conditions. Sometimes situations requiring quick adaptation actions from them can contribute to maximizing profit by accurately transforming the resulting threats into opportunities for the development of companies based on such examples: diversification of activities, expanding sales markets, opening up to cooperation with new contractors. This is visible primarily in industries where products are in the highest demand. This is primarily about new technologies or modern activities. However, also in this case, the other side of the coin is visible, related to the above-average demand for specialists in these industries, causing competition for them, access to information, markets, and innovative solutions. The complexity of the phenomenon of competitiveness among contemporary enterprises implies the legitimacy of searching for sources of competitive advantages beyond traditional success factors. The concepts of enterprise competitiveness have evolved from classical economics and macroeconomic theories to the present day and microeconomic theories with a practical purpose, among others, thanks to the theory of five forces by M.E. Porter and the theory of key competences by G. Hamel and C.K. Prahalad. Research on the phenomenon of the competitiveness of enterprises in the 21st century

seeks answers to the following questions: what is the role of intangible resources in being competitive on the market and what types of intangible resources are the most important from the point of view of the research?

The aim of the article is to examine the strength and direction of the impact of intangible resources on the competitiveness of listed companies included in the WIGtech index. Ten companies were selected for the study. Statistical data comes from their 2021 financial statements. The impact of intangible resources (IR) on the competitiveness of companies (CC) was examined using the PLS-SEM structural equation modeling method, which allows the study of relationships between directly unobservable variables. Non-measurable variables were defined on the basis of a selected set of observable variables. The proposed model specification and observable variables available in financial statements prepared in accordance with the principles of international financial reporting standards (IFRS) enable the implementation of a proprietary model for the analysis of other groups of enterprises.

The article consists of six main parts. After the introduction, a literature review was made, pointing to the key concepts of enterprise competitiveness. In the following part, the PLS-SEM method, its advantages and disadvantages and the justification for its choice are presented. The next section contains the results of an empirical study based on data on selected entities. The results of model estimation, its substantive and statistical verification as well as the analysis of the values of immeasurable variables are presented. The article ends with a discussion and conclusions. The discussion includes an assessment of the results of theoretical and empirical research, as well as the need to continue research. Conclusions show the added value of the article and recommendations.

2. Competitiveness of enterprise

The basic economic mechanism of a market economy is competition. The idea of competition boils down to the competition of groups or individuals to achieve the same goal (Manole et al., 2014, pp. 113–130). Competitive processes appear when resources are limited in relation to demand. Competition concerns not only rivalry for customers, profit and market share, but also for sources of supply of resources and employee capital (Porter, 1979, pp. 137–145). The issue of competition of enterprises is inherently related to the competitive potential, competitive advantage and competing with others. In the world of biological sciences, competition occurs on many levels. The expression of this is the competitiveness of plants consisting in competing for useful properties. Every plant wants to have all the functional characteristics that can affect the usefulness of the plant to the world. The reasons are sought in the genetics, rhythm and strength of plant growth, environmental conditions and in the consequences of interactions between these factors (Jacob et al., 2016, pp. 137–145). Equivalent processes occur when companies compete on the market. The winners are

those enterprises that, at a given time and in given conditions, optimally use their above-average features — competitive advantages.

The literature on the subject offers a lot of wide range of definitions of enterprise competitiveness. In a comprehensive way, it refers to the ability to manufacture and supply products and services more effectively compared to competitors, adding value to enterprise stakeholders (Dwyer & Kim, 2003). It also entails being profitable and holding a leading market position (Lombana, 2006). Competitiveness is often linked to price, product quality, resource productivity, production costs, CSR reporting (Lament, 2016).

All definitions directly or indirectly indicated the main aspects of competitiveness: ability to compete with others by possessing valuable and rare resources.

Currently, in a dynamically changing environment, companies capable of competing on the markets are forced to constantly develop their competitive potential in order to achieve competitive advantages and build a competitive position (Farhikhteh et al., 2020, pp. 13–21; Trąpczyński et al., 2016, pp. 29–50). The moment of offering competitive advantages to the customer is so important that the instruments of competition are an increasingly frequent challenge for enterprises. Scheme 1 illustrates the integrated model of competitiveness, taking into account the subsystems of the company's competitiveness and their characteristics.

Stankiewicz (2005) describes the phenomenon of the competitiveness of enterprises as an integrated system, the first element of which is the competitive potential subject to constant reorganization of the resource structure due to the changeability of customer preferences and needs as well as environmental conditions. The formula of the competitive potential based on tangible resources has exhausted itself with the growing importance of the potential of intangible resources (Wolak-Tuzimek, 2018, p. 1942). It is the intangible resource structure of the enterprise that has become the leading area of research for scientists. In contemporary enterprises, the competitive potential is based mainly on such intangible resources as: knowledge resources and information resources focused on customer needs, brand capital, human capital. To a lesser extent, the competitive potential is based on working capital or physical capital, which is now often acquired in the process of outsourcing (Read et al., 2004, p. 21).

The competitiveness potential is recognized as the basic source of competitive advantage and the foundation for achieving the expected competitive position. The use of the competitive potential of an enterprise allows for building a competitive advantage, which in turn gives grounds for preparing an offer and applying specific instruments of competition. Instruments in the sphere of price and non-price competition allow to achieve a specific competitive position.

On the other hand, competitive advantage (which is always relative) is defined as something that separates the company from others and makes it live and grow. However, the biggest marketing mistake made by enterprises is the incomplete use of their competitive advantages. Some companies assume

that they know their competitive advantage, but in reality they do not. Others do have an advantage but fail to take advantage of it (Smith & Flanagan, 2006, p. 208). Competitive advantage can be understood as the structure of the components of the competitive potential that enable the company to generate effective instruments of competition, i.e. tools and methods of acquiring customers. It is the instruments of competition that are designed to interest contractors in the company's offer and make it evaluated as more attractive than the offer of competitors. The competitive potential is related to the competitive ability (factor competitiveness — contribution to competitive processes), and the competitive position determines the result of the competition processes taking place on the market and the processes of managing the ways of competing that enable the transformation of the potential into a competitive position (Łukiewska & Juchniewicz, 2021, p. 3). It is a place on the scale of economic and non-economic benefits that the company provides to all its stakeholders, compared to the places occupied by its competitors.

In the theory of economics, the issue of competition was already explored by classical economists, who in their considerations narrowed the image of competition to market exchange only, leaving the sphere of production and the sphere of enterprise organization outside the scope of research (Smith, 1977, p. 58). Also, Marx's (1951) considerations on competition were reduced to the rivalry between capitalists, and the researcher himself considered competition as a mechanism balancing the market and determining the incorrect allocation of capital and throwing the economy out of balance. In addition, the founders of the neoclassical school are credited with coining the term perfect competition, which was criticized by Clark (1940, p. 242) as part of the concept of "workable competition". On the ground, among others These considerations resulted in theories taking into account the growing role of intangible resources, i.e. Porter's concept of five forces, the concept of competitiveness based on resources and key competences, and the concepts of key capabilities.

The new approach to the competitiveness of enterprises is a symbol of the change in the view of economists on the importance of intangible resources in building a competitive potential. More and more concepts emerging at that time concerned mainly intangible resources and their potential, which is the result of empirical observation of the economy (Franca & Rua, 2018, pp. 94–197; Pearson et al., 2015, pp. 179–89; Ying et al., 2019). External and internal factors determining the potential and, as a result, the competitive advantage are sought. Porter's concept of five forces was based on the search for distinguishing features of the company, and then on developing a competitive advantage in the structure of the sector. This is the foundation of the evolution of the competition phenomenon. Up to five forces of Porter (2004, p. 22) included: bargaining power of suppliers, bargaining power of buyers, competition within the sector, threat of emergence of new producers, threat of emergence of substitutes. Porter considered competitive forces in the light of competitive strategies. He called competition with others competition. This

has been the case when one or more competitors either succumb to the pressures of the situation or see opportunities to improve their position. However, according to the author, the tools for competition are always the production capacity resulting from the resource structure. Competitive forces are the result of the interaction of economic entities. Porter (2004, p. 34) rightly notes that the actions of one company entail the actions of other participants in the sector, initiating a change in their own and others' position to a more favorable or not. Porter concept helped researchers look at competitiveness from the perspective of the external environment and the formulation of competitiveness strategies. Nevertheless, already in the 1990s, economists criticized classical theories due to the lack of a full explanation of the mechanisms of creating a competitive advantage. In the 1990s, a new concept of competitiveness was created, the so-called resource school. Researchers observing the trends in the development of enterprises at the turn of the 20th and 21st centuries noticed that the specificity of a given market or industry does not allow to determine how companies currently achieve a competitive advantage. When analyzing the resource structure of competing enterprises, it was found that this structure has clearly changed in favor of the progressive diversification of possessed resources. Hence, the company and its resources became the starting point for new concepts, while building a competitive advantage is based on internal predispositions and conditions. The authors of these concepts did not stop taking into account the external environment in their analyses, pointing out that it influences financial results and market success to some extent (Prahalad & Hamel, 1990, p. 62).

At the end of the 20th century, Prahalad and Hamel (1990, p. 62) presented the concept of competitiveness based on resources and core competencies. The authors formulated the following thesis: "In order to achieve a competitive advantage on the market, an enterprise needs not only adequate resources, but also key competences". Key competencies are created at the interface of resources, processes (activities) and abilities (sets of skills). Thus, each company has its own core competencies. According to the authors, such competencies enable the company to achieve the intended results. The work of Barney (1991, pp. 99–120) complemented the above concept. The author gave the strategic resources, considered as specific and unique resources and competencies of the company, the following features: valuable, rare, inimitable, well-organized resources.

The end of the 20th century brought another important concept of competitiveness by Kay (2003, p. 29). He detailed the key capabilities of enterprises, which are factors that allow to achieve long-term competitive advantage. The author distinguished: architecture, i.e. contacts within the company and relations with its environment, i.e. internal and external connections of the company with employees, customers, suppliers and competitors; reputation, i.e. the way customers perceive the company, its activities, image and sales offer, constituting an important information instrument; innovations, i.e. the ability to create

products of excellent quality and the search for optimal solutions in the field of technology and management; innovations can effectively help a company stand out among competitors, and thus be a source of competitive advantage, i.e. strategic assets held by the company.

Summarizing the theoretical considerations, it should be stated that the phenomenon of competitiveness has gained a new face based on the presented theories of competitiveness. The essence of the competitiveness of enterprises tends towards intangible resources and their use. The authors anticipate that the tendency to build a company's competitiveness will increasingly depend on how companies approach intangible resources..

3. Methods

The article hypothesizes that the intangible resources of companies included in the WIGtech index have a strong impact on the competitiveness of these companies. The WIGtech index includes companies from industries including biotechnology, games, IT, telecommunications and new technologies. Both intangible resources (IR) and company competitiveness (CC) are immeasurable (hidden) variables that need to be defined using a set of observable variables. The study of the relationship between them requires the use of an appropriate method that enables the analysis of directly unobservable variables and the relationships between them. Such opportunities include a method of modeling structural equations estimated with the partial least squares method (partial least squares structural equation modeling — PLS-SEM), which is the second generation of the soft modeling method (Perło, 2020; Wold, 1980, pp. 333–346).

The PLS-SEM model consists of two parts: a structural (internal) model and a measurement (external) model, which are simultaneously used in the process of model estimation and verification. This means that the results obtained will depend on both models. The structural model describes the theoretical relationships between hidden variables. It studies the impact of intangible resources on the competitiveness of companies. It is assumed that hidden variables are linear combinations of their indicators. An important element of the modeling process is the specification of the measurement model, related to both the correct definition of hidden variables with the use of indicators, as well as their selection. A deductive approach has been adopted in determining latent variables, which means that economic theory is the starting point for the definition of latent variables, in other words, it is the basis for the selection of observable variables. Then the indicators are called reflective, and the measurement model is called reflective.

The structural model is represented by the following linear equation:

$$CC_t = \alpha_1 IR_t + \alpha_2 + \varepsilon_{1t}, \tag{1}$$

wherein:

CC_t — endogenous hidden variable at time t;
IR_t — exogenous hidden variable at time t;
α_i — structural parameters of the model, i=1, 2;
ε_{1t} — random component.

The diagram of the structural and measurement model is presented in Scheme 2. Hidden variables: endogenous and exogenous have been defined using reflective indicators, which by definition should be characterized by a strong correlation with each other. The structural equation model is estimated using the partial least squares (PLS) method. In this method, the parameters of the measurement model and the theoretical model are simultaneously estimated (Lee et al., 2014, pp. 1705–1722; Servera-Francés et al., 2012; Tenenhaus et al. 2005, pp. 159–205; Wold, 1980, pp. 334–339; 1982, pp. 1–54). As a result of the estimation, in addition to these parameters, estimates of the value of the latent variable are also obtained, which can be treated as a synthetic measure.

According to the stages of the modeling process, before proceeding with the analysis of the results, it should be verified. Testing the PLS-SEM model is a two-stage process. First, the measurement model is verified, and then the structural one. The most important methods of verifying the PLS-SEM model used in the analysis and their reference values are presented in Table 1.

Modeling structural equations using the PLS-SEM method has many advantages. Among them, one can distinguish such functionalities as: testing the strength and direction of the relationship between unobservable variables, as well as the ability to indicate indicators that reflect their latent variable most strongly, or making a linear ordering of the tested objects, based on the results of estimating the latent variables. Another advantage is the possibility to verify the model estimates — both substantive and statistical. Compared to the soft modeling method, the PLS-SEM method has a wider range of model verification methods, which has a significant impact on the quality of the results obtained, and consequently on their interpretation and prediction (Perło & Arszułowicz, 2022, pp. 191–192). On the other hand, the disadvantage of modeling structural equations with the PLS-SEM method is its linear nature. The empirical data of many economic phenomena are non-linear, which makes it impossible to use this method.

The constructed PLS-SEM model was used to analyze the cross-sectional data of selected companies included in the WIGtech index from 2021. The following criteria were decisive for the selection of companies as research objects: the company's membership in the WIGtech index, the company's AAA rating and the largest percentage share in the index. The research sample, which consists of 10 companies, is quantitatively sufficient from the point of view of the method used, and moreover, it is relatively homogeneous, the data obtained on their basis are reliable, which allows drawing more precise conclusions. It is also dictated by the availability of empirical data in the form of financial statements. The WIGtech index was introduced to the Warsaw Stock Exchange only

in 2019. Among the surveyed companies, one company belongs to the biotechnology industry, three represent the IT industry, and the remaining six companies specialize in the production of games. A rating of enterprises at the AAA level proves an exceptionally high ability to pay off its liabilities, which in turn translates into a high ability to invest in new projects. The calculations were made using the SmartPLS program (Ringle et al., 2014) and the MM program by D. Karaś.

Hidden variables: intangible resources (IR) and competitiveness of companies (CC) were defined using a set of indicators that met the substantive and statistical criteria for the selection of variables, and positively verified using all model evaluation methods, including those specific to modeling with the PLS-SEM method. The final set of observable variables is included in Table 2.

The hidden variable IR (intangible resources) was defined on the basis of three indicators. The first is a general cost approach to intangible and legal resources (IR_3) and their representatives within the concept of intellectual capital. The second one — software and licenses (IR_1), should be classified as technological, IT and legal resources within the framework of structural capital. The last one is human resources including development works (IR_2), classified as human capital. Due to the nature of the study, it was not possible to identify relational resources based on the available data.

The hidden variable CC (Competitiveness of enterprises) was also defined on the basis of three indicators — key indicators of financial analysis calculated on the basis of data contained in financial statements, showing the current situation of the enterprise and its ability to compete. The competitiveness of enterprises can be examined in many ways. The classic methods of assessing the competitiveness of enterprises include, among others: 1) SWOT analysis; 2) Porter's 5 forces analysis; 3) Benchmarking analysis; 4) Market analysis; 5) Financial analysis. The article uses the definition of competitiveness based on financial analysis indicators, due to the availability of financial statements. Other methods were not taken into account due to the need to conduct qualitative research, but they will be the subject of further research by the authors of the article.

4. Results

The result of the estimation of the PLS-SEM model parameters are the estimates of the internal and external relations. Estimated parameters have been positively verified in terms of content and statistics, thanks to which their interpretation is possible (Scheme 3).

Due to the fact that a deductive approach was adopted in the PLS-SEM modeling process, the analysis of the results is subject to factor loadings, which are correlation coefficients between the explanatory variables and the latent variable. Most indicators of the hidden variable IR significantly affect it, because their values oscillate between 0.706 and 0.963 (Table 3, Scheme 3). Intangible

assets/intangible assets have the greatest impact on the potential of intangible resources in the surveyed enterprises (IR_3 — 0.963). Pursuant to the *Accounting Act* (1994), intangible assets include: goodwill and other intangible assets, as well as advance payments intangible assets. The surveyed enterprises include categories of intangible assets alternately with intangible assets in their financial statements. However, the idea behind both categories is the same. The results of PLS-SEM modeling also indicate a strong impact of human resources defined on the basis of expenditure on development works per employee (IR_2 — 0.960). Expenditures on development works include expenditures directly related to a given project, which in the future becomes a sales product. Development works in enterprises play a key role in the process of creating new products and the use of more and more effective technologies. The results of PLS-SEM modeling clearly confirm the thesis that development works are a key factor in building the competitiveness of enterprises. Development work is largely the responsibility of human resources, which are responsible for the effective development of projects and, as a result, for future sales revenues. A slightly lower, but also quite significant impact on intangible resources has the last indicator defining technological resources as well as IT and legal resources, i.e. expenditure on software and licenses per employee (IR_1 — 0.706). Technological resources are tools in the process of creating new products. Combined with human resources, they allow enterprises to compete for the client against the background of other competitors. Too low quality of technological resources determines the low level of competitive potential, which in turn may be the reason for not achieving a competitive advantage

The indicators of the hidden variable CC have an even stronger influence than in the case of the variable IR. Factor loadings are between 0.881 and 0.971. This proves the high impact of all observable variables on the competitiveness of the surveyed companies. The CC_1 indicator — return on assets in % (CC_1 — 0.971) has the highest impact on the CC variable. The CC_2 indicator reflects the hidden variable CC in 91.2%, and the CC_3 indicator, i.e. the liabilities turnover ratio — in over 88%.

The results of the external model confirmed the correct — substantive and statistical selection of observable variables defining their latent variables, through their significant impact on IR and CC, both in terms of strength and direction. This is also confirmed by tests for convergent validity, internal consistency reliability and differential validity. In the case of convergent validity, all factor loadings are above 0.7, and mean explained variances (AVEs) are above the critical value of 0.5. Reliability of internal consistency was tested based on composite reliability and Cronbach's alpha. The obtained values (Table 3) are between 0.6 and 0.95, which enables a positive verification of the model in this respect. Differential validity confirmed the correct assignment of indicators to hidden variables (Table 4). The relationship between latent variables is evidenced by the estimates of the internal model.The indicators of the hidden variable CC have an even stronger influence than in the case of the variable

IR. Factor loadings are between 0.881 and 0.971. This proves the high impact of all observable variables on the competitiveness of the surveyed companies. The CC_1 indicator — return on assets in % (CC_1 — 0.971) has the highest impact on the CC variable. The CC_2 indicator reflects the hidden variable CC in 91.2%, and the CC_3 indicator, i.e. the liabilities turnover ratio — in over 88%.

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$$\widehat{CC}_t = \underset{(0.000)}{0.799} IR_t + 0.723,\ R^2 = 0.639. \quad (2)$$

It should be stated that the quality of the internal model is high, as evidenced by the coefficient of determination equal to 0.639. The estimated parameter of the IR variable, p-value of approximately 0.000, can also be evaluated positively. The model also has favorable prognostic properties, as evidenced by the positive value of the Ston–Geisser test, both general and for individual indicators of the endogenous variable CC (Table 5). According to the adopted thesis, the intangible resources of enterprises included in the WIGtech index have a strong impact on their competitiveness (0.799). They are an indispensable element that outlines the priorities of the development potential of the surveyed companies.

As a result of estimating the internal model, we also obtain estimates of the values of hidden variables, which are used to organize objects (companies), indicating the direction of changes in the measured quantities (Chart 1). Most of the analyzed objects have similar estimates of IR and CC latent variables (Scheme 1). Only the CIGAMES and PCF GROUP companies are characterized by slightly different values of the examined latent variables. This is due to the fact that CIGAMES incurred relatively low expenses for software and licenses, while PCF GROUP incurred relatively low expenses for development work — i.e. IR indicators. The reason is mainly the company's strategies in building new projects, which translates into balance sheet values and expenditures on development works. Both companies have completed costly projects in recent years, which will be reflected in product sales in the years to come.

Obtained results have deeper and broader application. The results of the study can also be used to study other sectors of the economy as part of the thesis on the strong impact of intangible resources on the competitiveness of enterprises. Although not all sectors are as sensitive to the impact of intangible resources as the technology sector, their role in building competitiveness in other sectors is still huge and worth examined. What's more, the results can be used for in-depth comparative analysis of companies from the tech sector in other countries. This can help define the relationship of intangible assets in the competitiveness of enterprises at the international level.

5. Conclusion

The conducted research confirms the global trend related to the growing role of intangible resources in the process of shaping the competitiveness of enterprises. The paper (Knut et al., 2000, pp. 52–62) argues that intangible resources contribute differently to competitive advantage depending on level of competition. Authors' results are in line with the mentioned-above thesis that the level of competition distinguishes the contribution of intangible resources to competitive advantage. What's more, not only the level of competition but also the examined sector has got different factors in the relation between intangible resources and competitiveness. Among all groups of intangible resources, intangible assets and development works were the most important intangible factors of the surveyed enterprises. The results of PLS-SEM modeling show that key intangible resources determine the level of competitiveness of the surveyed enterprises. Research in this area using other methods shows a similarly strong relationship between intangible resources and the phenomenon of enterprise competitiveness (Rajchelt-Zublewicz, 2018, pp. 376–389). The ability to compete with others is demonstrated by those enterprises that base their success on: technological resources, development resources with the use of human resources and general intangible resources recognized in financial statements. The surveyed enterprises achieved a high return on investment in intangible resources in the post-pandemic period. This is related to the changing conditions in the global economy. However, in the case of such dynamic changes in the environment, enterprises included in the WIGtech index are forced to constantly observe changes and adapt their resource structure in terms of competitive potential to emerging opportunities and threats. Searching for further causes and measures describing changes in the competitiveness of enterprises at all levels and in all sectors allows to identify key factors. According to technology and innovation report prepared by UNCTAD (2021), frontier technologies represent a $350-billion market, and one that by 2025 could grow to over $3.2 trillion. To put this into perspective, the current global market for laptops is $102 billion and for smartphones is $522 billion. This pattern means that the technology sector is growing rapidly fast. It has and will have a massive impact on global

innovation and society life. Therefore, The technological sector is a kind of signpost for the entire economy.

The next step in the discussion on the study of intangible resources in the process of shaping competitiveness is the question of how to use intangible resources to maximize their potential in the process of building a competitive tech enterprise?

The formulated hypothesis that the intangible resources of technological enterprises have a strong impact on the formation of a competitive enterprise has been positively verified. The analysis of the strength and direction of the impact of intangible resources on the competitiveness of WIGtech index companies showed that intangible assets are the main success factor, but not the only one. Development works combining human resources and technological resources have shown an equally strong impact in the process of building competitiveness. The competitiveness of the surveyed enterprises results from the effective configuration in the resource structure, which translates into the competitive potential, which allowed the companies to achieve a competitive advantage in the form of a high rate of product sales. The recommendation for the surveyed enterprises is to intensify the development of intangible resources, such as: intangible assets, development work and technological resources. By basing their competitive potential on the indicated resources, enterprises have a chance to constantly create competitive advantages, allowing them to compete with others and maintain a high competitive position on the market. The authors of the article pay particular attention to two issues. The first concerns flexibility in building competitive potential. Often, the lack of flexibility in the field of new technologies results in the lack of development in line with the prevailing trends, which in turn causes the company to regress. Emerging AI (Artificial Intelligence) technologies are the technologies of the future, without which it is difficult to compete with the largest enterprises. The second issue concerns the search for and use of advanced configurations of intangible resources, with particular emphasis on the role of the employee and his competence and knowledge. The added value of the article is mainly the use of the PLS-SEM method which is focused on the measurable factors causing the company competitiveness. It gives a lot of scope for application in the future research. The PLS-SEM method of modeling structural equations allows for the study of relationships between directly unobservable variables like intangible resources. This is the new element for the PLS-SEM method that is used in the context of intangible resources and competitiveness. Intangible resources can also be subjected to qualitative research, which is possible thanks to the PLS-SEM method. Authors' further research will be conducted in this direction. This approach is new and very promising nowadays. The conclusions of the analysis clearly indicate that intangible resources are currently the most effective way to be competitive, their potential is unlimited, and there should be more and more holistic research on them Hence, intangible resources are the future of the world.

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Appendix

Table 1.
Key methods of statistical verification of the PLS-SEM model

Statistical verification of the reflective measurement model		
internal consistency	Alfa Cronbacha	0.6–0.95
	ccomposite reliability	0.6–0.95
convergent validity	indicator reliability	>0.5
	average variance extracted (AVE)	>0.5
discriminant validity	cross factors loadings	estimated value of factor loading > values of cross factor loadings
Statistical verification of the structural model		
predictive power	coefficient of determination R^2	>0.5
predictive relevance	value of the test Stone'a–Geissera (S–G)	>0
significance and relevance of path coefficients	bootstrap method and significance tests based on it	significance p<0.05

Source: Own preparation.

Table 2.
List of indicators of hidden variables IR and CC

Hidden variable	Symbol	The name of the observable variable	Unit
IR	IR_1	software and licenses	million PLN per employee
	IR_2	development work	million PLN per employee
	IR_3	intangible assets	million PLN per employee
CC	CC_1	return on assets	%
	CC_2	return on equity	%
	CC_3	liabilities turnover ratio	day

Source: Own preparation.

Table 3.
Convergent validity and internal consistency reliability of observable reflective indicators in the PLS_CC_2021 model

Hidden variable symbol	Indicator symbol	Convergent validity		Reliability of internal consistency	
		Factor loading	AVE	Composite reliability	Alfa Cronbacha
		>0.7	>0.5	0.6–0.95	0.6–0.95
IR	IR_1	0.706	0.782	0.882	0.851
	IR_2	0.960			
	IR_3	0.963			
CC	CC_1	0.971	0.854	0.934	0.915
	CC_2	0.918			
	CC_3	0.881			

Source: Own calculations based on the results of modeling with the PLS-SEM method in the SmartPLS4 program, based on data as in Scheme 3.

Table 4.
Differential validity of observable reflective indicators in the PLS_CC_2021 model

Hidden variable symbol	Indicator symbol	IR	CC
IR	IR_1	0.706	0.588
	IR_2	0.960	0.754
	IR_3	0.963	0.765
CC	CC_1	0.698	0.971
	CC_2	0.614	0.918
	CC_3	0.854	0.881

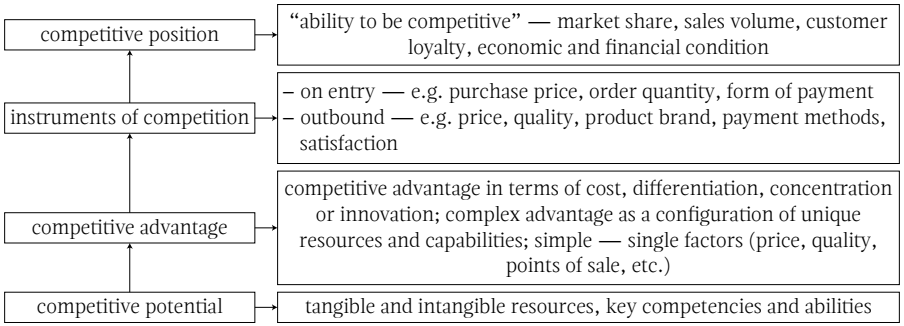
Source: Own calculations based on the results of modeling with the PLS-SEM method in the SmartPLS4 program, based on data as in Scheme 3.

Table 5.
Stone–Geisser (SG) test results

Variable	Test SG
CC_1	0.391
CC_2	0.333
CC^3	0.202
general test SG	0.203

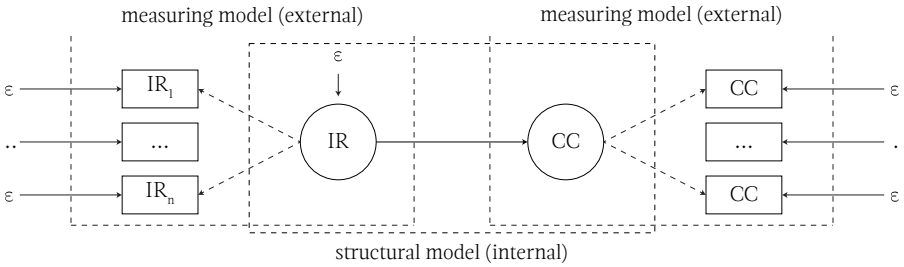
Source: Own calculations based on the results of modeling with the PLS-SEM method in the SmartPLS4 program, based on data as in Scheme 3.

Scheme 1.
An integrated model of enterprise competitiveness



Source: Own preparation based on Stankiewicz (2005, pp. 105–319).

Scheme 2.
PLS_CC_2021 model of the impact of intangible resources on the competitiveness of companies



Wherein:

——→ — internal relationship;

- - - → — external relationship;

◯ — hidden variable;

▭ — indicator;

IR, CC — hidden variables;

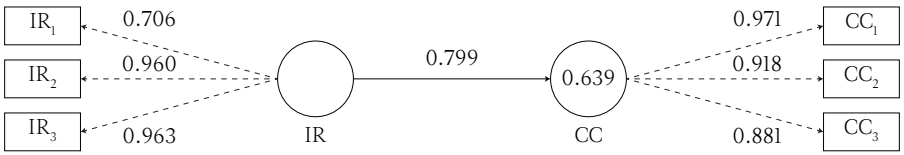
IR_1, ..., IR_n; CC_1, ..., CC_k — reflective indicators;

ε_{ij} — random components in the measurement model, i=1, 2; j=1, 2, ..., n or k;

ε_1 — random component in the structural model.

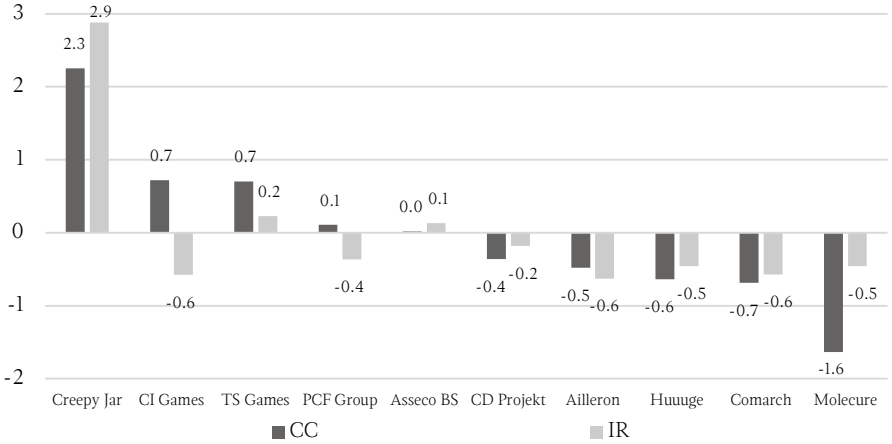
Source: Own preparation.

Scheme 3.
Results of estimation of the PLS_CC_2021 model



Source: Own preparation based on the results of modeling with the PLS-SEM method in the SmartPLS4 program, based on data taken from Ailleron (2023), Asseco (2023), CD Projekt (2023), CI Games (2023), Comarch (2023), Creepy Jar (2023), Huuuge (2023), Molecure (2023), PCF Group (2023), Ten Square Games (2023).

Chart 1.
Estimation of the value of hidden variables IR and CC in 2021



Source: Own calculations based on the results of modeling with the PLS-SEM method in the SmartPLS4 program, based on data as in Scheme 2.