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THE ROLE OF CLUSTERS IN ENHANCING BUSINESS COMPETITIVENESS AND INNOVATION

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Purpose: The purpose of this article is to analyze the role of industrial clusters in enhancing the competitiveness and innovativeness of enterprises, with particular emphasis on collaboration mechanisms and knowledge exchange. The paper describes the cluster concept, outlining its significance from the perspective of classical economics as well as more recent theories, including Michael Porter's theory of competitive advantage.
Design/methodology/approach: The article is based on a literature review and an analysis of cluster theories in the context of their economic functions. The analysis considers aspects related to both the national economy and regional innovation systems.
Findings: Research indicates that clusters play a crucial role in creating an environment conducive to collaboration, allowing enterprises to enhance innovation and efficiency through easier access to resources, knowledge, and technology. The synergy effect resulting from the concentration of businesses and research and development institutions in a single region contributes to intensifying innovative activities and increasing the region's attractiveness to investors. In Poland, grassroots clusters predominate, demonstrating particular effectiveness in the context of local development.
Research limitations/implications: The presented research is theoretical and based on literature analysis. The lack of direct empirical studies limits a full understanding of the specific characteristics of Polish clusters, suggesting the need for further qualitative and quantitative research.
Originality/value: This article provides new insights into the importance of industrial clusters as a tool to strengthen the innovativeness and competitiveness of enterprises. It is aimed at researchers in economics and management, as well as practitioners and policymakers interested in regional and innovative development.
Keywords: business competitiveness, clusters, innovation, regional clusters.
Category of the paper: Literature review.

1. Introduction

Some researchers trace the origins of the cluster concept to the works of Adam Smith (1776). His idea of labor specialization became the foundation for the theory of absolute

advantage in international trade. This theory was further developed by D. Ricardo, who proposed the theory of comparative costs (Ricardo, 1817). Among the representatives of classical economics, A. Smith and D. Ricardo are considered pioneers of cluster theory. However, in the context of neoclassical economics, the figure of A. Marshall—creator of the model of perfect competition—stands out. Marshall's concept of the industrial district explains the benefits of forming clusters. In his 1890 book Principles of Economics, A. Marshall also highlights the importance of the concentration of specialized industries in specific locations (Marshall, 1890). Observations of British industrial districts showed that clusters of firms engaged in a continuous exchange of ideas between the creators and users of machinery. According to A. Marshall, the industrial power of Great Britain was built precisely due to the development of these industrial districts (Martin, Sunley, 2001, p. 7). Through this process, firms benefited not only from favorable location and geographical proximity but also from cooperative and competitive relationships. Marshall's discussion on the significance of location for access to production factors sparked significant interest in this area within industrial economics. Key reasons for the close geographical location of firms include easy access to specialized labor, availability of specialized suppliers, faster information and knowledge flow, and economies of scale. The cluster concept gained popularity through Michael E. Porter, who published The Competitive Advantage of Nations in 1990 (Porter, 1990). Porter focused on clusters and networks of business connections, examining their competitiveness and utility (Skawińska, Zalewski, 2009, p. 19).

Today's economic environment is characterized by increasing complexity and dynamism, posing new challenges for enterprises in maintaining competitiveness and fostering innovation. In response to these challenges, the concept of industrial clusters has gained importance, becoming a key element of development strategies at both regional and national levels (Horzela, 2019, p. 65). Clusters not only enable enterprises to leverage local resources and competencies but also create a platform for collaboration between various entities, including academic institutions, public organizations, and the private sector. Consequently, clusters have the potential to generate innovative solutions and promote sustainable economic development. This phenomenon is particularly evident in knowledge-based sectors, where interactions among cluster participants contribute to intensified research and development processes and technology transfer.

This article aims to examine the role of clusters in enhancing enterprise competitiveness and innovation, with particular attention to the mechanisms of collaboration and knowledge exchange within these structures. The paper discusses competitiveness and innovation from the perspective of cluster definitions and analyzes the role that clusters play in enterprise development.

2. Methods

The study follows a literature review-based qualitative research design, which is appropriate for exploring theoretical frameworks and synthesizing existing knowledge about industrial clusters. This approach was chosen to examine the role of clusters in enhancing business competitiveness and innovation, emphasizing the interplay between collaboration, knowledge exchange, and regional economic development. The article draws upon classical economic theories (e.g., those of Adam Smith and Alfred Marshall) and contemporary frameworks (e.g., Michael Porter's competitive advantage theory) to explore clusters impact. This theoretical grounding ensures a robust analytical framework for understanding clusters functions within local, national, and global contexts. The research relies exclusively on secondary data sources, including: academic articles and books detailing the theoretical underpinnings of cluster formation, reports and policy documents from organizations such as the European Commission on cluster policies and innovation, case studies and empirical findings related to clusters in Poland and other international contexts. Key areas of focus for the literature review included: definitions and types of clusters, the economic benefits of geographic proximity and specialized collaboration, the role of policy and institutional frameworks in supporting clusters.

The author of the paper puts forward several research hypotheses:

H1: Businesses participating in industrial clusters exhibit higher levels of innovation compared to those operating independently.

H2: Geographic proximity of cluster participants enhances knowledge sharing, leading to improved business competitiveness.

H3: Synergistic effects from cluster interactions reduce transaction costs and enhance operational efficiency.

H4: The involvement of academic and research institutions in clusters significantly contributes to the innovation capacity of member businesses.

3. Results

3.1. Competitiveness and innovation in the context of the definition of a cluster

A century after Marshall, M.E. Porter introduced the theory of competitive advantage based on location and the formation of business clusters. Porter's research focused on the international competitiveness of national economies as well as sectoral competitiveness, leading to the development of the "competitive diamond" concept and the territorially rooted industrial cluster. In this model, proximity and the spatial nature of interactions between entities play

a crucial role in achieving sustainable competitive advantage (Brodzicki, Kuczewska, 2012, p. 15). In the context of the aforementioned theories, it is important to highlight that Porter's cluster concept significantly expanded the conceptual framework and provided essential analytical tools for studying market economic structures. This approach underscores the roles of companies, authorities, and other institutions in strengthening competitiveness. The existence of clusters suggests that competitive advantage is influenced by various factors external to a specific firm and even to a given sector. For Porter, the location of enterprises is critical, as it substantially impacts the competitiveness of both the cluster itself and the surrounding region.

According to M.E. Porter, clusters are defined as "geographical concentrations of interconnected businesses, final product manufacturers, specialized suppliers, service providers, firms in related industries, and associated institutions in specific fields that both compete and cooperate" (Porter, 2001, p. 246). This cluster concept allows for the formation and dissolution of clusters depending on the competitive positioning of the sectors they support. Clusters form informally around particular technologies and within specific locations, without relying on formal structures (Margiel, 2014, p. 12). For Porter, clusters represent an industrial complex focused on particular sales and procurement linkages between companies, aiming to reduce transaction costs and enhance competitiveness (Porter, 1998, pp. 213-218). The key determinants of clusters in this framework include: cluster competitiveness, the development of competitive technologies, industry specialization within the cluster, and the synergy effect from collaboration. The most critical aspects of Porter’s cluster concept can be summarized as follows (Porter, 2001, pp. 246-256):

- The presence of clusters characterizes nearly every national economy, particularly in developed countries.
- Clusters achieve critical mass and are competitive within their specialized fields.
- The existence of clusters necessitates new managerial practices, as the overall condition of the entire cluster significantly impacts the development of each entity within it.
- Clusters impose a new role and policy direction on authorities.
- Clusters also serve as a forum for dialogue between companies, government agencies, and institutions.
- Clusters are a driving force for exports and a determinant in attracting foreign investors.
- The firms, sectors, and institutions within a cluster are interconnected vertically, horizontally, or institutionally.
- Cluster boundaries represent a new method of organizing economic data, as clusters extend beyond traditional sectors, encompassing significant linkages, complementarities, and flows of technology, information, skills, marketing, and consumer needs that transcend the boundaries of individual firms and sectors.

The multitude of cluster definitions highlights the complexity of this concept, as well as its diverse nature and approaches. According to R. Martin and P. Sunley, the pragmatic functioning of clusters is currently described through networks of simultaneous causes and effects (Martin, Sunley, 2003, pp. 5-35). Business clusters are one of the many forms of network structures among enterprises, distinguished by geographical concentration, or their embedding within a specific local environment. According to M.E. Porter's definition, achieving competitive advantage for businesses within a cluster is possible due to the local environment, which fosters opportunities and capacities for entrepreneurship, specialization, innovation development, and a distinct strategy based on trust, coordination, and repeated exchanges. These factors, in turn, depend on the social structure of clusters and network relationships within local communities. This concept assumes that the source of competitive advantage for firms derives from benefits available in the local environment, rather than being created by the cluster members themselves. According to Porter's cluster model, five essential conditions must coexist (Skawińska, Zalewski, 2009, p. 173):

- Spatial concentration of entities competing within the region.
- Concentration of enterprises within a single sector or several related sectors.
- Formal and informal collaboration among firms and local institutions, organized both vertically and horizontally.
- Specialization of entities within the cluster.
- Flow of innovation, knowledge, and technology between entities within the cluster.

The key attribute of clusters is the systemic nature of connections linking cluster entities, which allows them to achieve significant external benefits (such as increased competitive potential, investment attractiveness, and economic development) or internal benefits (internalized by individual cluster entities, like lower production costs, improved productivity and profitability, and reduced transaction costs) (Plawgo, 2014, p. 9). It is important to note that not every territorial concentration of industry or agglomeration can be classified as a cluster. Characteristic features of a cluster also include long-standing traditions (rooted in the specific regional environment), substantial social capital (signifying trust and collaboration within a triple-helix structure between businesses, the R&D sector, and local governments) (Etzkowitz, Leydesdorff, 2000, pp. 109-123), cross-sectoral integration, an established market for specialized labor, a concentration of specialized suppliers and subcontractors, and efficient diffusion of tacit knowledge (Brodzicki, Kuczewska, 2012, p. 17). Generally, the benefits and costs of clusters should be considered from the perspective of the firm (micro level), the industry (meso level), and the regional or national economy (macro level) (Brodzicki, Kuczewska, 2012, p. 17).

M.E. Porter identified several main components of a cluster, illustrated in Figure 1 (Lis, Lis, 2011, p. 196). He grouped these components into four main categories of cluster entities, assigning each a specific role. The primary task of each group is to bring innovations to the market. In addition to conducting research, these entities should develop mutual cooperation,

promote the cluster, and lobby for its interests. These tasks also aim to expand the activities and development of all cluster participants (Porter, 2001a, p. 54). According to this framework, the cluster entities include:

- Companies with the objectives of joint research, collective lobbying, social initiatives, and collaboration.
- Government agencies aimed at recruitment, promotion, lobbying, supporting R&D, and providing funding.
- Academic institutions focused on specialized training, targeted educational programs, commercialization, and R&D.
- Informal networks dedicated to lobbying, financing, and commercialization.

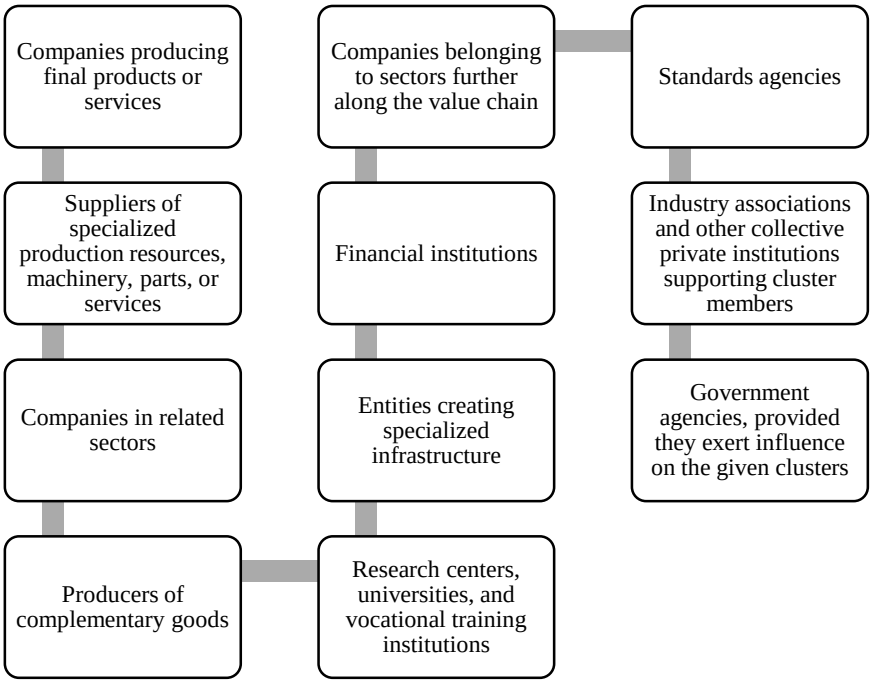

Figure 1. The main components of a cluster according to M.E. Porter.

Source: Own study based on: Porter, 2001, p. 248.

The classification by S. Iammarino and P. McCann suggests that clusters can also be understood as a social network (or "club" model) oriented around social ties and trust, which facilitate cooperation and innovation (Iammarino, McCann, 2006, pp. 1018-1036). This approach to the cluster concept emphasizes the activities of various organizations, with particular attention to civil society (Castells, Hall, 1994, p. 231; Chow, Chan, 2008, pp. 458-465). Key indicators of a cluster in this sense include interdependence, social capital, trust, and relationships. According to I.R. Gordon and P. McCann, a cluster can also be considered a knowledge hub (knowledge cluster) (Gordon, McCann, 2005, pp. 523-543), which is based on the collaboration between academic and research institutions and businesses (Maskell, 2001, pp. 921-943). The objective of such a cluster is to create new knowledge and breakthrough innovations. Key indicators in this approach to defining a cluster are the cluster's values, knowledge management, and resource configuration within the cluster.

Clusters are often also defined by network linkages or specifically as an innovation network (Bucka, 2007, p. 194). In this case, it is assumed that the connection of entities located within the same region through a network of formal and informal interactions facilitates joint R&D activities, sharing of information and knowledge (Olko, 2017, p. 58), as well as the intensive diffusion of innovation and exchange of advanced technological solutions (Kowalski, 2010, p. 318). M. Gancarczyk observes that, despite many positive aspects of networks, there are also negative effects for enterprise innovation, such as the internalization of benefits by individual enterprises, potentially leading to monopolization, the widespread adoption of suboptimal technologies due to network influence on consumer choices, or the formation of networks that generate shared innovations, thereby eliminating competition in the development of new solutions (inviting competitors into collaborative innovation to prevent independent innovative activity) (Gancarczyk, 2005, p. 81).

The role of science is also crucial in the definition of a cluster. L. Mytelka and F. Farinelli emphasize the importance of science, as well as investments and connections between cluster participants, which enhance cluster innovativeness (Mytelka, Farinelli, 2000; Drelich-Skulska et al., 2014, p. 24). Ö. Sölvell adds that clusters are created not only by companies involved in the flow of goods and services but are also oriented toward knowledge creation, innovation, and broader profitability (Sölvell, 2009, p. 15). According to these assumptions, a cluster can include not only enterprises (large firms and SMEs) but also financial institutions (banks, venture capital), media (responsible for providing information about cluster activities and building the cluster's brand), higher education institutions (including technology parks, industrial laboratories, etc.), and public institutions (regional authorities and regional agencies) (Sölvell, 2009, p. 15).

B. Asheim and L. Coenen in their research highlight the connections between theoretical cluster concepts, the innovation system, and the specificity of knowledge as an economic good (Asheim, Coenen, 2005, pp. 1173-1190). In sectors where activity is based on synthetic knowledge, clusters are surrounded by supporting innovation institutions that contribute to the regional innovation system. In contrast, for sectors relying on analytical knowledge, regional innovation systems constitute an integral part of the cluster.

The broad variety of cluster definitions may reflect the rapid pace of change characterizing this phenomenon. It is worth noting that each successive definition aims to explain new cluster models and principles of operation within a given economy. Considering the Polish context, an example is the definition provided in the Regulation of the Minister of Economy, where a cluster is defined as: "a spatial and sectoral concentration of entities working toward economic development or innovation, including at least ten businesses conducting economic activity within one or more neighboring provinces, competing and collaborating in both formal and informal ways, with at least half of the entities in the cluster being businesses" (Regulation of the Minister of Economy, 2006). As seen here, Polish legislation specifies the operational area and the number of entities comprising the cluster. The presence of a cluster in a particular region

is conditioned by a high concentration of businesses and their skilled, experienced workforce. Companies invest their capital locally and leverage their resources—human, financial, technological—as well as infrastructure and industry-related environmental regulations, focusing on supply and export-oriented industries (Drelich-Skulska et al., 2014, pp. 25-26).

A. Bąkowski's glossary of terms describes a cluster as "a spatial concentration of enterprises, institutions, and organizations interconnected by a broad network of formal or informal relationships, based on a shared developmental trajectory (e.g., technological, shared target markets, marketing strategy, etc.), simultaneously competing and cooperating in certain aspects of operations" (Bąkowski, 2005, pp. 81-82). According to this definition, a cluster is not merely a simple sum of individual entities; rather, it is a spatial form of production organization that arises from interaction and synergy, enhancing flexibility and competitiveness.

In summary, the concept of the industrial cluster, initiated by M.E. Porter, emphasizes the importance of local concentrations of interconnected economic units in terms of competitiveness and innovation. A key element in cluster operations is the synergistic impact of participants, which supports technological development, efficiency growth, and reduction of transaction costs. Collaboration among businesses, academic institutions, and local authorities forms the foundation for innovation, allowing firms to gain competitive advantage. Social capital and trust also play an essential role, facilitating cooperation and knowledge sharing, which are crucial in a dynamically changing economic environment (Horzela, Olko, 2021, p. 460). In the Polish legal context, cluster definitions reflect the need to formalize cooperation in regions where the concentration of businesses and resources contributes to increased innovation and economic growth. Consequently, clusters serve not only as an organizational form but also as a dynamic system in which competition and cooperation coexist, generating added value for participants and the regions in which they operate.

3.2. Role of clusters in enhancing business competitiveness and innovation

The impact of a cluster on the innovativeness of enterprises depends on numerous determinants. One of these is the method of cluster formation—whether it is a bottom-up initiative driven by businesses that are prospective cluster members or a top-down approach. In Poland, bottom-up initiatives prevail and are found to be the most effective. An initiating group, predominantly led by businesses, identifies areas, goals, and tasks whose achievement, through the participation and collaboration of various entities, can yield tangible economic benefits—outcomes that would be difficult for a single enterprise to accomplish independently. An additional reinforcing element for these initiatives is the synergy effect, which can manifest in various areas of cooperation and economic activity within the cluster (Stanienda, 2014, p. 198).

Cluster policies and programs have been evolving within the European Union member states for nearly two decades. Today, both program agencies and policymakers agree that cluster development extends beyond simply establishing cluster organizations; it also encompasses the development of world-class cluster organizations that are internationally competitive and impactful on national economies. In 2008, the European Commission proposed the concept of the "World Class Cluster" to maintain and further develop Europe's global competitiveness through improved cluster policies, enhanced transnational cooperation, excellence in cluster management, and better integration of innovative SMEs within clusters (European Commission, 2008, p. 2). Highly developed clusters can transform into world-class clusters, becoming centers of innovation and business known worldwide (Europa InterCluster, 2010, p. 39). Such world-class clusters are characterized by a dynamic innovation system based on high-quality R&D and educational systems, as well as a critical mass of dynamic cluster participants, including market and technology leaders (Ahlqvist, 2014, pp. 1724-1726). They also focus on integration with global business, supporting breakthrough technologies, and providing an optimal environment for fostering emerging industries (Büscher, Schierenbeck, 2012, p. 40). Cluster excellence contributes to regional prosperity, enhanced business competitiveness, and a higher return on investment for investors (Meier zu Köcker et al., 2010, p. 1).

According to M.E. Porter's principles, a defining factor distinguishing a cluster from other types of networks is geographic proximity. Such spatial closeness promotes competitiveness while also facilitating cooperation (Klemens, 2016, p. 42). Business linkages within a cluster may be vertical, involving collaboration between suppliers and buyers within the value chain, or horizontal, involving shared clients, distribution channels, and technology. The vertical dimension primarily concerns cooperation, while the horizontal dimension reflects competition (Baran, 2008, p. 38). Businesses benefit from cooperation through activities such as fulfilling joint orders, sharing technological or commercial information, conducting joint training, or implementing technological improvements. M. Szewczuk-Stępień identifies cooperation benefits as increased access to knowledge and new opportunities to leverage effective, proven solutions, which in turn fosters idea generation and strengthens competitiveness on the international stage (Szewczuk-Stępień, 2014, p. 176).

Companies in competitive industries (operating in international markets) are typically geographically concentrated and surrounded by specialized suppliers, clients, and R&D institutions. This concentration stimulates efficiency, accelerates innovation processes, and encourages specialization. Furthermore, proximity to the R&D sector facilitates access to advanced technologies and allows companies to quickly acquire new partners for addressing technological challenges. Geographic concentration and the recognized reputation of the region attract skilled workers and international companies specializing in modern technologies. Additionally, interactions among entities and the progressing specialization of the region create highly favorable conditions for industrial development.

M.E. Porter identifies two main categories of benefits for enterprises operating within a cluster: improved efficiency and increased innovation. This article will focus on the latter aspect. The rise in innovation primarily stems from the following factors (Porter, 2001, pp. 267-268):

- Companies within a cluster are able to detect new customer needs more quickly and effectively.
- Close collaboration among businesses provides greater flexibility for innovation.
- The cluster environment enables companies to gain an advantage in recognizing new operational, technical, and supply opportunities.
- The proximity of companies in the same industry creates competitive pressure, which in turn motivates innovative processes and encourages firms to differentiate themselves creatively.
- Companies can experiment and delay financial commitments, allowing for a more flexible approach to innovation.

Cluster structures emerge across all economic sectors in numerous countries worldwide. Empirical research demonstrates that they can be regarded as drivers of entrepreneurship, supporters of innovation, enablers of export activity, and attractors of foreign capital. B. Drelich-Skulska et al. (2014, pp. 9-10) present several arguments for viewing clusters as stimulators of innovation, both within their structures and in the local business environment in which they operate (Drelich-Skulska et al., 2014, pp. 46-47). The key arguments include:

1. A cluster fosters both collaboration and competition. The presence of many competitors within a cluster encourages companies to distinguish themselves creatively, which sustains innovation processes.
2. Entities within a cluster establish relationships in an environment characterized by a pro-innovation atmosphere, resulting from the accumulation of skills, knowledge, and new ideas derived from shared experiences.
3. Companies within a cluster have the opportunity for direct and continuous market observation, enabling a faster response to buyer needs compared to large, isolated enterprises.
4. Clusters include specialized and experienced workers who have the ability to influence curricula at local universities and higher education institutions, which helps address skill gaps.
5. Cluster firms are adept at meeting new demands. Local partners are highly engaged in innovation processes, striving for the rapid commercialization of their inventions. The proximity of partners facilitates mutual knowledge and experience exchange in the implementation of innovations.

The presence of strong scientific institutions within a cluster is essential, as they directly influence the cluster's innovativeness, manifesting in new products, services, processes, or business models. While the cluster is responsible for all innovations, science drives them

across all levels. Entities collaborating within a cluster can undertake joint investments and share the same distribution network (Drelich-Skulska et al., 2014, pp. 46-47). Joint procurement can lead to reduced production or administrative costs. Through joint marketing efforts, entities build the brand of the entire cluster and each individual unit with a lower financial outlay. Participation in a cluster enables companies to benefit from synergies and focus on the activities in which they are most effective. Cooperation and competition can act as motivating factors (Horzela, 2019a, p. 99). Intense competition stimulates or even compels firms and entrepreneurs to explore new market opportunities (Bengtsson et al., 2005, p. 49). Companies operating within a cluster are able to generate more value than they would independently, and their products often become more competitive, both technologically and in terms of price. The positive aspects of cluster participation can be divided into soft and hard benefits. Soft benefits include the continuous learning process, business improvement (e.g., benchmarking), which contributes to increased innovation. Hard benefits primarily encompass efficient business transactions, more strategic investment, reduced costs while maintaining or increasing employment, and higher profits (Rosenfeld, 2002, pp. 15-25).

There are also strong assertions in academic literature that operating within a cluster is essential for innovativeness. Ch. Le Bas argues that cluster formation is a systematic element of innovation, as companies are unable to innovate independently. He believes that innovations can only occur with complementary innovations that reinforce each other (Żminda, 2011, pp. 145-146). However, most scholars do not share this view, as noted by M. Portugal Ferreira and F.A. Ribeiro Serra, who cite Philips and Xerox as examples of highly innovative companies in their sectors despite not being located in clusters (Ferreira, Ribeiro Serra, 2008, p. 6). J.M. Shaver and F. Flyer contend that highly innovative companies that succeed in the market and maintain close relationships with customers and suppliers may derive minimal benefits from operating in a cluster (Shaver, Flyer, 2000, pp. 1175-1193). This is because operating within a cluster may expose companies to the risk of having their innovative ideas, technological solutions, methods of collaboration with partners, or even employees copied or poached. The authors argue that clusters serve more as an integrative framework for companies with lower levels of innovation, which have a greater tendency toward agglomeration. A. Świadek, referencing research by C. Beaudry and S. Breschi (2003, p. 339), noted ambiguities in this area, indicating that the propensity for innovation is high when a company is located among other innovative firms within the same industry, but declines when low-innovation companies dominate the cluster (Świadek, 2005, p. 57).

Although innovativeness is a characteristic of clusters, it is not always a direct result of their activities. The European Commission outlines three main cluster concepts to define the relationship between clusters and innovativeness: the regional cluster (at the base of the hierarchy), the regional innovation network, and the regional innovation system (European Commission, 2002, p. 14). In this context, the mere establishment of a cluster does not equate to creating a regional innovation system, which is the most advanced form. According to the

European Commission, cluster policy focused solely on identifying clusters and supporting their operation will not increase the innovativeness and competitiveness of enterprises. The main task of cluster policy is to transform identified clusters into regional innovation systems, which involves supporting a specific development goal for the cluster (Żminda, 2011, pp. 146-147).

Intense competition drives companies to continually seek new innovation strategies that can provide a competitive market advantage over rivals. Consequently, novel concepts for enterprise innovation strategies have recently gained popularity, applicable both to large multinational corporations with developed R&D departments and to small and medium-sized enterprises (SMEs), which base their innovative potential on the creativity of their owners and employees (Łobejko, 2017, p. 77). These new concepts include strategies such as the Blue Ocean Strategy, innovation niches, open innovation, and innovation networks. A particular type of new innovation strategy is the innovation network. Collaboration within networks has become an integral component of the contemporary global economy. Increasingly, networks form the foundation for conducting economic tasks and achieving strategic goals, such as R&D activities, which SMEs can accomplish through innovation networks. Network innovations relate to transformations in both people and organizations (Albinsson et al., 2007, p. 1). Through network collaboration, companies can achieve success by joining forces with other entities. This collaboration can evolve into multilateral strategic alliances, in which a dominant company (the "hub partner") creates a network based on agreements with several independent partners to achieve common goals (Doz, Hamel, 2006, p. 25).

J. Tidd also uses the innovation criterion in his research, identifying several types of global innovation networks based on the radicalness of innovation and the similarity of companies within the network (Tidd, 2006, p. 10). In his classification, Tidd distinguishes types of innovation networks such as strategic alliances, sectoral forums, innovation networks, and regional clusters (Knop, Odlanicka-Poczobutt, 2016, p. 480). Moreover, the network concept is applied in policy-making by organizations or as a basis for introducing innovations and new management approaches (Brzóska, 2014, p. 10). A literature review reveals an increasing number of publications referencing network approaches, including various forms of organizational networks (Stańczyk-Hugiet, 2013; Barczak, 2016). P. Trott highlights different types of inter-organizational networks where innovation develops, such as R&D consortia, innovation networks, sectoral clusters, and other alliances that facilitate knowledge transfer (Trott, 2017, pp. 264-302).

Synthesizing P. Trott's findings, it can be concluded that the existence of inter-organizational networks brings significant benefits to the entities involved. Key factors contributing to cluster success include network partnerships, innovative technologies, human capital, corporate entrepreneurship, infrastructure, the presence of large firms, specialized services, and access to funding sources (Staszewska, Foltys, 2021, pp. 15-16). Technology acts as an accelerator for organizational network formation, taking the form of the Fourth Industrial

Revolution (Industry 4.0) in the global economy (Barczak, 2020, p. 25). Today, technology and innovation form the foundation of competitiveness for businesses, regions, and nations. Inter-organizational networks have become highly popular in management practices, especially in fast-paced industries such as IT, aerospace, and biotechnology, as well as in sectors with complex technologies and large-scale operations, such as the automotive and construction industries (Lichtarski, 2016, p. 51). Industry 4.0 is seen as an innovative approach to production management, enabling companies to achieve efficiency and enhance competitiveness (Pawłyszyn et al., 2020, pp. 1-2).

The concept of Industry 4.0 encompasses new organizational methods, management practices, work styles, and competencies, which are manifested through the use of intelligent machines, simulations, autonomous robots, augmented reality, and other technologies essential for product design and production processes (Szum, Magruk, 2019, pp. 73-74). In the context of Industry 4.0, collaboration and networks among businesses involved in economic processes are particularly crucial (Ślusarczyk, 2019, p. 7). It is posited that individual company actions yield isolated solutions, preventing the full potential of these transformations from being realized (Schneider, 2018, pp. 1-46). Digitalization, networked operations, and the shift toward an innovation-based economy pose challenges that are difficult for a single enterprise to overcome (Brakman, Van Marrewijk, 2013, pp. 217-231). In this sense, industrial clusters are evolving from their traditional role as collaboration platforms into innovation hubs for Industry 4.0 (Tsakalerou, Akhmadi, 2021, p. 319). Negative aspects of participating in inter-organizational networks, though less frequently identified, include limited contact with external environments, opportunistic behavior, competition for resources and influence, or a decline in internal innovativeness (Lichtarski, 2017, pp. 65-66).

Research by I. Pawłyszyn's team has shown that companies within Marshallian clusters, by collaborating, contribute to the diffusion of knowledge and the spread of new Industry 4.0 solutions (Pawłyszyn et al., 2020, p. 22). Clusters, with their advantages such as a knowledge base, agglomeration benefits, and labor resources, foster an environment of trust and collaboration, which facilitates digital transformation, particularly during the introduction and testing phases (Götz, Jankowska, 2017, p. 1633). It is beneficial for an innovator within the cluster to be a medium or large enterprise, as this significantly accelerates these processes. At the cluster level, it is essential to cultivate a culture of collaboration and encourage organizations to share knowledge about innovation and technological development to create a competitive and future-ready region. Furthermore, cluster coordinators should work to establish learning and knowledge-sharing conditions on Industry 4.0 among the management of cluster member entities, while also seeking new communication channels (Pawłyszyn et al., 2020, p. 23). B. Bembenek emphasizes that most resources essential for implementing radical and comprehensive economic changes are under the control of ICT clusters and their partners (Bembenek, 2017, pp. 41-42).

Supporting regional clusters is a key action within the state's innovation policy (Kowalski, Mackiewicz, 2019, p. 272). Mutual cooperation primarily enables the flow of knowledge, information, and technology, while the presence of companies from the same industry stimulates innovation (Osarenkhoe, 2010, pp. 344-347). Clusters contribute to economic growth, stimulate local entrepreneurship, and positively influence the regional labor market (Żabińska, 2013, p. 177). Scientific units within clusters gain the opportunity to conduct research, secure project funding, and find markets for the technologies they develop. Clusters create better avenues for linking the worlds of science and business, enabling the identification of mutual needs and capacities, which fosters more effective collaboration (Machnik-Słomka, 2011, p. 96). The scale of benefits for companies, research units, and regions is substantial, which explains the prevalent tendency to develop cluster-based policies (Drelich-Skulska et al., 2014, p. 50). The presence of innovative clusters in a region enhances its attractiveness and competitiveness. In the global economy, the most successful regions are those based on knowledge and focused on fostering innovation (Mackiewicz, Namyślak, 2021, p. 1295). Research conducted on nearly four thousand Portuguese enterprises found that companies within industrial clusters and engaged in innovative activities tend to enter the market faster. This trend further encourages companies with lower technological advancement, who face market entry or internationalization challenges, to participate in industrial clusters (Mendes et al., 2021, pp. 623-624). Economic growth is largely driven by innovation, making clusters an integral part of this process as carriers of innovation and knowledge transfer.

4. Conclusion and discussion

This article underscores the pivotal role of industrial clusters in enhancing business competitiveness and innovation. Through the hypotheses presented, the study demonstrates that clusters serve as dynamic ecosystems fostering innovation, efficiency, and collaboration. Key conclusions can be drawn based on the explored hypotheses. Businesses participating in clusters exhibit significantly higher levels of innovation compared to independent entities. The clustering environment, characterized by resource sharing, knowledge diffusion, and intense collaboration, creates a fertile ground for innovation. This finding aligns with empirical evidence suggesting that proximity and shared goals among businesses accelerate the adoption of cutting-edge technologies and innovative practices. Geographic proximity within clusters enhances knowledge exchange among participants, contributing to improved competitiveness. The physical closeness of firms and institutions within clusters facilitates both formal and informal interactions, enabling the rapid diffusion of ideas and best practices. This interconnectedness not only enhances operational efficiencies but also strengthens regional innovation systems. The synergistic interactions inherent to clusters reduce transaction costs and enhance operational efficiency. The collaborative environment enables businesses to

leverage collective resources, pool investments, and access specialized suppliers. Such synergies are instrumental in achieving economies of scale and scope, further reinforcing the economic viability of cluster participation. The involvement of academic and research institutions is a critical driver of innovation within clusters. These institutions provide the intellectual capital and technological expertise required to sustain innovation cycles. Their active participation fosters the development of advanced solutions, supports commercialization efforts, and bridges gaps between scientific research and market needs.

The presence of clusters in the Polish regional economy reflects not only the level of its development but also, more importantly, indicates the potential of Polish regions and their future development prospects. Clusters have become a permanent and essential component of both developed and developing economies (Miszczak, 2010, pp. 9-10). They are often regarded as a simultaneous manifestation of globalization and regionalization. At the regional level, clusters contribute to the economic development of local communities (stimulating the regional economy by providing essential goods and services), the development of regional businesses (clusters and highly specialized firms in networks drive metropolitan area activity), and local development (by improving infrastructure and increasing regional wealth levels). Clusters are economic structures that enhance both the competitiveness and innovativeness of regions.

This article analyzes the role of industrial clusters in building the competitiveness and innovation of enterprises, particularly in the context of collaboration and knowledge exchange. Research highlights that clusters are a critical component of regional economies, providing businesses with access to specialized knowledge and resources and facilitating the rapid flow of information. The geographical proximity of firms and R&D institutions supports innovation development and efficiency gains, positively impacting the competitiveness of both clusters and their regions. Findings suggest that clusters have the potential to generate added value through collaboration among various economic entities, the scientific sector, and public institutions. Their development fosters regional entrepreneurship, attracts investors, and facilitates adaptation to global innovation standards.

The analysis confirms the importance of clusters as structures that strengthen both competition and cooperation. It is established that clusters play a dual role—they provide direct benefits to companies by offering access to new markets, technologies, and collaborators, and serve as a tool for supporting economic development at the macro level by increasing employment, social capital, and the overall innovativeness of a region. However, the literature also points to potential risks associated with operating within a cluster. These include the risk of competitors replicating innovative solutions or limiting interactions with firms outside the cluster, which could weaken innovativeness. Future research should focus on optimizing collaboration strategies and intellectual property protection within clusters to maximize innovative efficiency, particularly in rapidly evolving sectors like IT and Industry 4.0. Additionally, in the Polish context, exploring cluster policy in conjunction with infrastructure development and human capital resources may provide further tools to enhance local competitiveness and support sustainable development.

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