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Managing relational competences of industrial cluster and the challenges of Industry 4.0 — theoretical approach

Zarządzanie kompetencjami klastra przemysłowego a wyzwania Przemysłu 4.0 — ujęcie teoretyczne

Abstract

Clusters, due to their unique properties, form an excellent space for establishing inter-organizational relationships. Cluster attributes, such as high levels of transactional trust, wide spectrum of interdisciplinary relational competences allocated in cluster members and in the cluster as a whole, contribute to maintaining the sustainability of these relationships. In turn, the sustainability of relationships depends on the quality of relational competences, which guarantee the achievement of benefits from cluster participation. The management of cluster relational competences boils down to guaranteeing the achievement of benefits stemming from cluster relations and sharing competences between entities in the cluster network. The durability of relationships, the capacity and ability to absorb assets, including knowledge from other entities, guarantees that cluster members build competitive advantages that meet the requirements of Industry 4.0. The cluster coordinator therefore faces the following challenge: how to efficiently and effectively manage the cluster's relational competences. Therefore, the research problem is the answer to the question of what the right course of management processes in a cluster should look like, fully utilizing the potential inherent in the cluster's entities, which at the same time would guarantee the achievement of synergistic benefits from cooperation in the cluster in the form of a pension from cooperative relations (relational pension). For the purpose of this article, the following thesis was formulated: a set of various relational competences available within a cluster and the interactions between the its members create an ecosystem which predispose the cluster to generate solutions on level with the requirements of Industry 4.0, which forces the cluster coordinator to care for the effectiveness of relational competences management.
The paper proposes of a model for managing the relational competences within a cluster, taking into account the demands of Industry 4.0. It is written based on a review of literature on inter-organizational relations, relational competences, and cluster management and development

Streszczenie

Klaster dzięki swoim atrybutom jest doskonałą przestrzenią do nawiązywania relacji międzyorganizacyjnych. Atrybuty klastra (m.in. wysoki poziom zaufania transakcyjnego, szerokie spektrum interdyscyplinarnych kompetencji relacyjnych ulokowanych w podmiotach klastra i w klastrze jako całości) przyczyniają się do zachowania trwałości tych relacji. Z kolei trwałość relacji zależy od jakości kompetencji relacyjnych gwarantujących osiąganie korzyści dla członków klastra. Zarządzanie kompetencjami relacyjnymi klastra sprowadza się do gwarantowania osiągania korzyści z relacji w klastrze i dzielenia się w sieci klastrowej kompetencjami pomiędzy podmiotami. Trwałość relacji, możliwość i zdolność absorbcji zasobów, w tym wiedzy od innych podmiotów, gwarantuje członkom klastra budowanie przewag konkurencyjnych spełniających wymagania Przemysłu 4.0. Przed koordynatorem klastra pojawia się zatem wyzwanie, jak sprawnie i skutecznie zarządzać kompetencjami relacyjnymi klastra. Problemem badawczym jest odpowiedź na pytanie, jak powinien wyglądać właściwy przebieg procesów zarządczych w klastrze w pełni wykorzystujący potencjał tkwiący w podmiotach klastra, a który jednocześnie gwarantowałby osiąganie korzyści synergicznych ze współpracy w klastrze w formie renty z relacji kooperacyjnych (renty relacyjnej). Na potrzeby artykułu sformułowano następującą tezę: zbiór różnorodnych kompetencji występujących w klastrze i interakcje zachodzące między podmiotami klastra generują ekosystem predysponujący go do generowania rozwiązań na poziomie wymagań Przemysłu 4.0, co wymusza na koordynatorze klastra dbałość o skuteczność zarządzania kompetencjami relacyjnymi.
Celem artykułu jest przedstawienie propozycji modelu zarządzania kompetencjami relacyjnymi klastra z uwzględnieniem wymagań stawianych przez Przemysł 4.0. Artykuł został przygotowany w oparciu o przegląd literatury z zakresu relacji międzyorganizacyjnych, kompetencji relacyjnych, uwarunkowań rozwoju klastrów i zarządzania klastrami, wyzwań Przemysłu 4.0. Według autora artykuł

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factors, cluster management, and the challenges of Industry 4.0. This article contributes to the literature on the management of relational competences in clusters in the face of the challenges of Industry 4.0. Moreover, it enriches the literature with a postulated model of relational competence management across cluster and can be a practical tool for improving the efficiency of the managing clusters as ecosystems of open innovation.

Keywords
cluster, cluster management, relations, cluster relation competence, relation competence management in clusters, Industry 4.0

stanowi wkład do literatury dotyczący zarządzania kompetencjami relacyjnymi w klastrze w obliczu wyzwań Przemysłu 4.0. Stanowi ponadto wzbogacenie literatury o postulowany model zarządzania kompetencjami relacyjnymi klastra i może być wykorzystany jako praktyczne narzędzie służące do podnoszenia sprawności procesu zarządzania klastrem jako ekosystem otwartych innowacji.

Słowa kluczowe
klaster, zarządzanie klastrem, relacje, kompetencje relacyjne klastra, zarządzanie kompetencjami relacyjnymi klastra, Przemysł 4.0

JEL: D4, L1, L2, O3

Introduction

The effectiveness of cluster management is important to many stakeholders in cluster cooperation. It is important to cluster members because of the expected benefits of cooperative relationships. The efficiency and effectiveness of the cluster relationship management process, the process of gathering and sharing competences located in cluster entities depends on the level and dynamics of cluster development and the scale of benefits of this cooperation for its members.

The development processes inside the cluster, including the growing number of entities, the depth of relationships, the wealth of various competences embedded in the cluster and external conditions, including technological progress, the challenges of Industry 4.0, force the cluster coordinator to look for the right management model. A model that would ensure its continuous development as a whole and guarantee the achievement of benefits for its individual members, including in terms of increasing innovation and competitiveness.

This, however, raises the issue of the cluster management process — one which would fully use the potential inherent in cluster entities (competences), while guaranteeing the achievement of synergistic benefits from cooperation in the cluster (sharing competences) in the form of a relational rent. Especially in the case of industrial clusters, it is important that this type of management model corresponds to the current challenges posed by Industry 4.0 (Pôle SCS Cluster, 2018). The effectiveness of a cluster depends on the processes of forming relationships within and between units at the micro level. Establishment of effective and efficiently managed clusters must be done through an in-depth examination of the nature of the network relationships of the various actors (Scott, Hughes & Kraus, 2019). Based on the above, it should also be pointed out that focusing on the relationships between cluster entities on a micro scale, while generalizing to the management process for the entire cluster population, will allow to fill the research gap in the field of competence management of relationships in clusters. Based on this model of managing relational competences in a cluster, the coordinator at each stage focuses on the individual propensity to share relational competences and the ability to absorb acquired competences from partners.

Focusing on relationships, optimizing benefits in collaborative networks is particularly relevant for small and medium-sized enterprises facing capital — and resource-intensive challenges of the fourth industrial revolution: increasing operational efficiency, changing business models, digital transformation of the manufacturing and distribution process, etc. (Pietrewicz, 2018). The increasing pressure of the competitive environment triggers companies to implement components of Industry 4.0 (Rüßmann, Lorenz, Gerbert, Waldner, Justus, Engel & Harnisch, 2015). Thanks to cooperative relations companies in the cluster will be able to more easily meet the requirements of Industry 4.0 and acquire desired competencies on an ongoing basis. Clustered companies are able to overcome some of the main constraints they usually face: lack of specialized skills, difficult access to technology, resources, markets, information, credit, and external services (Giuliani, Pietrobelli & Rabellotti, 2005).

Therefore, the research problem is the answer to the question of what the right course of management processes in a cluster should look like, fully utilizing the potential inherent in the cluster's entities, which at the same time would guarantee the achievement of synergistic benefits from cooperation in the cluster in the form of a pension from cooperative relations (relational pension).

For the purpose of this article, the following thesis was formulated: a set of various relational competences available within a cluster and the

interactions between the its members create an ecosystem which predispose the cluster to generate solutions on level with the requirements of Industry 4.0. In order to verify the thesis, the research question was posed: how should the process of managing relational competences convergent with the requirements of Industry 4.0 be modelled in the cluster?

Considering the above, the aim of the article is to propose basic assumptions for a model for managing the relational competences of industrial clusters, taking into account the requirements set by Industry 4.0.

The article is prepared on the basis of a review of literature on the subject of cluster development factors, cluster management, and challenges set by Industry 4.0. The model proposed here is also based on observing participating in the functioning and management process of the Metal Processing Cluster (a Key National Cluster),[1] as well as the results, coordination and the authors' participating observation in the project "*Regional Centre for Future Industrial Competence as a dispersed system*", commissioned by the Ministry of Entrepreneurship and Technology in March 2019.[2] The proposed model responds to the actual needs of cluster coordinators in terms of how to manage the cluster as an ecosystem.

Table 1. Establishing the literature database

Keywords 1	EBSCO	Scopus	Keywords 2	EBSCO	Scopus
Industrial cluster	6101	10.430	Industrial cluster	6101	17.617
Management	2123	5028	Management	2123	3255
Industry 4.0	7	54	Relationships	265	412
After verification of abstracts and content	3	11	After verification of abstracts and content	13	14
Total		14	Total		27

Source: own elaboration.

Relations, relational competences and management of relational competences in a cluster — literature review

The literature sources referred to in the article are a derivative of the conducted literature review using the free-text searching method as well as searching by keywords (Czakon, 2011b; Mazur & Orłowska, 2018). After the preliminary literature review, two sets of words (Keywords 1: Industrial cluster/Management/Industry 4.0 and Keywords 2: Industrial cluster/Management/Realtionship — by adding another criterion-word) were adopted as keywords for the verification of EBSCO and SCOPUS electronic databases in accordance with Table 1, taking into account the criterion of full texts in peer-reviewed scientific journals. In the case of the first set of keywords from both databases, a total of 14 articles (3 + 11) referred to the subject directly after verification of abstracts and content. In the case of the second set of keywords from both databases, after verification of the abstracts and the content, a total of 27 articles (13 + 14) referred directly to the subject of the article.

The database was supplemented with texts that were the references in the searched articles, as well as books, reports and documents, in accordance with the thematic scope defined by the objective of the article. Moreover, individual comments and author's remarks are a derivative of many years of scientific research conducted in the field of clustering, cluster management and cluster policy. The model of cluster relational competency management proposed in the fourth part of the article is the result of participant observation in the process of managing an industrial cluster and the observed necessity of a systemic approach to managing relations in a cluster in the face of Industry 4.0 challenges.

This paper focuses on inter-organizational relationships in clusters. At this point, we should also talk about inter-organizational relations between various types of entities that can create a cluster: enterprises, R&D units, business environment institutions, and administration units. Both in relation to each other and in relation to the cluster coordinator. However, due to the limited form of this study, the focus was primarily on the relationship between the cluster/cluster coordinator and the cluster member.

Classically, clusters are defined as a geographical aggregation of interconnected companies, specialized suppliers, service providers, businesses operating in similar sectors, and related institutions (such as universities, standardising bodies, and trade associations) in specific fields, which compete but also collaborate (Porter, 2001).

It is worth noting that the actual management process can only take place in formally functioning organizations with a separate organizational structure. Thus, whenever a reference to a cluster and cluster management is mentioned later in the article, it should be considered by default that it is a formally selected cluster initiative/cluster organization, which is managed on behalf of the members by a coordinator appointed by them.

W. Czakon defines a cluster as basically a set of entities and relationships connecting them (Czakon, 2012). Based on cluster relationships, many authors classify them as network organizations (Czakon, 2011a; Czakon, 2012; Wozniak-Sobczak, 2015). Interaction in innovation networks is an important way of acquiring and transferring new knowledge, gathering relevant information about new business. Exchange of information and resources in turn affects the effectiveness of decision-making and business activities of organizations, especially in dynamic and unstable business environments (Corsaro, Cantu & Tunisini, 2012). The cluster's growing critical mass as well as increasing expectations makes it necessary for the cluster coordinators to expand their network management skills and relational management capabilities within the cluster (Möller & Svahn, 2003; Rothaermel & Deeds, 2006).

Clusters are seen as "repositories of competence"(Götz & Jankowska, 2017). In the opinion of various EU institutions, industrial clusters have become one of the key catalysts supporting industrial specialization (European Union, 2018) and are treated as a current and future tool for the implementation and development of Industry 4.0 (European Union, 2013; European Commission, 2016; European Union, 2018). The popularization of new technologies, particularly in Industry 4.0, fosters cooperation, accelerates the development of innovation and creates new challenges for SMEs. Clusters are focused on providing services supporting the innovation processes of their members, but there are noticeable differences between the supply of these services by cluster managers and demand from cluster entities (Batz, Kunath & Winkler, 2018). Clusters can also create a natural environment conducive to technological convergence by, among other things, facilitating the flow and dissemination of knowledge between key players in innovation processes. Increasing importance of geographical proximity and the so-called social networking contributes to the development of technology convergence, especially between the representatives of the academic sector, R&D, and business (Runiewicz-Wardyn, 2011). Literature has shown the innovation effectiveness of SMEs is positively affected by its participation in innovation networks and those ties within the network are more beneficial when heterogeneity is higher (Gronum, Verreynne & Kastelle, 2012; Eisingerich, Bell & Tracey, 2010).

In the simplest terms, inter-organisational relationships are defined as relationships between two or more groups of organizations. They can be cooperative relationships (striving to achieve a common goal), competitive relationships (striving to compete for something important: the customer, resources, market position) and the nature of conflict relationships (striving to achieve a common or own goal in violation of applicable rules of conduct) (Sulimkowska-Formowicz, 2018). In clusters we are dealing with a situation in which cooperative relationships intersect with competitive relationships, creating a specific nature of relationships referred to as "coopetition" (Jankowska, 2009) or "cooperation" (Cygler, 2009).

In the relational approach to the management of organizations, attention is drawn to the factor determining the implementation of this strategy, namely the willingness to cooperate with partners in order to achieve a relational rent, understood as common, above-average results achieved through cooperation (Stańczyk-Hugiet, 2012). Faced with the increasing dynamics of changes in the environment of enterprises, they undertake a number of relationships that allow them to acquire or supplement key resources to meet the challenges of changes taking place in the environment (Sołoducho-Pelc, 2017). Thus, at the level of an enterprise entering into cooperative relations, one can talk about relational competences. Network capability, as Kohtamäki indicates, is the ability of an organization to develop and use inter-organizational relationships to access the resources of other organizations (Kohtamäki, Vesalinen, Hnnenberg, Naude & Ventresca, 2012). From the point of view of the cluster as a whole, it is reasonable to have alliance management capability, which is a type of dynamic competence that determines the entities' ability to create, develop or modify its own database of resources and partner resources (Schilke & Goerzen, 2010). The relational competence of an enterprise must be skilfully managed and, like any resource, it must be utilized to provide benefits (Sulimkowska-Formowicz, 2018). Being dynamic, relational competence is a company's ability to integrate, build and reconfigure internal and external

competences in order to meet the challenges of a rapidly changing environment (Ciszewska-Mlinaric, Mlinaric & Obłój, 2011).

It is worth noting that a component of a company's relational competence is its absorptive capacity. It is defined as a set of routines and processes by which the company acquires, assimilates, transforms and exploits knowledge in order to create a dynamic competence that allows for obtaining and maintaining a competitive advantage (Zahara & George, 2002). That is why the extent to which the cluster entity is able to use this relationship is important, as it optimizes the use of competences offered by the partners.

For the cluster development processes, the most important factor is the development of the relational capability of cluster entities, which Dyer and Singh understand as a pro-partnership attitude as well as the ability to be a partner, conducive to building a competitive advantage through relationships. At the same time, it is a strategic tool for companies in achieving mutual benefits (Dyer & Singh, 1998).

Therefore, the management of relationships in the cluster is to serve the efficient and effective achievement of benefits for cluster entities in the form of a relational rent. For cooperation in the cluster, diffusion of possessed competences located in cluster entities and in the cluster as a whole will result from the relationships that occur in the cluster. An appropriate measure of efficiency and effectiveness of the cooperation relations is the final advantage stemming from these relationships in the form of relational rent (in economic terms) (Dyer & Singh, 1998) or inter-organisational synergy effects (in organisational theory terms) (Czakon, 2003; Wójcik-Karpacz, 2012). Relationship management will allow optimal use of resources in cluster members. That is why it is so important to utilise the potential dispersed across the entities associated in a cluster. The challenge over the course of a cluster's growth is to configure inter-cluster relations in order to combine the potential of the cluster's participants as well as generating cluster competences — not belonging to any individual company, but rather creating so-called "network goods" (Citkowski, 2016). That is why there is numerous literature emphasis on how important it is for the final success of cooperation in the cluster to understand the relational behaviour of individual members of the cooperation network and the conditions in which the boundaries of the enterprise are crossed and cooperation is initiated (Scott, Hughes & Kraus, 2019).

The specificity of cluster management is partly derived from its characteristics, which include, among others, geographical and utilitarian proximity (Ketels, 2003; Klimas, 2014), networking of relational processes (Brasili & Fanfani, 2002; in Skawińska & Zalewski, 2009); openness and trust (including organizational trust) (Chrupała-Pniak & Sulimkowska-Formowicz, 2016); diversity and richness of competences; diffusion of knowledge (Baran, 2013), ecosystem of open innovations (Huang & Rice, 2013), the possibility of obtaining benefits from the cluster — relational rent (Romaniuk, 2016). The benefits of the cluster will be achieved through efficient management processes, which lead, among others, to an efficient process of sharing competences between cluster entities. Cluster managers should facilitate the creation of strategic alliances and networks, identifying key persons and entities with already established mutual trust, attracting potential partners and helping them to establish relationships (Coletti, 2010).

In short, the main challenge on the part of cluster coordinator is to manage relational competences of the cluster, where the *cluster's relational competences* should be read, based on literature, as the sum of relational assets and relational skills stemming from individual members associated in the cluster. Such understanding of cluster's relational competence includes the cluster members' relational assets and capabilities. *The cluster members' relational assets* — includes human resources, material and financial assets, as well as the knowledge and experience of cluster entities in a specific field — which it is willing to offer within the cooperation relationship in the cluster. Relational assets also include a specific scope of tacit knowledge which is held by a company's employees, who are potentially dedicated to cooperate for the purposes of other entities functioning within the cluster. Apart from intangible assets, there is also a whole range of material assets which may be used in relational cooperation: specific machines, equipment, parts of machinery resources, R&D departments, etc. The sum of such assets in individual companies which are available to be shared with other entities is the cluster's relational assets. The *cluster members' relational skills* are the capacity of the cluster's entities to share their relational assets, and this skill determines not only the fact of lending some assets to a co-operator/co-operators, but it also determines the parallel capacity for achieving various benefits stemming from establishing relations with other entities within the cluster. The component of the cluster's relational skills is undoubtedly the sum of the absorption capacities of cluster members referred to in the earlier fragment of the study.

The relational competences of the cluster are dynamic. They may be subject to changes and

development depending on the relations undertaken so far and in the future (April, 2018; Czakon, 2007) and the advantages/disadvantages and changes in the business environment. It is therefore the responsibility of the cluster coordinator not only to adequately manage the accumulated relational competences, but also to shape the appropriate membership structures of the cluster. This is done, for example, to properly shape the structure of competences (supply) in relation to expectations (demand) by admitting new entities to the network of relationships. Thanks to this, the coordinator will ensure a dynamic balance of relational competences in the cluster.

The development of network forms of cooperation, solving problems related to the formation and management of networks is an excellent basis for the rapid implementation of the Industry 4.0 concept, especially at the level of small and medium-sized enterprises (Saniuk & Saniuk 2017).

Current literature lacks both thoroughly described management practices and a built scientific basis containing a proven cluster management model (Knop, 2013). In the context of cluster management, cluster management models are based on key actors (Provan & Kenis, 2008), cluster life cycle (Kordel, 2010) and the model of inter-organisational governance within regional clusters (Eisingerich, Bell & Tracey, 2010). The conducted literature review indicates two more interesting management models to be used in clusters. The first one, developed by D. Corsaro, Ch. Cantu and A. Tunisini (2012), points out three elements important for the management of the innovation network, which can include clusters. The first is the six core attributes of heterogonal actors in innovation networks that need to be taken into account to achieve the final benefits. Managing such a network and wanting to benefit from it requires taking into account actors' goals, actors' perceptions, actors' power and position, actors' knowledge bases, actors' capabilities and competences, actors' cultures. In the second element, the development of innovation in such a network, according to the authors of the cited study, requires taking into account three processes: knowledge integration, technological development, coevolution business-social relationships. In order to achieve the desired network efficiency, a continuous process of verification of network actors in terms of their inclination and wealth is required, among others, knowledge and competence to cooperate for the development of innovations within the network.

However, L. Knop (2013) points to components of strategic cluster management. In order to achieve the cluster's objectives, its management requires stability and sustainability of the relationship based on trust. For this, as the author points out, we need appropriate rules and principles, building a climate of cooperation and efficient communication channels. The second key element is the coordination and configuration of resources, which is to be used by the proper cluster structure. The third element of the model is the creation of knowledge-based value, including primarily consideration of the type and transferability of knowledge, aggregation of knowledge for innovation and competitiveness, and appropriation of knowledge. As the author of the model emphasizes, creating knowledge requires proper order and climate for cooperation (Knop, 2013).

In the mentioned models of management of innovative networks, including clusters, the common feature is primarily the recognition of the specificity of relations between cluster entities, recognition of their cooperation potentials, and then for the final benefits of cluster and cluster actors as a whole, the management of these relations based on the relational competences of the cluster.

Therefore, it is essential to attempt to redefine the presented models taking into account the challenges of Industry 4.0, which the models do not take into account. The author's participation in and observation of the process of cluster management, as well as managing cluster relationships, in the face of the challenges of Industry 4.0 — determines the challenge of generating a model of relational competence management of the cluster, in order to meet the challenges of Industry 4.0, chiefly by small and medium-sized companies.

Cluster management in the face of the fourth industrial revolution

By definition, a cluster is an aggregation of heterogonal entities and its objective is to facilitate the implementation of any new solutions in terms of production processes, organising the production process, as well as the organisation of the company as a whole. Clusters are natural ecosystems of innovation (Citkowski, 2019). Advantages contributing to the innovation of cluster companies often result from the possibility of developing knowledge and competences in the cluster (Jankowska, Götz & Główka, 2017), among others, thanks to the effective management of relationships in the cluster.

It is therefore worth pointing out a number of cluster management requirements imposed by the specificity of Industry 4.0, while at the same time

the attributes of the cluster facilitate understanding the essence of Industry 4.0. As literature indicates, to properly understand the vision of Industry 4.0, it is necessary to view it through the lens of collaborative networks. Because the field of networking is inherently multidisciplinary and interdisciplinary, it can enhance a holistic understanding of the essence of Industry 4.0. Therefore, it is argued that "collaboration" is at the heart of most of the challenges of Industry 4.0, and thus the area of networking should be considered a major factor — though certainly not the only one — for this industrial transformation (Camarinha-Matos, Fornasiero & Afsarmanesh, 2017).

This article treats Industry 4.0 as an umbrella terms for the integration of smart machines, systems, and the implementation of changes to production processes aimed at increasing manufacturing efficiency and introducing the capacity for flexible changes in the range of offered products. Industry 4.0 concerns not only technology, but also new ways of working and the role of people in industry (Piątek, 2019). However, according to the McKinsey report (2015), the essence of the fourth industrial revolution are not only new technologies in themselves, but the transformation of manufacturing processes and value chains that these technologies enable. The challenges that the development of the fourth industrial revolution poses to enterprises concern operational efficiency, business models and the foundations of the digital transformation of enterprises (Pietrewicz, 2018). The basic elements making up Industry 4.0 are: autonomous robots, simulations, system integration, industrial Internet of Things, cybersecurity, cloud computing, 3D printing, augmented reality, Big Data (Rüßmann, Lorenz, Gerbert, Waldner, Justus, Engel & Harnisch, 2015). The economic transformation caused by I4.0 means that in the future, all business processes, such as supply, production, maintenance, delivery, and customer support will be connected to the Internet. The resulting highly flexible value networks and established standards and standards will require new forms of cooperation between companies in the industry and beyond, at the regional level, national and global level (Kagermann, Anderl, Gausemeier, Schuh & Wahlster, 2016).

The fourth industrial revolution is primarily based on digital transformation along with increasingly extensive cross-integration of vertical and horizontal value chains. In the face of these processes, micro, small and medium-sized enterprises, which constitute an advantage of the enterprise sector, are not sufficiently developed to make it worthwhile for them to individually implement solutions in the field of Industry 4.0 (Bondyra & Zagierski, 2019). The cluster ecosystem is an excellent environment in order to facilitate enterprises to gradually adjust to the challenges of the industry of the future and, at subsequent stages of development, both enterprises and cooperation in the cluster can increase the competence to implement solutions of Industry 4.0.

In the context of Industry 4.0 and network relations management, the need to guarantee the transparency of the transmitted data between entities (Khan & Turowski, 2016) and the security of transfer is emphasized. With risk factors added to this set of requirements, such as changes in a restless environment, breakthrough technologies and uncertainty related to the creation of new advanced solutions, what is left is an image of a very difficult business area. Clusters in this situation focus on relatively stable conditions for incubation of solutions so as to minimize risk through the exchange of knowledge and cooperation of companies (Jasinska & Jasinski, 2019). They can act as laboratories for Industry 4.0 experiments, provide a conducive environment for the creation and dissemination of knowledge (Götz, 2019). The importance of clusters as attractive locations for Industry 4.0 companies results from the fact that they take into account the specificity of creating and disseminating knowledge, which is the basis for the fourth industrial revolution (Götz & Jankowska, 2017).

Review of literature and the diagnosis prepared within the RCFIC Project[3] enabled the identification of the following fundamental requirements of I4.0 in the cluster governance process.

The cluster management process in the face of the challenges of Industry 4.0 should guarantee its entities continuous access to the constant expansion of knowledge. It should develop internally by stimulating entities to develop their competences and increase absorption capacity. This should be preceded by the process of diagnosing the demand and supply of given competences inside the cluster. At the same time, the cluster should be open to the admission of new members, in order to guarantee the inflow of new interdisciplinary competitions (Arikan, 2009).

Competitive pressure and I4.0 itself dictate the need for fast and effective diffusion both in and out of the cluster. Competitive advantage in I4.0 will determined by the capacity for collecting data, processing it quickly, and using it in business (monetizing) (Bosch, 2019). The process of knowledge diffusion between individual entities will require compatible tangible and intangible infrastructure.

Another Industry 4.0 challenge that the cluster manager needs to address is the issue of data flow

Table 2. Selected challenges of Industry 4.0 and cluster management

Industry 4.0 Challenges	Actions included in cluster management systems
Interdisciplinary competence	Guaranteeing access to the cluster and the presence of heterogonal entities with various competences and skilfully using them by mapping competences and diffusion of competences in the cluster population
Functional, technological and management integrity	Establishment of compatible social and technological infrastructure within a cluster
Data transfer security	Intellectual property management and protection, cybersecurity
Transparency of networking and data flow processes	Building a climate of trust and transparent channels of diffusion of relational competences, transfer security
Development of specific competences of employees, including engineers	Inside cluster systems for training and development of employee competences
New forms of cooperation between companies in the industry and beyond	Managing members' relational competences based on adopted functional and technological standards

Source: own elaboration based on: Jasinska & Jasinski, 2019; Götz, 2019; Kagermann, Anderl, Gausemeier, Schuh & Wahlster (Eds.), 2016; Götz & Jankowska, 2017; CGI GROUP INC, 2019.

security in integrated ICT networks, For I4.0 there is a requirement for new ways to protect intellectual property far beyond traditional property rights (Kagermann, Anderl, Gausemeier, Schuh & Wahlster, 2016). The above is possible by building a high level of inter-organisational trust (Sankowska, 2011).

Another challenge to implementing I4.0 solutions that clusters face is to prepare a sufficiently large number of new specialists, who must be equipped with a new set of skills for Industry 4.0 (Götz, 2019).

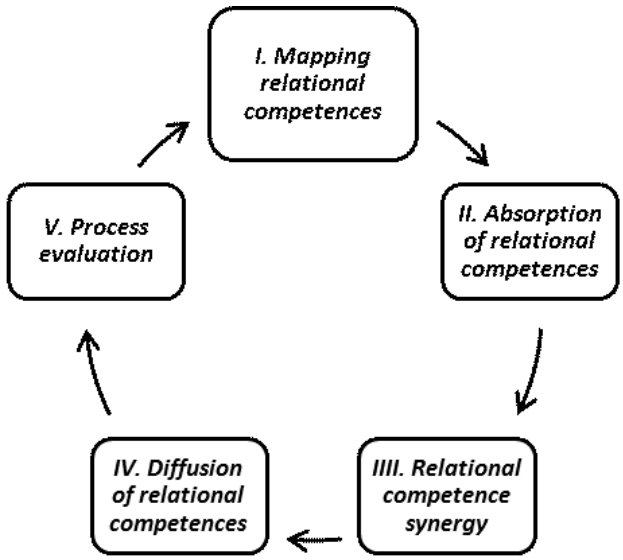
A cluster, as a set of autonomous entities, fits into the implementation of the next challenge of Industry 4.0, which is the creation of new forms of cooperation between enterprises. In this regard cluster management should strive to develop stable, transparent rules of cooperation, implementation of innovative projects in consortia of cluster entities, etc. Effective flow of knowledge between partners becomes a priority for effective cluster management (Baran, 2013).

Summing up, cluster members have a sufficiently high level of social capital when it comes to entering into relationships. Due to their presence in a cluster, its members are by definition more open to cooperation than entities not entering into such cooperative relations. Having at their disposal a large base, e.g. technological and at the same time a huge level of know-how in given technological areas, they are open to cooperation. They are involved in various types of innovative projects in various configurations. At the same time, I4.0 in a sense forces the need for cooperation, including in order to quickly reach new knowledge, new technology, etc., which are part of the challenges of the fourth industrial revolution, thanks to the mutual exchange of knowledge and experiences between cluster entities. At the same time, there are growing expectations towards the cluster coordinator to improve, dynamise and increase the target scope of benefits from mutual cooperation through the cooperation ecosystem that is formed by developed clusters.

Proposed model of relational competence management within a cluster in the face of challenges posed by Industry 4.0

The proposed model of managing cluster relational competences in the face of Industry 4.0 should primarily concentrate on managing the relations between entities within the cluster. This will allow the full use of relational competences located in cluster entities, thus the relational competences of the cluster as a whole. The proposed model takes into consideration not only the dynamics of growth processes which affect the relational competence structure, but also considers the challenges of Industry 4.0 (Diagram 1).

Diagram 1. Proposed cluster relational competence management model in the face of Industry 4.0



Source: own elaboration.

The model emphasizes identifying and deepening of relationships within the population of cluster members as a leading challenge of the coordinator and building trust and compatible social technology infrastructure to share competences.

The entire process begins with *Stage I.: The mapping of assets, skills and relational competences* is supposed to indicate to the coordinator the amount of demand and supply of relational competences of the cluster.

Consequently, the question is which entities in the cluster have key competences, e.g. in the process of manufacturing a given product, which are simultaneously desired by other entities in the cluster. Entities that have not used this technology before and want to implement it, as well as entities for which the level of mastery of the technology is low. Thus, they expect support — reporting demand for competencies located in another cluster entity.

At the mapping stage, it is extremely important not only to promote the ability to "acquire" offerings, but above all to diagnose and encourage actors to increase their absorptive capacity, which will improve the company's ability to sense and exploit opportunities arising from involvement in the cluster and external networks (Terstriepa & Lüthjeb, 2018). Companies can achieve the "lock out effect". If the company does not develop absorption capacity in a certain initial period, it may underestimate the importance of relational competences offered in the cluster population (Rudny, 2015). This may cause difficulties in subsequent processes of sharing competences, constitute a source of negative assessment of the existing cooperation, and thus reduce the assessment of readiness to further cooperation in the cluster and achieving any benefits. Absorption capacity of cluster entities is crucial for the effectiveness of the process of diffusion of relational competences (Stage IV). Therefore, internal cluster interactions not only contribute to generating new knowledge, increase the learning opportunities of companies. Frequent interactions foster the development of cognitive closeness and a shared knowledge base, facilitate communication, and increase the likelihood of collaboration (Terstriepa & Lüthjeb, 2018).

A competence map (supply and demand) will make it possible to identify which entities require support in terms of I4.0 and other fields, and what that support should be, and within the whole cluster population — what can the cluster offer. Mapping will match the technological capabilities of some companies on the supply side with the absorptive capacity on the demand side. Because as the preliminary study by A.M. Lis, M. Rozkwitalska indicates, if there are companies with different levels of technological capability in a cluster, it is reasonable to create smaller subgroups composed of businesses with similar levels of technological capability. This may translate into higher dynamics of their development in the technological area (Lis, Rozkwitalska, 2020). This also applies to the cooperation space of various entities from outside the cluster, where the compatibility of

competencies is a condition for increasing the dynamics of cooperation (Lis & Žemguliene, 2020).

Moreover, it also signals which individual components within such relational competences (assets, skills) can be combines through synergy to obtain new competences — in demand both in and outside the cluster — or which new competences should be obtained by accepting new entities in the cluster. All this requires the knowledge of the cluster coordinator about the heterogonal attributes pointed out by D. Corsaro, Ch. Cantu and A. Tunisini (2012). In L. Knop's model, this stage fits into the process of coordination and configuration of resources (Knop, 2013).

The perfectly conducted process of mapping the demand and supply of relational competences is a prerequisite for the effective course of the other stages of the model.

Stage II. Absorption of relational competences will take place according to the categories of individual competences that have been catalogued in the competence map (Stage I). The absorption process is supposed to involve acquiring knowledge, skills, etc. from cluster entities ready to share resources. It will be a process of acquiring, among others, knowledge, including, above all, classified knowledge in specific areas, but also in a specific group of people, which in the next stage will combine individual components of competences in a given area. This will allow for the synergy stage to combine very rare highly specialized resources in the desired configurations. Thanks to this, individual entities or groups of entities will implement projects that could not have been created if this knowledge, know-how was not absorbed in one specific space, e.g. a common competence platform using the most modern ICT solutions (RCFIC, 2019). Placing a variety of specialized resources in one place allows to generate conceptual and implementation solutions with a high level of technological advancement. Associating these competences will be possible thanks to a proper mapping of the really desired competences.

Stage III. Synergy of relational competences is directly related to Stage II. The integration of resources is an organizational activity, consisting in organizing them in such a way, allocating them to appropriate organizational units, developing appropriate ways of using them, which lead to achieving the expected results. This procedure is clearly directed internally to the organization and reflects the need to allocate resources and adjust them to static and dynamic elements in order to achieve a positive synergy effect (Czakon, 2008).

This is the crucial stage for clusters, namely the matching of co-operators in order to create new and complex competences using relational assets and skills from several entities in parallel. From the perspective of creating rare and crucial competences, which are also hard to copy, this is the stage coordinators should focus on. The synergy of the aggregated competences creates a strategic advantage. Once again, a competence platform is important here in terms of technology. But what is more important is a mutual trust platform among partners to share their achievements. This is because companies that maintain trusted relationships with cluster entities can not only benefit from increased transparency of available knowledge, but also benefit from reduced reliance on contractual guarantees in collaborative internal innovation within the cluster. Moreover, companies with higher levels of trust are better able to detect relevant knowledge, access such knowledge through formal and informal interactions and intended and unanticipated knowledge dissemination, and strategically use this knowledge to collaborate in innovation (Lüthje & Terstriepaand, 2018). In the presented model developed by D. Corsaro, Ch. Cantu and A. Tunisini all this fits into the process of integration of knowledge within the innovation network (Corsaro, Cantu & Tunisini, 2012), and in the case of L. Knop's model, into the process of creating value through aggregation of knowledge (Knop, 2013).

Stage IV. Diffusion of relational competence is the crucial stage from the perspective of effective cluster operations and the scale of advantages which are achievable by the largest portion of the cluster population. The availability of knowledge, other resources and cooperation partners within clusters favours companies' innovation performance (Götz, 2019).

Diffusion is a process of dissemination and interpenetration of knowledge accumulated and structured within the cluster as a competence integrator in Industry 4.0. The conditions necessary for the proper course of the diffusion process are: high efficiency and transparency of the offer acquisition process, promotion of products and services, quality and specialization of products and services, current diagnosis of the needs of beneficiaries (Citkowski, 2019). At this stage it is necessary to find answers to questions about the instruments and channels used for distributing the cluster competences across the whole cluster population and, depending on the decisions made by the cluster — also outside the cluster. It is important to precisely specify how those who are willing to offer support should do it, and what the expectations of those in demand are. Particular emphasis should be placed on a proper estimation of the relative absorption capacity of the entities to which the cluster diffusion is directed. Clustered companies must continually develop absorption capacity in various areas of

knowledge and improve the operation of the knowledge creation spiral in order to make full use of external knowledge and contribute to the development of knowledge (Arikan, 2009). In addition, it is necessary to take into account the specific, resulting from the heterogeneity of the cluster entities, the nature of the relationship of the entity, which is a sender and a receiver in the process of competence diffusion (Lis, 2017). In the process of knowledge diffusion, technological similarity between cluster entities will play an important role, especially in the implementation of solutions tailored to Industry 4.0. It is indicated that a large technological difference causes uncertainty regarding the cooperation coordination process and will strengthen differences in the absorption possibilities of knowledge from partners (Rudny, 2015). The implementation of solutions that meet the requirements of Industry 4.0, the cluster must not only work to ensure adequate accumulation of knowledge and innovation or facilitate the creation of know-how, but also secure the transfer of technology and guarantee all its members adequate access (Götz, 2019).

The final stage of cluster management in light of the specific requirements of Industry 4.0 is: *Stage V. Process Evaluation*. At this stage, the crux lies in answering the question of how effective and efficient these efforts are for the cluster as a whole and to its individual members. It is necessary to constantly monitor of the value chain: the current value of cooperation effects, the reasons for the decrease in efficiency in cooperation and the search for new links in cooperation. It is recommended to use a benefit measurement system in clusters as a key element in the evaluation of cluster management processes, which will verify measurable and measurable effects of intra-class cooperation. In the presented model developed by D. Corsaro, Ch. Cantu and A. Tunisini this fits into the process of coevolution of business-social relationship (Corsaro, Cantu & Tunisini, 2012).

At the stage of evaluation, it is necessary to assess which elements of the demand for relational competences and the supply of relational competences diagnosed in the competence map (Stage I) have actually been implemented. In addition, efforts should be made to properly determine the benefits of the conducted relational competence management process at cluster member level, and at the cluster level as a whole. Another challenge is to assess the degree of growth/decline in relational competences in individual cluster entities, including estimating the absorption capacity of cluster entities. All to prepare for the next cycle of cluster relational competency management.

Conclusion

Clusters are objective market structures with deep collaborative processes, which ensure the diffusion of various competences between its members to create the relational competences of the cluster. Development of collaboration, increasing number and strength of ties, the growth of cluster entities paired with the pressure to increase global competitiveness make it necessary to implement solutions which go in line with the concept of Industry 4.0. Thanks to the wide spectrum of relational competences, a cluster is the right ecosystem for facing the challenges of the fourth industrial revolution. Proper management of processes occurring at various levels of inter-organizational relations in the cluster population is a prerequisite.

The challenge lies, therefore, in finding an effective management model in order to make full use of the attributes of the cluster, optimizing the level of obtained relational rent at the level of a single cluster member and the cluster as a whole.

In order to meet the goal set at the beginning of the study, the proposed model for managing the relational competences of the cluster was proposed in the fourth part of the article. The focus in the model on the relational competences of the cluster results from the fact that the benefits of cluster relationships are derived from the degree of readiness to enter into relationships, involvement in relationships, and thus the degree of propensity to share resources. As a result of access to new resources, companies benefit from these relationships, while stimulating the development of their absorption capacities. Consequently, enterprises expand their relational competences in order to enter into subsequent relationships consisting in sharing relational competences that are at the entities' current disposal.

The challenge for the cluster coordinator is to ensure the efficiency and effectiveness of the above-mentioned processes inside the cluster. For this purpose, a model of cluster relational competence management was proposed.

Receptiveness and trust in clusters is the starting point for technologically advanced collaboration in terms of implementing the idea of Industry 4.0. Also, Industry 4.0 makes it necessary to have compatible material and immaterial infrastructure. It is important to properly diagnose and map relational competencies in cluster entities, diagnose not only their openness to entering into relationships, but also their ability to make optimal use of these relationships. Continuous dialog and established relational competences of cluster entities will unlock the channel of accumulated diffusion and, often, non-utilized or under-utilized competences (including

knowledge) in enterprises, all for the benefit of the cluster population. Combining the competences of cluster entities may cause new competences to be placed inside the cluster, not belonging to any of the entities, as well as at the interface of two or a group of entities cooperating in the cluster and generate new elements of relational rent. On this occasion, entities involved in the process of sharing competences as well as in the process of synergy of competences develop their relational competences by simultaneously acquiring new relational assets and developing new relational skills.

The proposed cluster relational competence management model, in the face of the challenges of Industry 4.0, should be rooted in a high level of transactional trust between cluster entities. The process of synergy of relational competences, and then diffusion, taking place within the framework of cluster cooperation should be built on the compatibility of technological and social infrastructure between cluster entities. In addition, the relational competence management process for Industry 4.0 should guarantee a continuous diagnosis of the population of co-operators, including the structure of the flow of inflow and use of competences inside the cluster, a continuous diagnosis of effective demand and supply of relational competences and measurement of benefits resulting from functioning in the cluster.

In view of the above, the cluster coordinators face the challenge of guaranteeing the security of property rights in the process of absorption, synergy and diffusion of competences, i.e. an above-average level of cyber security. Cybersecurity, which on the one hand is an element of Industry 4.0, on the other hand, is a prerequisite for the effective implementation of the model to meet the requirements of the fourth industrial revolution.

The advantage of the proposed model is the focus on the key element of management processes, which are the relationships and expectations of entities as to the benefits of these relationships. This is due to the core attribute of the cluster, which is coopetition in favour of the expected benefits in this respect. The proposed model is particularly applicable in network organizations with a large number of inter-organizational interactions. Its limitation may stem from the relative versatility of the instrument. In the author's opinion, the role of a specific cluster coordinator is to specify the types of relationships in relation to the nature of the cluster resulting from the industry specialization of the cluster.

The presented context of relational competence management between cluster development and Industry 4.0 requires further in-depth research (both qualitative and quantitative) on cluster populations. The challenges include answering the question of what set of arguments determines the company's strategic decision to start the process of cooperation within a cluster and enter into the sphere of inter-organizational relations. Which variables in the cluster contribute to the absorption capacity of the enterprise involved in the process of sharing relational competences, and what is the extent of their impact?

Notes/Przypisy

[1] The Metal Processing Cluster is a cluster established in 2007 in Podlaskie Voivodeship, but as its membership exceeds 120 entities, including 100 enterprises, it covers a significant part of Poland. Cluster entities represent mainly the metal and machinery industries, but also the IT, medical, agricultural and boatbuilding industries.

[2] The measure was carried out by the Metal Processing Cluster (Key National Cluster) and was coordinated by the Centre for Promoting Innovation and Development based in Bialystok. The project was commissioned by the Ministry of Entrepreneurship and Technology in March 2019 in Warsaw.

[3] Results and participating observation in the project: Regional Centre of Future Industrial Competence SUPERFACTORY as dispersed system, Ministry of Entrepreneurship and Technology, March 2019.

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