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A Network Approach in Strategic Management: Emerging Trends and Research Concepts

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Network approaches and strategic management: Exploration opportunities and new trends

Beata Barczak[1], Tomasz Kafel[2], Pierpaolo Magliocca[3]

Abstract

PURPOSE: *The analysis of the literature shows that the attempts to conceptualize the strategic aspects of the network bring a significant impact on the development of research on organizational networks. This article aims to analyze the new trends in strategic management, and in particular on the possibility of exploring the network approach in strategic management, through the existing literature and the presentation of the new contributions of the following articles published in the current issue.* ***METHODOLOGY:*** *The article is descriptive in character; thus it is based on a literature review and its constructive critics. A narrative literature review was used to present the main assumptions and features of the network approach in strategic management, along with an indication of emerging trends and new directions. Also the identification of theoretical foundations for understanding the processes of strategic change in inter-organizational networks and the proposition of the way to understand network strategy were presented.* ***FINDINGS:*** *The research included in this issue shows that from a network perspective, business strategy plays an important role in guiding the development of individual relationships and networks. Exploring the network approach in strategic management allows one to adopt the category of network strategy, which can be described through the coexistence of cooperation and competition.* ***IMPLICATIONS FOR THEORY AND PRACTICE:*** *Considerations lead to the conclusion that the business strategy must be expressed in terms of potential changes in the network in which the company operates, taking into account its*

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current and selected position in the network. Despite the fact that the current state of research on organizational networks in the theory of strategic management shows that this approach is already quite well established, on the basis of the analysis of research results concerning the conceptualization of strategic aspects of the network, the existing problems and limitations were identified. ***ORIGINALITY AND VALUE:*** *The main problems related to the exploration of the network approach and the resulting consequences for the definition of the network strategy were indicated. Also, the combination of an organizational and economic approach with the logic of competitive advantage and relational annuity. The demonstration that the network perspective in strategic management allows for a more complete understanding of the strategic behavior of modern enterprises.*
Keywords: *network, network strategy, network approach, strategic management*

INTRODUCTION

In today's changing competitive environment, enterprises, traditional markets, and hierarchical organizations are partly replaced by inter-organizational networks (Achrol & Kotler, 1999; Gulati, Nohria, & Zaheer, 2000: Håkansson & Ford, 2002; Möller & Halinen, 1999: Ring & Van de Ven, 1992; Wang, Chen, & Fang, 2021). Inter-organizational networks have become a way of describing the new reality created by complex social, economic, and technological changes. The accelerator in this process is the technological factors taking the form of the fourth industrial revolution (Industry 4.0) (Barczak, 2016, 2020; Wang, Yang, & Guo, 2021). Along with the development of the network concept, the so-called network approach was developed, which emphasizes the importance of the whole company's contacts with the environment, forming an extensive network of connections.

Modern research indicates a wide range of possibilities for exploring the network approach in the field of strategic management. The shift towards increasingly networked business environments raises the question of whether current strategic management theories still offer the right picture of business strategy. Traditional theories of strategic management place great emphasis on gathering and controlling resources within one company. However, adopting a network perspective points to the need to establish external relationships to gain access to resources (Tikkanen & Halinen, 2003; Baum & Rowley, 2008). The logic of strategy based on a traditional approach is no longer applicable in a reality where organizations are increasingly linked and networked. These organizations compete and cooperate at the same time, they are forced to reorganize their resources constantly, and their boundaries are blurred. This is reflected in the increasingly accepted economic practice

paradigm of the network economy or the economy of sharing. Today, we are even talking about a network society (Castells, 2010).

The dynamic development of the concept of inter-organizational networks has put management theorists, who previously analyzed the relationships between actors in dual systems, before a series of completely new and so far insufficiently described and explained problems, relating to the nature, sources of competitive advantages, and conditions of effectiveness of network structures.

This article aims to analyze the new trends in strategic management, particularly the possibilities of exploring the network approach in strategic management, through the existing literature and the presentation of the new contributions of the following article. The starting point is the discussion of the evolution of strategic management and the network approach, which allowed to indicate the limitations and basic research areas in the field of exploring the network approach in strategic management, as well as to present the contribution of the articles in this issue to the discussion on the possibilities and directions of the network approach development in strategic management. We also pay attention to neostrategic management as a concept that points to networking the organizations as a way to solve enterprises' problems in the 21st century and the possibilities of obtaining a synergy effect in designing the organizational network through the integration of digitization, sharing economy, or a friendly ecosystem.

We use a narrative literature review to present the main assumptions and features of the network approach in strategic management and indicate emerging trends and new directions. The contribution of this article is to identify the theoretical foundations for understanding the processes of strategic change in inter-organizational networks and to propose a way to understand network strategy as a dynamic and emerging process that makes it possible both to manage the development of inter-organizational relationships and networks and to remain under their influence.

In this continuous process, the formulation and implementation of the strategy becomes an inseparable and integral part of relationship management. It has been pointed out that networks are unique, value-creating constellations of resources and competences, and companies can act both to adapt to the requirements of the network and to changes and external stimuli. In particular, the article describes the possibilities of exploring the network approach in strategic management, pointing out significant problems and limitations in this area.

LITERATURE REVIEW

The development of strategic management concepts

The achievements of strategic management are continuously enriched by the current research results in economics and, above all, in the management sciences. The following diversification in this field, which we are witnessing today, dates back to the 1980s, when economics, organizational sociology, and political science-oriented fields began to develop. New theories have also emerged, such as: transaction cost economics, agency theory, contemporary game theory, evolutionary economics, resource theory, resource dependency, organization ecology, new institutionalism (Rumelt, Schendel, & Teece, 1994).

A significant influence on the way the strategy was perceived was the development of the resource approach, which directed the researchers' attention towards the resource matching of many organizations in order to gain an advantage due to the configuration of resources and the ability to use them efficiently. In addition, theoretical perspectives such as evolutionary or networking perspectives have emerged. The ambition to analyze phenomena at the level of entire populations, not just individual organizations or their pairs, is reported. The evolutionary approach recognizes acceptable strategies in business ecosystems (Mouzas & Henneberg, 2008; Wang, Chen & Fang, 2021). By focusing on interdependence with other organizations, it imposes a dual obligation on the strategist to take the most favorable position possible in the business ecosystem and influence the coevolution of companies to maintain or increase benefits in the future (Czakon, 2017). The network perspective, on the other hand, has been developed by including more than one relationship, which is tantamount to expanding the research field beyond a single alliance, further beyond the portfolio of alliances perceived egocentrically by the company to the network structures in which it is embedded (Czakon, 2012). The focus of the researcher's attention shall be on a single relationship, a set of relationships by their characteristics, nodes by their characteristics, nodes by their position, and a set of network nodes by their characteristics.

The development of strategic management concepts is still progressing and we can see two dimensions in this transformation. The first of the dimensions is related to the emergence of subsequent, new strategic management concepts, which often hark back to the previous schools and approaches. The second dimension of development applies to the operationalization and adjustment of the previous concepts to the changing conditions. These changes have specific consequences, both for the strategic management process and the future research areas related to the strategic

management concept. The contemporary conditions of business operations create new challenges for strategic management. These include, for instance, the use of dynamic capabilities in strategy building (Segal-Horn, 2004; Teece, 2007; Krzakiewicz & Cyfert, 2014; Herhausen, Morgan, Brozović, & Volberda, 2021), relational strategies (Zakrzewska-Bielawska, 2017), networking of organizations (Krzakiewicz & Cyfert, 2013; Czakon, 2016), technology development and automation of processes (Schwab, 2016), global strategies (Porter, 1986; Gupta, Govindarajan, & Wang, 2008). In view of these challenges, some researchers postulate the assumption of a new term: neostrategic management (Vrdoljak, Raguž, Jelenc, & Podrug, 2016). According to their assumptions, the key disciplines shaping neostrategic management are strategic entrepreneurship, spiritual management, behavior strategy and cognition, and strategy as practice. Among the disciplines shaping neostrategic management, the authors of the term have also identified supplementary disciplines, such as entrepreneurship, cognitive and social psychology, spiritual and religion movements, sociology, and anthropology (Vrdoljak et al., 2016). In the proposed neostrategic management concept, its creators have addressed an important and valid problem of adjusting the strategic management concept to the new economic conditions of the 21st century. In this concept, particularly valuable is its link to the problems faced at present by the strategic management concept and an indication of the proposals to solve these problems. These solutions oscillate around such areas as networking the organizations, a multidisciplinary approach to strategic management, continuous improvement of strategy (in accordance with the idea of a learning organization), the enterprising nature of strategic thinking, and strategic group leadership (Vrdoljak et al., 2016; McGrath 2013).

The development of strategic management has also been significantly influenced by two factors (Schwab, 2016: Wang, Yang, & Guo, 2021):

- the advent of the era of the knowledge-based economy (KBE), where information and knowledge are the key resources of an enterprise;
- the advent of the era of Industry 4.0, which assumes that companies will create global networks, including machinery, storage systems, and production facilities in the form of Cyber-Physical Systems (CPS).

To sum up, if we take an evolutionary perspective as a starting point, the development and evolution of strategic management can be presented in three eras (Venkatraman & Subramaniam, 2002):

- firstly, the era in which strategy is seen as a business portfolio (traditional strategic management);

- secondly, as a portfolio of opportunities (competency-based perspective);
- thirdly, as a portfolio of relationships (network approach to strategic management).

Each era presents a specific way of approaching strategic management and the formulation of that strategy. One can be tempted to say that the third era, strategy as a portfolio of relations, is still a poorly recognized area. It is a collection of fragmented ideas, not an established area in the field of strategic management. It is, therefore, also a rather amorphous perspective.

Network approach

In the literature on management sciences, one can notice enormous terminological diversity related to networks, probably resulting from the interdisciplinary nature of this concept. The heterogeneity in the perception and explanation of this issue results from the fact that the network ontology, not to mention epistemology and methodology, is only in the incubation and development phase. One may be tempted to say that the network concept is still amorphous, not thoroughly researched, and poorly structured. The aforementioned heterogeneity of the perception of the network is reflected in the multiplicity of definitions of organizational networks. A review of the literature in this area shows great cognitive value, and at the same time, confirms the multiplicity of views on network structures. An attempt at organizing various approaches and definitions of networks is the proposal to formulate the understanding of the network by researchers into three main approaches (Światowiec-Szczepańska & Kawa, 2018):

1) Metaphorical – the term "network" is used as a metaphor for new organizational phenomena related primarily to the change of theoreticians' orientation from dyadic relations to a constellation, portfolio, or system of relations maintained by an organization. This approach largely corresponds to the phenomenon of strategic networks, strongly represented in management science theory. It also directly refers to the indirect form of coordination between the market and the hierarchy, which is the network.
2) Graphic – refers to an attempt to faithfully reflect the structure of connections within the enterprise or enterprises with other external entities. The aim here is a kind of "mapping" or "imaging" of the network (Abrahamsen, Henneberg & Huemer, 2017; Czakon, 2017; Knoke & Yang, 2020).
3) Mathematical – refers to the treatment of networks in mathematical terms, which focuses on the application of graph theory and mathematical

tools to analyze network structures, often considered more important than the network context itself. An example is research in the field of complex networks, including small-world models or scale-free networks (Barabási, 2003; 2016).

The network approach has become more and more important in management theory and practice in recent years, and a multitude of studies related to networks and network approaches can be seen in the literature. As a new concept of cooperation between business entities, it was developed in the late 1970s as a result of technological changes in the business-to-business (B2B) market and increased international competition. It was then that the role of the company's contacts with its environment began to be noticed and highlighted, which formed an extensive network of connections. The 1990s brought an increase in interest in researching relations and links between companies. Breakthrough views in this area were presented by the IMP – Industrial Marketing and Purchasing Group. Among the creators of this model, Swedish researchers H. Hakansson, J. Jahanson, A. Lundgren, L.G. Mattsson and G. Easton (cooperating with Swedish researchers) have had major contributions. The Swedish model refers primarily to industrial markets, where there are networks of interconnected companies (Jahanson & Mattson, 1993, p. 19). The basis of the model of industrial networks is formed by links in terms of entities, activities, and resources.

The network approach is based on the assumption that there are other participants in the exchange in commercial transactions, apart from suppliers and customers, creating various interdependencies. This creates a complex network of participants involved in various forms of exchange, having various effects on transactions and the state of relations between supplier and buyer, both during and between transactions (Sashi, 2021).

The achievement of this trend is to describe a business network model defined as a set of long-term formal and informal (direct and indirect) links (relationships) that exist between two or more entities (Hakansson & Snehota, 1995; Wang, Chen, & Fang, 2021). The Swedish school's work provides the genesis for a contemporary approach to networking and the basis for reflection on business networks and industrial districts, and cluster models.

The network approach defines the way of describing and analyzing reality (organizations, institutions, phenomena). The application of the aforementioned network metaphor allows the indication of the regularities that constitute research areas for the organization and management sciences. An interesting issue is the measurement of the influence of particular network measures on the efficiency of nodes, as well as the whole system. These issues are dealt with by network analysis, which uses SNA (*Social Network Analysis*)

methods (Knoke & Yang, 2020; Scott, 2017). The network analysis method is distinguished from conventional social research tools by the fact that its focus is on the so-called relational data, not attributes. This method allows one to study complex multi-element and multi-level structures of relations between different types of social entities and uses graph theory to study social phenomena. Using data about relations, network analysis allows one to study the structure of relations between individuals, as well as the dependence of the structure on the attributes of individuals and the impact on processes that occur through relationships (transactions, information flow, cooperation) (Batorski, 2008; Knoke & Yang, 2020). For example, in organizational research, the analysis of the structure of communication in an organization can identify informal relationships, the importance of individual units for information and knowledge flows, as well as identify informal leaders (Kilduff & Tsai, 2003). Currently, the analysis of social networks is a tool rooted in the tradition of many disciplines (e.g., mathematics, sociology, anthropology, statistics, etc.). Among others, the following researchers and experts are considered to be the main creators and promoters of SNA: Stanley Wasserman, Steve Borgatti, Philippe Bonacich, Berry Wellman, Linton C. Freeman, Valdis E. Krebs, Mark Granovetter, David Knoke, and Rob Cross.

The development of the network approach was significantly influenced by research on scale-free networks and small-world networks. In the 1990s, Hungarian physicist Albert-László Barabási discovered that a number of networks (from the Internet, through the cellular metabolic system, to the network of connections between Hollywood actors) are dominated by a relatively small number of nodes connected to many other points of the network.

In the literature on organizational networks, apart from the terms networking, network approach, the term "network paradigm" appears which means abandoning the unrealistic assumption of atomization of the enterprise environment in favor of structuralism. The network paradigm takes over the postulates of structuralism, explaining the embedding of every business activity in the systems of social relations. According to the authors, the key significance of the network paradigm is to discover a certain structural order in social networks. On the one hand, this means the need to consider the network as a context for action, and on the other hand, it implies methods of learning about the network. This network order can be measured, parameterized, and studied with the help of social networks analysis. It affects the very possibility of action, which is not the same for individual actors, and the effects of their actions. It reveals the privilege of some actors and the advantage of some types of networks over others (Czakon, 2012; 2016: Knoke & Yang 2020; Scott, 2017).

The broader context for considerations on the network approach is the concept of "network science." Network science, whether it is rooted in the social sciences, computer science, or the natural sciences such as physics or biology, has three general, interrelated, and ongoing goals: (1) to measure, describe, and categorize network structure and the patterns of relationships between network nodes; (2) to understand network evolution and growth and its relationship to network structure; and (3) to understand how the collective behavior of entities connected in a network depends on and derives from the network's structure. Many open questions exist at all three levels. The overall intuition behind the interdisciplinary conversations that characterize "network science" is that common structures, growth patterns, and collective behaviors will arise in networks composed of very different kinds of elements and linkages. If this is the case, common concepts and methods will be useful in understanding widely varying networks and in answering the very different substantive questions posed by physicists, biologists, computer scientists, sociologists, and, most recently, by organization, management and strategic management (Strandburg et al., 2006).

The above considerations show that the possibilities of exploring network theory are very large. This applies to many disciplines, including management and social sciences. The research areas presented are interdisciplinary and amorphous. Many concepts are emerging, which proves that the coming years will be associated with the further development of the network approach.

Theoretical basis of network research in strategic management

One of the important issues, which enable the formulation of rules for the creation, functioning, and management of organizational networks, is to indicate the theoretical basis of the network concept. Therefore, it is necessary to search for possible links with a large number of theories and methodological schools. The most frequently used theoretical bases in network research in strategic management are the theories of embeddedness, resource, resource dependence, social capital, and industrial networks. It is worth noting that these theories can be used for both emergent and intentional networks research (Światowiec-Szczepańska & Kawa, 2018).

Sources of network origin, particular processes taking place in them, coordination issues and the mechanism of network functioning are closely related to certain specific theories. It seems that the research theories related to the network issues can be arranged as follows (Table 1).

In the context of the cited network theories, it is easier to understand the ongoing discussion in the literature concerning the network theory itself. The most common thesis is that there is no universal network theory,

and individual network models have their foundation in different theories. Światowiec-Szczepańska and Kawa (2018) indicate four areas of research: contamination, convergence, capitalization, and position in the network.

Table 1. Theories underpinning the development of the network concept

Economic theories	Social (sociological) theories	Modern theories in management sciences	Mathematical approach
• transaction cost theory • contract theories (the contents of the "black box" are analyzed) • ownership theory • contract theory agency theory • *corporate governance* • game theory	• embeddedness theory (including relational embeddedness theory) • functional and structural theory • interactive approach • sociological concept of social network • analysis of social networks • actor-network theory • relational capital theory	• resource theory • capital concept • resource dependency theory • the concept of knowledge management • the concept of organizational learning • cognition theory • complexity theory • quota theory • business ecosystem theory • institutional theory (institutional • isomorphism) • industrial network theory	• graph theory • scale-free theory • small-world theory • structural gap theory • theory of weak/ strong ties • complex systems theory

Research in the area of contamination (diffusion and adaptation) is based on theories of: learning and innovation, cognition, business ecosystem, in the area of convergence: industrial network theory, small-world theory, structural equivalence theory, in the area of capitalization: resource theory, deposition theory, relational capital, structural gap, weak/strong bonds and in the area of position in networks: graph theory, scale-free theory, small worlds theory, structural gap theory.

Literature analysis reveals that only a few researchers, mainly from two research areas, (1) IMP's theory of industrial networks (Håkansson & Snehota, 1995; Sashi, 2021) and (2) strategic network research (Czakon, 2012; 2016; Gulati, Nohria, & Zaheer, 2000; Jarillo, 1988; Niemczyk, 2013; Wynstra, 1994; Kosch & Szarucki, 2020; Hettich & Kreutzer, 2021) address the issue of a strategic perspective in inter-organizational networks. This phenomenon is already addressed by the issue of a strategic perspective in inter-organizational networks. In line with the approach represented by the IMP Group's mainstream research, the creation of a business network and network connections does not constitute an active implementation of the

strategic plan of one main company. However, the principle of the strategic equivalence of entities is far removed from economic reality. Often, among entities connected by relationships, a dominant company (or companies) can be distinguished in this respect, and companies increasingly consciously create business networks focused around themselves. Such relationships illustrate the strategic approach to the creation of networks. In contrast to the IMP Group's mainstream research, the strategic approach emphasizes that there is usually one main actor supervising, managing, and creating the network strategy (the so-called network leader – hub firm, network captain). The resulting strategic network[4] has more formal links than the business network described by the IMP Group. More formal links do not exclude the importance of informal relations (Ratajczak-Mrozek, 2010). The direction of linking the idea of network and strategic management is therefore still emerging and rather amorphous.

The main problems of the network concept in strategic management

Networks have become a widespread concept, both in social and economic life. For this reason, some authors have considered it as "defining the paradigm of the modern era" (Kilduff & Tsai, 2003, p. 13) or as the "dominant metaphor of our times" (Clegg, Josserand, Mehra, & Pitsis, 2016, p. 278). There is no doubt that the network concept has achieved great popularity in recent years and is used in various research areas in management. Currently, the literature on inter-organizational networks is vibrant, and many authors are trying to define principles describing a "coherent" understanding of the network approach and theory as one of the disciplines of network science. This science has achieved significant development in the 21st century and has become one of the most active interdisciplinary research areas according to the principle that "networks are everywhere" (Barabási, 2016; Christakis & Fowler, 2011; Newman, 2010). However, it is not entirely certain that the research conducted so far has contributed to the development of a coherent network theory. It seems that its existence is not a foregone conclusion but rather that it is in the development and testing phases. It is also questionable whether there is a consensus in the management sciences on what the network actually is, or whether it should be assumed that the network may have different meanings in different contexts. The main reason for this seems to be the interdisciplinary nature of this concept. The concept of

4 Strategic networks are long-term, targeted agreements between independent but affiliated organizations that enable them to gain or maintain a competitive advantage over companies outside the network (by optimizing operating costs and minimizing coordination costs). The concept of a strategic network clearly follows the network approach, in line with the IMP Group's current approach, breaking only with some of its assumptions, such as the absence of a dominant entity and the non-strategic selection of affiliate partners.

'networks' is currently a central issue in many fields, including social sciences, communication, computing, physics, and even biology and ecosystems (Dorogovtsev & Mendes, 2003; Barabási & Bonabeau, 2003).

The importance of network science can be considered from the point of view of the emergence of a new paradigm, introduced by Kuhn (1962) as a set of concepts and theories that form the basis of a given science. The aforementioned researcher indicated that science is undergoing periodical paradigm changes. One can risk a claim that today we are witnessing such a change and the emergence of network science as a scientific discipline (Lewis, 2011). This emergence is mainly inspired by empirical research on networks in the real world, including technological networks (Balthrop, Forrest, Newman, & Williamson, 2004; Gemünden & Heydebreck, 1995), biological networks, information networks (Wellman, 2001) and social networks (Scott, 2017; Wasserman & Faust, 1994: Knoke & Yang 2020) and the discovery of common principles that govern them (Ujwary-Gil, 2020; 2019).

The growing popularity of network organizational solutions has led some researchers to see them as the dominant feature of the new paradigm also in strategic management. The presence of the network as a new model of competitiveness and value creation research has given rise to the consideration of the network paradigm (Batorski & Zdziarski, 2009; Borgatti & Foster, 2003; Czakon, 2012; Hettich & Kreutzer, 2021). The literature points to the rationale for moving away from strategic management towards strategic "shaping the network" (Bowman, 2000, p. 35), as well as the need to change the branch and resource concept to understand the strategy as a "portfolio of inter-organizational relationships" (Dyer & Singh, 2004). However, it should be noted that the legitimacy of this type of postulate has not been so far confirmed by empirical research.

The current state of research on organizational networks in strategic management theory shows that this approach is already quite well established. Analysis of the results of research conducted after 2000, relating to the conceptualization of strategic aspects of the network (Krzakiewicz, 2013; Wang, Yang, & Guo, 2021; Wang, Chen, & Fang, 2021; Jussila, Mainel, & Nätti, 2016) indicates that there are certain limitations in the discussed scope:

1) Despite many attempts, no generally accepted definition of the concept of network organization has been developed. The analysis of studies representing such sciences as economics, management sciences, sociology, psychology of organization, ecology allows us to conclude that this large variety of approaches translates into difficulties in making a precise definition.

2) The network's competitive advantages and competitive advantage annuities have become the subject of discussion in the literature on strategic management. However, the first attempts to study the strategic aspects of the network's functioning have already indicated the existence of significant theoretical problems. First of all, a contradiction has emerged between the underlying rationale of team-based managers and managerial control and the need to operate on the basis of cooperation and agreements (negotiations) in the process of creating and managing networks (Krzakiewicz, 2013; Wang, Chen, & Fang, 2021). Secondly, the existing paradigms relating to the ways in which companies' strategies are examined proved to be insufficient. The approach to analysis from the position of the sector structure, developed by M. Potter, was quickly rejected as not very useful from the perspective of the reality of network structures; also the traditional resource-based approach, in which the basic unit that is analyzed is not the sector, but individual entities operating in the sector, proved not fully useful. According to the resource concept, competitive advantages are within the organization, whereas according to the network structures, the network actors do not try to hide their individual competencies and skills from the rest of the participants, and assets are allocated within the network, due to the pursuit of synergistic business potential.
3) The consequence of modern competitive conditions is the need for organizations to complement their internal competencies with as many external relations as possible. The above assumption was formulated within the concept of strategic management as a "portfolio of relations." It seems, however, that the concept of a "portfolio of relations" can be treated in terms of complementing the preceding concepts of a "business portfolio" and "capacity portfolio." These three concepts point to a separate source of creating competitive advantages – the stage of evolution, economies of scale and diversity, and diversity of expertise, respectively[5]. However, the creators of the concept of the strategy as a "portfolio of relations" admit that it has not yet gone beyond the considerations of defining its distinctive characteristics. However, the basic principles of building inter-organizational networks have not been defined, it is not clear how to conceptualize a business structure that is embedded in a specific organizational system, what possibilities this concept provides in terms of explaining differences between companies and how to measure the competitive advantage shaped by networks (Venkatraman & Subramaniam, 2002; Krzakiewicz, 2013; Wang, Chen, & Fang, 2021).
4) A certain difficulty in interpreting the income generated by networks and in the network is caused by the location of the reference point (in the

5 The concept of economy of expertise is related to the benefits that a company obtains due to its central position in the network, which provides it with privileged access to sources of knowledge created in the network. This makes the inter-organizational network the object of strategic management research.

context of network solutions, however, the problem of generating added value from a wider perspective than just that of the individual parties to the contract very often arises) and additionally the dynamics of the business processes themselves is too high.

5) A particular problem related to the perception of organizational and inter-organizational networks is the definition of what is inside an organization and what can be considered as its environment. The boundaries of the network are fluid; the boundaries of the network are blurred.
6) Network learning is associated with a number of additional, current challenges (Kocarev & In, 2010; Wang, Yang, & Guo, 2021), relating to how to draw conclusions from network data (e.g., how to characterize the network, its structure and properties; what are the processes that take place in networks). These challenges are related to a number of problems, such as the problem of missing links in the network or understanding the dynamics of processes taking place in the networks. There are almost as many dynamic phenomena as there are networks. However, our understanding of the flow mechanisms, long-term dynamics or interdependencies in the network is still far from being clear.

Towards a network approach to strategic management

In the context of the above considerations, it can be concluded that the key issue in the framework of the network approach is to indicate its consequences for the definition of the strategy. In the most general sense, a strategy always refers to the objective and the means by which the objective will be achieved, and can therefore be considered a fundamental part of any company. The approaches described so far have pointed out various determinants of the strategy. In the case of the planning approach, the archetype of strategy was the question of the scale of market or product development. In the positional approach, the company could beat the competition with a low-cost or differentiating strategy. In the resource approach, the basic dilemma was about competence development in relation to market development. The innovative and entrepreneurial approach, on the other hand, indicated an opposition in the form of activation in the blue ocean or a conservative attitude in the red ocean (Niemczyk, 2012). The exploration of the network approach in strategic management allows us to adopt the category of network strategy, which can be described through the coexistence of cooperation and competition. Starting from the assumptions of the relational and network approach, network strategy can be defined as a continuous and dynamic process of choices concerning the establishment, development, as well as withdrawal from inter-organizational relations, made under conditions of uncertainty (limitations, pressures, and opportunities) to:

- maintain and develop the capacity of the organization;
- create and capture the value;
- receive a relational annuity and widely understood benefits from network cooperation.

It is also a process of continuous strategic choices:

- selection of key partners (competing and/or non-competing);
- the way the relationship is created (intentional and/or emergent);
- the dynamics of the relationship (decisions about their establishment, development or withdrawal, the duration of the relationship, the intensity of the relationship, the nature of the relationship: concentration on cooperation and/or coopetition);
- how to create value and capture it.

The network strategy should also specify:

- the company's internal resources and competences;
- expectations towards external organizations;
- the type of external links that will provide access to the required resources and competences.

Such a strategy implies that an organization is an intentional and entrepreneurial entity with a unique specialization of resources and competences, acquiring external resources and competences and developing interactions with other organizations. There are strategic conflicts within a network organization when network actors pursue their own goals and have their own perception of the network and the parties interacting.

From a network perspective, business strategy plays an important role in guiding the development of individual relationships and networks. The business strategy must take into account the interdependencies between actors who are linked by direct or indirect relationships (Juttner & Schlange, 1996; Hernandez & Menon, 2021). The resources and competencies that provide the existing portfolio of relations and ways of developing and using it are vital here. Furthermore, the business strategy must be expressed in terms of potential changes in the network in which the company operates, taking into account its current and selected position in the network (Johanson & Mattsson, 1992; Kumar & Zaheer, 2019).

Due to interdependencies and the mechanisms of change and dynamics in the networks (Håkansson & Snehota, 1995; Hedvall, Jagstedt, & Dubois, 2019; Hettich & Kreutzer, 2021), it can be said that it is not only strategy that influences the development of an organization. An organizational network also influences business strategy. Many of a company's strategic choices and actions are a response to the actions of other companies (Ford et al., 1998)

and changes in the network of relations. The company's strategy and the network of relations are interconnected.

It is worth noting that so far network research has focused primarily on recognizing the benefits of inter-organizational collaboration, indicating that collaboration and coopetition contribute to achieving synergistic effects, gaining access to resources, their exchange or general improvement of the organization's performance and efficiency through collaboration (Ritala, Ellonen, 2010; Czakon, 2012; Kobayashi, 2014; Hettich, & Kreutzer, 2021). Meanwhile, inter-organizational cooperation may also result in the loss of potential opportunities or destruction of values. Therefore, the implementation of a network strategy may not only bring benefits, but is also associated with negative effects, risks, and costs (Alders, Van Liere, Berendsen, & Pieters, 2010; Mitręga & Zolkiewski, 2012; Hernandez & Shaver, 2019; Jussila, Mainela, & Nätti, 2016).

Summarizing the above considerations, one can point to several conclusions:

- the analysis of the literature shows that the attempts to conceptualize the strategic aspects of the network bring a significant impact on the development of research on organizational networks, but the analyses and research reveal many shortcomings resulting mainly from the narrow treatment of the problem from the perspective of individual disciplines;
- the use of the network approach in strategic management theory allows for a better understanding of the strategic behavior of modern companies;
- particularly important for the development of a network approach in strategic management is the combination of an organizational and economic approach with a logic of competitive advantage and relational annuity;
- the network approach in strategic management should be more explicit about how organizations can use their belonging to an inter-organizational network to increase their competitiveness and competitive advantage, as well as the strategic actions needed to achieve strategic success;
- although many researchers seem to have touched on this area, aspects of the mutual, very important exchange between the strategy and the network still need to be explored.

Contributions

The authors of the papers submitted and accepted in this special issue of JEMI addressed emerging trends, research concepts, problems, and challenges

that refer to the contemporary approaches to the network perspectives in strategic management.

In this issue, the collection of articles shows how different and distant the research fields can be in which the concept of network approach is applied in strategic management. Our scholars cover areas such as: a review of the literature on networks and network strategies to develop a new theorization based on a systematic review of the literature; the seeking of another research path to examine the contribution of networking to strategic management; the definition of the network of scientific and technological policies in the form of social networks; virtual reality and its synergistic effects in network interconnections; the development of an economic model that connects strategic management and network theory; the notion of network resource distribution to study how business resources and network structure work together to influence business performance.

All the articles present the findings of both conceptual and empirical research, in this last case conducted with the use of both qualitative and quantitative research methods and with the application in different countries such as the USA, Iran, and the Czech Republic.

The article by **Rossella Canestrino and Amir Forouharfar** introduces a broad all-embracing taxonomy of networks and its relevant strategies to make easy and efficacy the learning and teaching of the basic concepts of networks in strategic management. The research was conducted by a systematic literature review (SLR), on the assumption that the introduced taxonomy and its corresponding strategies should represent the synthesis of the current literature in the studies on strategic networks. As a result, the research focused and revealed seven potential configurations of the networks and then the proposition of their relevant strategies with regard to the networks' relationships and forms. These networks are as follows Reciprocally Interdependent Networks, Sequentially Interdependent Networks, Partnering Networks, Complementary (Overlapping) Networks, Supporting (Logistic) Networks, Distributing Networks, and Co-Innovation Knowledge-Sharing Networks and, at the same time, their corresponding network strategies were identified as Multi-Level Promotion Strategy, Just-In-Time Strategy, Network Partnership Strategy, Compensatory Strategy, Network Logistic Strategy, Distributing Network Strategy and Network R&D Strategy respectively. From the point of view of the implications for theory and practice, this paper helps all scholars through a comprehensive and concise means of systemizing and classifying networks and their own strategies in an attempt to bridge an existing gap in literature: these efforts invite future research and conversation about networks and network strategies. Based on completed studies, a conclusion can be formulated that inspiration for their

research is the lack of consensus on theories and conceptualizations in the study of strategic networks.

The intent of **Nancy J. Miller, Carol Engel-Enright** and **David A. Brown's** research is to fill some of the gaps in interorganizational networking strategy by analyzing five antecedents that have been suggested in the literature as individually associated with entrepreneurs' engagement in network ties. As the activities of others influence each firm and thus all direct and indirect relationships shape and influence the firm's strategic management, these relationships are key to accessing and creating knowledge and other strategically important resources. Research work is framed by the resource-based view of the firm perspective and social capital theory and its shared constructs in network theory. In this way, it provides another research avenue for examining networking's contribution to strategic management. By a quantitative approach, the research group tested their proposed macrolevel direct and moderating connections through an online survey of 125 U.S. apparel manufacturing firms to confirm their hypothesized connections, even if, when all five were collectively examined only three of them – absorptive capacity, social interaction, and business goals – were significant. So, the research's results were that the effects of a supportive environment on the relationship between business objectives and network links were more intense when perceptions of a supportive environment decreased, while the effects of a supportive environment on the relationship between entrepreneurship orientation's and network links were greater when perceptions of a supportive environment increased.

Defining the science and technology policy network in the form of a social network and then analyzing it using the social networks analysis (SNA) method is the main goal of **Esmaeel Kalantari**, **Gholamali Montazer** and **Sepehr Ghazinoory's** paper. They analyzed the science and technology policymaking network in Iran using the content analysis of 25 policy documents and an interview with 20 Iranian science and technology policy elites: then they were interpreted by NetDraw and UCINet. As result, performing a two-dimensional core-periphery analysis, identifying the cut points and blocks, and measuring the structural power of each institution using the degree centrality, closeness centrality and betweenness centrality methods, the authors revealed that the most head science and technology policy-making institutions in Iran and their interactions were determined from the network viewpoint. The most prominent practical implications of this research are: the integration of some policymaking institutions, the precise allocation of roles and competences between the policy institutions, the definition of vertical and horizontal coordination mechanisms between the institutions, the elimination of overlaps in the tasks between some institutions, the design

of complementary mechanisms for monitoring the role of cutting points and attention to important activities in the margins of the network. The originality and value of this research are first to define a framework for studying science and technology policy and, after that, develop a method for studying science and technology policy based on SNA.

Kateryna Kraus, Nataliia Kraus, Olena Shtepa bring us into virtual reality conditions to spread the synergistic effect as a consequence of the network interactions of the development institutions in the new virtual economic reality and explain their relationships through knowledge of the functioning of clusters. Using the institutional-network approach, the characteristic features of cluster formation network interactions in virtual reality conditions are studied and, at the end of research activities, the authors stated that the synergistic effect of networking creates a new phenomenon of marginal growth utility and increasing marginal productivity from innovative glocalization and digital globalization: so the greater the scope of innovation and digital activities in virtual reality conditions is, the greater the efficiency of the use of additional resources is. The implications are to demonstrate that the synergistic approach used in the formation and development of innovation-digital clusters is considered through the prism of the relationship "subjective - subjective relationship of innovation organisations and digital enterprises" and, in this case, the effect lies in the restructuring plan of the "old" development institutions in the "new" ones. Understanding the content of the network economy, an economy in which activities are carried out using electronic networks, is an element of originality. The basis of this economy are network institutions, entities, organizations and, moreover, they create an environment in which any business entity or individual has been able to communicate easily and at minimum cost.

The article by **Martin Pech, Drahoš Vaněček,** and **Jaroslava Pražáková** addresses, from the network point of view, the problem of complexity, continuity, and strategic management of buyer–supplier relationships. The paper aims to analyze and study, referring to firms' dimensions and sectors to which they belong, the connection and relation between enterprise characteristics and characteristics of buyer–supplier relationships in supply chain networks. Using a quantitative method, they collected data during the period 2016–2019 in the Czech Republic through an online and personal survey to the firms and, at the end of the process, they used a two-proportion Z-test to compare different categories of firms in line with the above. Research showed that there are no differences in industrial sectors but only in their size: in the Czech Republic, the complexity of networks is low and long-term relationships are preferred. At the same time, bigger firms adopt contracts for more or less short periods. Starting from the assumption that there is

a connection of supply chain management and strategic management from the network perspective, and that supply chain management is viewed as being a part of strategic management, the paper helps in understanding how the buyer–supplier network works and the value of the relation between contemporary ideas of strategic management and supply chain management.

The issue of the network approach was also discussed in the article by **Jesse Karjalainen**, **Aku Valtakoski,** and **Ilkka Kauranen**. This conceptual paper starts from existing and available literature about interfirm networks and then develops the unifying concept of network resource distribution with the aim to suggest the notion of network resource distribution that allows an integrated study of how business resources and network structure work together to influence and improve business performance. Although strategy scholars have worked long and hard to combine the resource-based vision and the social network explanations of firm performance with poor and partial results, the suggested concept of network resource distribution systematizes prior research activities and highlights how network structure and firm resources interact with each other to affect and improve firm performance regardless of the closer network partners. The theoretical and practical implications of this research are, firstly, to illuminate the shortcomings in the literature on interfirm networks and suggest unique solutions to solve this problem and update and enrich the theory and, secondly, to prevent managers from limiting their strategic alliances to immediate partnerships. The topics covered are new concepts that bind and systematize different lines of research on intercompany networks, thus providing a basis for future research in this area.

Further research

The presented problems as well as research related to network approach exploration in strategic management, enrich the present knowledge in this area, but also indicate further directions of exploration, creating inspiration for other researchers and management practitioners. Network approach is a branch of management science that is constantly being developed. Changes in the environment of enterprises create new challenges in this area and contribute to the creation of new concepts of network approach in management. Classic methods are also perfected to increase their effectiveness. This special issue of JEMI presents selected current problems in the development of network approach exploration in strategic management concerning both the development of known concepts and methods of network strategic management, as well as new ones. The conducted research provided new knowledge in the discussed problems and allowed to set the directions for further research.

Lack of consensus about theories and conceptualizations in strategic network studies became an inspiration for **Rossella Canestrino and Amir Forouharfar's** research, which allowed them for the clarification of the existing paucity mentioned. The authors of the article: *Networks and Network Strategies: New Theorization Based upon Systematic Literature Review* presented a literature-supported systematics classification for the strategic studies of networks and introduced network taxonomy and its related network strategies. In their opinion, more research is needed using more articles and databases, to compensate for the potential shortcomings of the research in this field, done so far.

The contribution of the article by **Nancy J. Miller, Carol Engel-Enright, and David A. Brown** is in the examination of how an organization's decisions may relate to engaging in networks. This research provides new insights into the benefits of directing efforts to engage in network ties as a strategy managing market challenges. In their opinion, further research in this area should concern, for example, further integration of social capital and network theory with other leading perspectives in management research (e.g., institutional theory or resource dependence theory), the interaction effect between entrepreneurial orientation and perceptions of a supporting environment in relation to firm engagement in network ties or the interaction among business goals and supporting environment perceptions in relation to network tie engagement.

The paper's main purpose by **Esmaeel Kalantari, Gholamali Montazer, and Sepehr Ghazinoory** was to define the science and technology policy network in the form of a social network, from the perspective of policy documents, and then analyzing it using the social networks analysis (SNA) method. The most pivotal science and technology policy-making institutions and the interactions between them were determined from the network viewpoint. The authors noted that sometimes policy documents are different from what is happening in reality. Therefore, in future research, they recommended to analyze the science and technology policy network in reality, for example, based on mere interviews with experts, and compare and analyze the differences between that network and the document-based network.

Kateryna Kraus, Nataliia Kraus, and Olena Shtepa's research noted that the network economy in the XXI century, like no other economy (innovative, informational, knowledgeable, blue, green, circular, row, digital), highlights the organic relationship of technological (virtual-real networks) and institutional specifics of a constantly updated way of life (networked social environment). They stressed that the formation of a new quality of networking and cooperation is a new approach to solving the problem of competition in virtual reality and in digital market of goods/services. In their opinion, it is

still important in the future to conduct research aimed at understanding the ideology of a digital economy, in order to form a new virtual reality and to find the answers to the following questions: How is virtual reality different from digital, augmented, and mixed realities? How is it possible to work in a digital ecosystem with an innovation ecosystem? How can digital entrepreneurship, start-up, and the state "in the smartphone", influence the development of innovations and derive economic benefits from it?

The business relationships in networks with respect to the various enterprises' sizes and sectors of industry were analyzed in the research done by **Martin Pech, Drahoš Vaněček, and Jaroslava Pražáková**. They show an empirical study on buyer–supplier networks and accentuate the importance of developing and fostering business collaboration for strategic management. In their opinion, the strategic management of networks is a current challenge in network research, and the future research directions should be related to the conditions, factors, and variables that affect the division of roles and power networks. The authors' potential area for further research is applying and using new technologies (such as blockchain) that virtualize relationships and connections into a digital form.

The authors of the article: *Interfirm network structure and firm resources: Towards a unifying concept*, **Jesse Karjalainen, Aku Valtakoski, and Ilkka Kauranen,** proposed a unified concept of network resource distribution that systematizes prior research and illuminates how network structure and firm resources interact to affect the firm performance beyond the immediate network partners. The network resource distribution concept opens new and significant opportunities for researchers to contribute to the survey on interfirm networks and firm performance. In the authors opinion, many further theoretical issues in this field need to be investigated in the future to find answers to the following questions: How does the network configuration at the network node level—the resource mix and the resource characteristics—affect the optimal shape of network resource distributions? How do configuration choices at the relational level affect the optimal shapes of the distributions? In their opinion, it would be interesting to study how the optimal shapes of network resource distributions depend on the configuration choices made on the whole network level and how optimal distributions evolve over time. Future research could also seek to investigate how network resource distributions on various levels of analysis interact with one another.

We believe that the results of the presented research and analysis have certainly enriched network theory and research on the network approach in strategic management and will inspire other researchers and management practitioners. We postulate the need for further intensive research in the area

of possibilities to explore the network approach in strategic management, indicating the directions and areas of potential research.

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Abstrakt

CEL: *Analiza literatury wskazuje, że próby konceptualizacji strategicznych aspektów sieci mają istotny wpływ na rozwój badań nad sieciami organizacyjnymi. Niniejszy artykuł ma na celu analizę nowych trendów w zarządzaniu strategicznym, a w szczególności możliwości eksploracji podejścia sieciowego w zarządzaniu strategicznym, poprzez istniejącą literaturę oraz prezentację nowych wkładów kolejnych artykułów opublikowanych w bieżącym numerze.* ***METODYKA:*** *Artykuł ma charakter opisowy, dlatego bazuje na przeglądzie literatury i jej konstruktywnej krytyce. Do przedstawienia głównych założeń i cech podejścia sieciowego w zarządzaniu strategicznym wykorzystano narracyjny przegląd literatury, wraz ze wskazaniem pojawiających się trendów i nowych kierunków badawczych. Dokonano identyfikacji teoretycznych podstaw procesów zmian strategicznych w sieciach międzyorganizacyjnych oraz zaproponowano sposób rozumienia strategii sieci.* ***WYNIKI:*** *Badania zawarte w tym numerze pokazują, że z perspektywy sieci strategia biznesowa odgrywa ważną rolę w kierowaniu rozwojem poszczególnych relacji i sieci. Eksploracja podejścia sieciowego w zarządzaniu strategicznym pozwala na przyjęcie kategorii strategii sieciowej, którą można opisać poprzez współistnienie współpracy i konkurencji.* ***IMPLIKACJE DLA TEORII I PRAKTYKI****: Rozważania prowadzą do wniosku, że strategia biznesowa musi być wyrażona w kategoriach potencjalnych zmian w sieci, w której działa firma, z uwzględnieniem jej aktualnej i wybranej pozycji w sieci. Pomimo tego, że obecny stan badań nad sieciami organizacyjnymi w teorii zarządzania strategicznego wskazuje, że podejście to jest już dość dobrze ugruntowane, to na podstawie analizy wyników badań dotyczących konceptualizacji strategicznych aspektów sieci, określono istniejące problemy i zidentyfikowano ograniczenia.* ***ORYGINALNOŚĆ I WARTOŚĆ****: Wskazano główne problemy związane z badaniem podejścia sieciowego i wynikające z tego konsekwencje dla określenia strategii sieciowej. Wartość dodaną artykułu stanowi połączenie podejścia organizacyjnego i ekonomicznego z logiką przewagi konkurencyjnej i renty relacyjnej. Wykazano, że perspektywa sieciowa w zarządzaniu strategicznym pozwala na pełniejsze zrozumienie strategicznych zachowań współczesnych przedsiębiorstw.*

Słowa kluczowe*: sieć, strategia sieciowa, podejście sieciowe, zarządzanie strategiczne.*

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Conflicts of interest

The authors declare no conflict of interest.

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Networks and network strategies: New theorization based upon a systematic literature review

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Abstract

PURPOSE: *This paper aims to introduce a general all-embracing taxonomy of networks and its relevant strategies to facilitate the teaching and learning of the strategic concepts of networks in strategic management.* ***METHODOLOGY:*** *To fulfill its intention, the paper has adopted a systematic literature review (SLR), since the introduced taxonomy and its corresponding strategies should be a compendious reflection and summary of the current literature of the studies on strategic networks.* ***RESULTS:*** *The paper unfolded seven potential configurations of the networks and then proceeded with the proposition of their relevant strategies with regard to the networks' relationships and forms. These networks were named as Reciprocally Interdependent Networks, Sequentially Interdependent Networks, Partnering Networks, Complementary (Overlapping) Networks, Supporting (Logistic) Networks, Distributing Networks, and Co-Innovation Knowledge-Sharing Networks. Their corresponding network strategies were identified as Multi-Level Promotion Strategy, Just-In-Time Strategy, Network Partnership Strategy, Compensatory Strategy, Network Logistic Strategy, Distributing Network Strategy, and Network R&D Strategy, respectively.* ***IMPLICATIONS FOR THEORY AND PRACTICE:*** *Systematics or a system of classification is a fundamental necessity in any field of knowledge, benefiting both academia and learners. Accordingly, this paper provides a comprehensive but concise means of classifying networks and their strategies to overcome the paucity still existing in the literature. These efforts invite future research and conversation about networks and network strategies, proposing a guiding framework for the debate.* ***ORIGINALITY AND VALUE:*** *Lack of consensus about theories and conceptualizations in strategic network studies became an inspiration for this research, which allowed for the clarification of the mentioned existing paucity.*

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Keywords: *network taxonomy, network configuration, network strategy, strategic management, systematic literature review (SLR)*

INTRODUCTION

Global networks in commerce, business, communication, R&D, goods and passenger transportation – which are the fruits of gigantic and massive-scale economic globalization – have culminated in a modern global economy, which is inherently a *network economy*. Thus, as Carmichael (2016) puts it, "*As our economy has grown more global and more digital, businesses have had to shift their competitive strategies, marketing techniques, and business models. One of the most powerful changes? The rise of network effects.*" Globalization has come hand in hand with the global networks and hence strategic studies of these networks in the organizational world could equip the organizational strategists with the necessary insight, not only for taking advantage of the emerging, current or nascent opportunities, but also for avoiding the potential strategic threats out there. From an academic perspective, a network is certainly not a new topic and previous efforts have been made to introduce conceptual clarity (Blanco et al., 2011; Isett et al., 2011; Berry et al., 2004; Börzel, 1998): disciplines addressing networks include health sciences, management, political science, social science, social work, computer science, ecology, etc. (Hill, 2002). An extensive literature dealing with the analysis of inter-organizational relations and networks within the management field (Mizruchi & Galaskiewicz, 1993; Jarillo, 1993; Ebers & Jarillo, 1998; Sydow, 1998) embeds its roots in organization theory.

Moreover, Oliver and Ebers (1998) performed a literature search culminating in a network analysis of 158 articles published in four leading journals from 1980 to 1996. According to their research, the most frequently employed theories within this field are resource dependence, political power, and network approach. However, the proliferation of different perspectives resulting in the creation of various concepts, definitions, and metrics is responsible for a confusing picture requiring further clarifications (Dal Molin & Masella, 2016). Thus, the current and severe paucity of consensus-making theories and conceptualizations in strategic network studies is the rationale for such a study. One of the primary reasons for such conceptually system-making meagerness could be the network approach, as roughly a new emerging paradigm in strategic management. Context and relations play pivotal roles in this approach. It strongly relates to the organizational environment and it consists of various concepts from the firms' internationalization to the inter-organizational connections. Despite the mentioned considerations,

network approaches still lack a sound typology for the strategic networks, thus requiring new advancements in the field. The need for such a typology relates to the growing importance of network economy in the truly global organizations day in day out. Thus, this paper's aim is to introduce a general all-embracing taxonomy of networks and its relevant strategies to facilitate the teaching and learning of strategic concepts of networks within a system in strategic management. This process paves the way for reaching an answer to the following research question (RQ):

RQ: What is the literature-supported taxonomy of inter-organizational networks and its relevant network strategies?

Hence, one of the approaches to presenting a typology for the strategic networks is by discovering the strategic networks' configurations in the real inter-organizational world. The logic behind such an approach is the possibility of arranging the salient strategic elements of any network through the outstanding and influential relationships and by their directions. These two features, which could be defined as *structuration* (i.e., finding and presenting justifiable structures in the studied networks) and *directionality* (i.e., finding the relationship directions within each network), contribute to the schematic presentation of the network configurations.

Additionally, even though strategic researchers of networks have reached praiseworthy results, current mainstream strategic literature on networks suffers deep one-sidedness. In other words, the current literature mainly deals with one or at most very limited aspects of networks and strategies. This one-dimensional approach to the strategic study of networks is currently a ubiquitous and prevalent phenomenon easily diagnosable in highly-cited works of scholarly quality, for example from the 'industrial organization (IO) perspectives' in McIntyre and Srinivasan (2017) to 'strategic alliances' in Kale, Singh, and Perlmutter (2000).

Yet, broadly, introducing strategic network typology could be either deductive or inductive. Induction or inference from a general principle is out of the question, since due to the vast and stupendous arena of strategic networks it is nearly impossible to propose a universal general theory. Thus, the only approach for fulfilling the research goal is by applying induction or inference from particulars. The particulars in our study are the secondary data derived out of the precise systematic strategic networks' literature study.

On the other hand, the organizational morphologies were labeled under broad categories as *network*, *network-centric*, *networking* or *networked organizations* and in the management literature each shed light on a specific

dimension of the concept of network, but inwardly. In other words, they mainly refer to the internal networks within organizations, which are irrelevant when referring to the network approaches developed in the organizational/ strategic studies.

In this paper, first in the methodology section, our SLR, its criteria and steps were unfolded. After that, both descriptive and content analyses were performed and the network literature was reviewed and analyzed here. Finally, according to our research results, seven network configurations, as well as their relevant strategies were proposed in line with the studied literature.

METHODOLOGY

In the context of networks and their strategy, the Systematic Literature Review (SLR) may be considered an effective and robust way to collect, sum up and evaluate evidence, since an SLR is usually undertaken to deeper understanding into the phenomenon being addressed within existing studies, as well as to provide recommendations for further research (Unterkalmsteiner et al., 2012). For this review, the authors have broadly followed the guidelines proposed by Kitchenham and Charters (2007). These guidelines have established that a review should be comprised of three phases, including its planning, conducting, and reporting. In line with the mentioned guidelines, the research questions should be first stated and then some relevant criteria be developed for collecting the literature. Particularly, two main phases (*desk-based literature study* and *literature compilation*) were managed at this stage. In the next step, a plan for classifying, describing, and coding the literature was developed through *literature filtration* and *variables' distillation*. As a final step, the literature was synthesized (Forouharfar et al., 2019; Merli et al., 2018; Denyer & Tranfield, 2009; Tranfield et al., 2003) in order to provide a taxonomy for networks and their corresponding strategies (Table 1).

Scopus and *Web of Science (WoS)* were selected as sources of data because they were deemed to be the most comprehensive and authoritative scientific catalogs (Merli et al., 2018), featuring full texts and searchable cited references for top journals, as well as providing complete information in the field of networks and firms' strategy. Many scholars (Bakkalbasi et al., 2006; Burnham, 2006; LaGuardia, 2005; Dess et al., 2006; Li et al., 2010) have compared the coverage, features and citation analysis capabilities of *Scopus* and *WoS*, concluding that these two databases are permanently improving their potentiality. Depending on the above, the use of both *Scopus* and *WoS* is in line with the research question in this paper.

Table 1. Systematic approach in reviewing strategic networks' literature in this study

LITERATURE REVIEW				
Method	**Context**	**Process**		**Final Results**
		a. Phase	**b. Purpose**	
Systematic Literature Review (SLR)	Strategic Networks	# 1: Desk-Based Literature Study	***Acquisition*** of secondary data	Salient variables/ elements for classifying strategic networks and introducing their corresponding schematic configurations
		# 2: Literature Compilation	***Compilation*** of strategic network literature	
		# 3: Literature Filtration	***Filtration*** of the literature variables/ elements based on their relevance to strategic networks	
		# 4:Variables' Distillation	***Extraction*** of the strategic as well as network variables/ elements	
		# 5:Variables' Generalization	***Generalization*** of the extracted variables/ elements of strategic networks	

Thus, after reading several publications on the general network topic (e.g., Håkansson & Laage-Hellman, 1984; Jarillo, 1988; Hinterhuber & Levin, 1994; Borch & Arthur, 1995; Ibarra, Kilduff, & Tsai, 2005; Knoben, Oerlemans, & Rutten, 2006; Hite, 2008; Chang, Chiang, & Pai, 2012; Krzakiewicz & Cyfert, 2013; Kohtamäki, Thorgren, & Wincent, 2016; Christakis et al., 2020), and based on the authors' experience, five keywords were selected as search strings employed in both databases, namely:

1) Strategic network.
2) Strategic network configuration/shape/type/typology.
3) Network strategy.
4) Network strategy element/variable/feature.
5) Organizational network configuration/shape/type/typology.

Depending on the selected keywords, the following research string was defined in accordance with Boolean and proximity operators suggested narrowing down the scope of advanced search:

("Strategic network" OR "organizational network*") AND (configuration* OR shape* OR type*) OR ("Network strategy*") AND (element* OR variable* OR feature*)*

AND NOT

"Internal network" OR "strategic coalition*" OR "organizational relationship*"*

According to the databases' research functionalities, the chosen keywords were searched in "Topic" (covering Title, Author Keywords, Abstract, Keyword Plus®) on *WoS*, as well as in "Title, Author Keywords, Abstract" on *Scopus*. As recommended in the literature, only journal articles were selected, which inherently improves a literature review's potential rigor and quality (Vigolo et al., 2018; Orzes et al., 2018; Jia & Jiang, 2018). Since most academic journals are English based, with English being the most used language by researchers in the modern global academic community (Snyder et al., 2016), the research only focused on the English papers.

After defining the language and the type of the papers, articles belonging to Business, Management, and Accounting; as well as Economics, Finance and Social Science subject areas were considered in our databases' search. Moreover, no chronological restriction was employed. As a result, *WoS* returned 149 papers and *Scopus* 42 papers, giving a total of 191 documents. Table 2 summarized the research strategy adopted to develop the systematic literature review.

Additional exclusion criteria were also adopted for the systematic review, as suggested by De-La-Torre-Ugarte-Guanilo et al. (2011), when rejecting papers referring to:

1) Internal organizational networks.
2) Internal strategic coalitions.
3) Internal organizational relationships.

After the removal of redundant duplications, a final sample of 172 papers remained (77 full papers and 95 abstracts[3]).

3 The distinction between full papers and abstracts depends on the availability of the documents on the selected databases. Since the key strategic characteristics and variables were important to us for moulding the network strategic figures and we could easily find these key variables in some of the relevant papers' abstracts, both full papers and abstracts were considered in managing our analysis.

Table 2. Summary of the results for the employed search string

Search string	Scopus	Total sample size on Scopus	WoS	Total sample size on WoS
("strategic network*" OR "organizational network*") AND (configuration* OR shape* OR type*) OR ("network strategy*") AND (element* OR variable* OR feature*) AND NOT "internal network*" OR "strategic coalition*" OR "organizational relationship*"		77		409
LIMITED TO:				
Language	English	75	English	391
Document type	Articles	54	Articles	298
Subject Areas	• Business/ Management and Accounting • Economic, Econometric and Finance • Decision Science • Social Science • Multidisciplinary	42	• Management • Business • Economics • Social Science Interdisciplinary • Multidisciplinary Science • Business Finance • Operation Research Management Science	149
TOTAL PAPERS				**191**

LITERATURE REVIEW FINDINGS

Descriptive analysis

Following Siva et al. (2016), the year of publication, type of paper, adopted methodology, etc. was established as our analytical categories (Table 3).

Table 3. Our research analytical categories

Category	Description
Year	Year in which the paper was published
Country	Countries where authors have published research
Journal	Journals in which authors have published research
Type of paper	Type of paper (empirical paper, conceptual paper, literature review)
Adopted methodology	Methodology adopted to manage the research (qualitative, quantitative, mixed methods)

Table 4 shows the number of publications published from 1983 to 2021. Our latest access for searching on *Scopus* and *WoS* was on March 18, 2021. This means that potentially some of the publications for the last year (2020) were still under review or publishing by their pertinent journals. Hence, the incorporated data in this research, about the papers published in 2021, should be considered provisional and are expected to increase until the end of the year. In order to evaluate and fully understand the possible trends, we divided the whole period by four, investigating them through a content analysis.

Table 4. Number of papers published from 1983 to 2021

Period of time	No. of publications
First Period (1983–1992)	5
Second Period (1993–2002)	14
Third Period (2003–2012)	53
Fourth Period (2013–2021)	100
Total	**172**

The first paper about the topic was published in 1983. During the first period (1983–1992), papers mainly belong to the social science subject areas, aiming to explore the role of inter-organizational networks and the way they support formulation of policy, democratization, as well as urban development. However, the papers roughly doubled in the second period. It has only been since the beginning of 2011 that scholars started focusing on inter-organizational networks from the managerial and strategic perspectives. The papers published during the third period (2003–2012) are diverse, as no specific network issue seems to prevail over the others. By contrast,

a predominant approach/method was emerging for the analyses, with several scholars providing conceptual frameworks of networks and network analysis. The final period (2013–2021) shows a significant growth in the number of the strategic network papers to 100 in total, representing an increase of almost 50% in comparison to the previous period (2003–2012). In the fourth period, concepts such as "innovation," "innovation process," "business-model innovation," "innovation systems," and "organizational learning" were largely emphasized when discussing firms' networks and strategies, mainly with the intention of exploring the linkage between stakeholders' interactions and the firms' potentiality for success. As scholars emphasize (Biemans, 1991; Håkansson & Waluszewski, 2007; Powell, Koput, & Smith-Doerr, 1996; Rampersad, Quester, & Troshani, 2010), firms' competitiveness in contemporary markets increasingly requires co-operation within extensive networks, as many technological innovations tend to require multi-sectoral collaboration. Researchers have acknowledged that while the involvement and participation of diverse stakeholders in the innovation process are essential, they complicate interaction. Therefore, examining inter-organizational networks and interactions as strategic management issues becomes crucial when discussing the network-participating firms' relationships.

Moreover, according to the country analysis, pertinent articles from 42 different countries from five continents – Africa, America, Asia, Europe, and Oceania – were identified. The USA (38 contributions) and the UK (24 contributions) represent the highest number of published papers (nearly 36% of all the studied papers).

Table 5 shows countries with the highest contribution in the research field. The ranking is limited to the top 15 countries, since the number of publications under 5 was not considered.

Europe (other than the UK) is the continent with the largest participation with 67 articles (38.9%) from 9 different countries (Germany, Netherlands, France, Italy, Finland, Denmark, Poland, Romania, Spain), where Germany produced 16 articles, as the highest contributing country to the strategic networking literature.

Table 5. Countries with the highest contribution in the field

Ranking	Country	No. of publications	Contribution to the field (% on the whole sample)
1	USA	38	22
2	UK	24	13.9
3	Germany	16	9.3
4	China	12	6.9
5	Australia	11	6.4
6	Canada	9	5.2
7	Netherlands	9	5.2
8	France	8	4.6
9	Italy	8	4.6
10	Finland	6	3.4
11	Denmark	5	2.9
12	Poland	5	2.9
13	Romania	5	2.9
14	Russia	5	2.9
15	Spain	5	2.9

The 172 selected papers come from 126 different journals from within very diverse fields, nevertheless pertinent to management and management studies, thus revealing a significant fragmentation and dissonance in strategic network literature. For example, 53 papers, out of the studied papers, were published in 33 diverse journals, but only in few circumstances; the studied journals accepted more than 4 papers dealing with relevant or the same topics on strategy and networks.

Table 6 shows the list of journals that have published the study sample of articles from 1983 and 2021. Journals with fewer than five papers were not included, as their number of publications was considered irrelevant. Information about the Impact Factor (IF), and SCImago ranking were collected from the journals' official websites, as well as from SCImago's ranking system. The IF provides scholars with an objective measure of the importance of different journals within a given category (Rey-Marti et al., 2016). In addition, SCImago is a prestige metrics based on the idea that not all citations are the same. It provides a quantitative and qualitative measure of the Journal's impact, based on a similar algorithm to Google page ranking.

Table 6. Journals publishing the articles

Ranking	Journals	Publisher	No. of publications	Impact factor (IF)*	Scimago journal rank (SJR)**
1	Industrial Marketing Management	Elsevier	9	4.695	125
2	Journal of Business and Industrial Marketing	Emerald	7	2.497	62
3	Strategic Management Journal	John Wiley and Sons Ltd	6	5.463	269
4	Journal of Business Research	Elsevier	4	4.874	179
5	Technological Forecasting and Social Change	Elsevier	4	5.846	103

*IF measures the average number of citations received in a particular year by papers published in the Journal during the two preceding years (Clarivate Analytics, 2020 – www.clarivate.com)
** SJR is a prestige metrics based on the idea that not all citations are the same. It provides a quantitative and qualitative measure of the Journal's impact (Elsevier Analytics, 2020 – www.elsevier.com)
Source: Authors' own work (last access to the online data: March 27, 2021).

Our study reveals the need for improving the quality of contributions in the field of networks, since only 30 papers (in the studies sample) were listed among the top 5 high-ranked journals, with the *Strategic Management Journal* hosting 6 of them.

In order to provide a full understanding of the selected papers, they were finally categorized according to the article type (i.e., empirical, conceptual, review) and the applied methodology, namely qualitative *versus* quantitative. The results showed that the majority of the reviewed contributions were empirical studies (62%), followed by conceptual papers (30.63%) and reviews (7.37%). From a methodological perspective, 34.6% of the empirical studies adopted qualitative approaches, 57.1% adopted quantitative approaches, and only 8.3% used a mixed-method approach (combining both qualitative and quantitative methodologies).

Thematic analysis

According to our literature review, three main issues were outstanding:

First, "*The term 'network' is often misconstrued*" (Satell, 2015; p. 1). In any organization, we could have two types of networks: (1) internal networks and (2) inter-organizational networks. The network approach deals with the second type of networks – the networks that constitute the surrounding environment.

Second, any study of organizational networks is a *contextual* phenomenon. That is strictly relevant to the context such as organizational structure, environment, relationship, or inter-synergism. Particularly, Satell (2015) referred to a network as an organizational structure, stating "*… networks are informal structures. If it can fit on a traditional org chart, it's not a network*." Moreover, he continues, "*For functional purposes, networks have two salient characteristics: clustering and path length. Clustering refers to the degree to which a network is made up of tightly knit groups while path length is a measure of distance – the average number of links separating any two nodes in the network*." There is not a unanimously/commonly accepted or developed definition for these organizations (Krzakiewicz & Cyfert, 2013); but, "*A 'network organization' is usually conceived as an organization that is quick and flexible in adapting to changes in its environment*" and hence they are *adaptable* and have a special organizational structure (Vega-Redondo, 2013, p. 72) for the facilitation of inter-organizational/inter-company cooperation. Yet, in network approaches, we search for the constituting elements of the sophisticatedly inter-organizational interwoven networks, which are replete with idiosyncratic motifs and incentives for their involvement and participation in the networks. In other words, setting aside the common tendency of network organizations for *adaptability* and *environmental cooperation*, they all share another common salient feature, which is the undeniable strategic propensity for synergistic inter-organizational connections and even network generation and later network sophistication. Besides, two main phenomena, fostering the emergence of the concept, were the nonstop globalization and the necessity for inter-organizational connection, cooperation, competition and, in many cases, rivalry.

According to Krzakiewicz and Cyfert (2013), the rising relevance of international business cooperation, especially in the 1960s, called for the exploration of inter-organizational solutions. The emerging globalized markets and the ever-growing necessity for outsourcing required new organizational designs and structure. Thus, 'hollow corporation' and 'modular organization' have soon become established as two of the most familiar network organizational designs. Particularly, the introduction of the "hollow corporation" in the 1980s could be interpreted as one of the earliest signs of emphasizing inter-organizational solutions and approaches. 'Hollow corporations' "*focus on their core competencies and outsource peripheral processes*" and 'modular organizations' "*order different parts [modules] from internal or external providers and assemble them [the product modules] into a product*" (Narasimhan & Yu 2021, p.1); they act for "*the vertical disaggregation of the firm [structural modules] and the use of market mechanisms within hierarchies*" (Kuntz & Vera, 2007, p. 48).

Although outsourcing and its benefits were not the only strategic necessity for accentuating the need for designing organizations with the emphasized tendency towards inter-organizational networking and interrelation-makings, it played one of the major roles for the justification of the trend. The ever-increasing contracting out of manufacturing and services providing jobs needed precisely defined networks. Thus, inter-organizational networks were not only limited to nongovernmental entities, but they also extended to the governments' execution of their departmental affairs and public service provision through contractors. For example, only by 1980, 80% of the people involved in implementing the United States departments' programs and plans were contractors (Crawford & Krahn, 1998).

Third, as discussed above, networks could be found either within organizations (in network organizations) or outside of the organizations (in the organizational environment). The strategic network approach mainly focuses on the organizational environment, its emergence, texture, and sophistication.

To address the specific theme of this paper, namely strategic networks and their configurations, we should not neglect that theoretical arenas as diverse as embedding, dependence on resources, social capital and industrial networks have been studied. As Lin et al. (2011, p. 183) report, "*researchers have realized the crucial impact of embeddedness on governance structures of strategic alliances*." Based on the data from strategic alliances among semiconductor firms in Taiwan, the authors also revealed the influential significance of 'network structural embeddedness' on 'the design of alliance governance' among the companies within the network. *Network embeddedness* is not only crucial for knowledge sharing but also for the innovation and development of enterprises (Liu & Tang, 2020; Canestrino & Magliocca, 2019). In addition, network relationships among organizations could lead to *resource dependence* and even *external control* by the outside constituting organizations within the network. For example, a study by Mitchell (2014) on the strategic responses to resource dependence among transnational NGOs registered in the United States, demonstrated that these organizations engagement in fundraising activities to support their operations globally led to their excessive dependence on the external environment for financial support and hence resource dependence which could culminate in external control. Additionally, *corporate social capital*, "*as processes of forming and mobilizing social actors' network connections within and between organizations to gain access to other actors' resources*" (Knoke, 1999, p. 17) deserve close study in understanding the strategic networks' configuration formations and dynamics. Finally as Baraldi (2008, p. 99) has emphasized, in organizational networks, "*Network strategies cannot be used as shortcuts to compensate for severe weaknesses, but instead*

can only be pursued by firms that possess adequate competences, external organizational interfaces, and network-oriented cultures."

Taking into account the adopted criteria for the SLR (see Table 1), the content analysis allowed us to extract main network variables/elements, as well as network strategies, out of the highly-cited literature. Therefore, the study results are presented in the following section.

RESULTS

Adopting the following search string:

("strategic network" OR "organizational network*") AND (configuration* OR shape* OR type*) OR ("network strategy*) AND (element* OR variable* OR feature*)* AND NOT *("internal network*" OR "strategic coalition*" OR "organizational relationship*")*

and, according to the five phases of the SLR previously described in Table 1, the salient variables/elements of strategic networks, organizational networks, and network strategies were identified, allowing us to finally propose a taxonomy for various networks and their corresponding strategies. Table 7 summarized the main outputs of the literature review process, particularly referring to its derived concepts.

Then by fulfilling the generalization phase (the fifth and the last phase of the SLR in this study), we identified 7 different configurations and their dominant relevant strategies. For each configuration, salient features were presented, revealing the key relationships each network possesses.

Table 7. Literature review and its derived key concepts

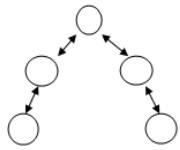
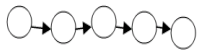
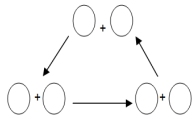
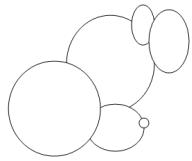
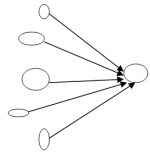
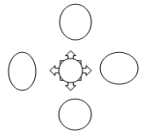
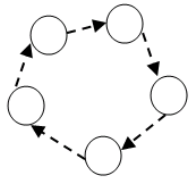
LITERATURE REVIEW PROCESS		
Main category/keywords	**Derived key concepts**	**References**
Strategic network	- Cooperative behavior - Aspects of firm behavior (cooperative vs. competitive) - The cooperative relationships of a firm can be the source of its competitive strength.	Jarillo, 1988
	- The strategic network design have both interrelated spatial and temporal characteristics - The decisions made during the strategic network planning have a major impact on the long-term profitability and competitive position of a corporation - Expansion into a new geographical area - Design of world-class supply chains - A holistic view of a supply chain does not focus exclusively on a single aspect of the supply chain performance such as inventory or direct labor cost, but takes an integrated and comprehensive view of the whole supply chain from the raw material suppliers, through the various transformation facilities and transportation channels, to the final customers.	Goetschalckx & Fleischmann, 2005

LITERATURE REVIEW PROCESS		
Main category/keywords	**Derived key concepts**	**References**
	- Establishment of reverse logistics (RL) networks for various original equipment manufacturers (OEM's) is gaining significant importance. - Various green legislations are forcing OEMs to take back their used, end-of-lease or end-of-life products, or products under warranty to minimize wastes and conserve resources. - OEMs have turned to a better design of their products for maximum reuse and recycling and to retrieve back the used products through a network for reuse, remanufacture, recycle or disposal, so that maximum value can be achieved from their used products. - Designing of network points and assigning capacities to them depend not only on the volume of returned products but also on the demand for remanufactured products and the parts of used products. - Dismantled parts are sent for remanufacturing or to the secondary market as spare parts.	Mutha & Pokharel, 2009
	- A firm's relationship management practices serve as antecedents to its strategic network identity. - Network sensing, relational embeddedness and partner integration lead to strong strategic network identity and, subsequently, to enhanced market performance. - Network relationship management activities can create enduring strategic advantages for the firm.	Bonner, Kim, & Cavusgil, 2005
	- Formation of R&D partnerships - Strategic network capabilities, specifically centrality-based capabilities and the efficiency, with which companies choose their partners, are found to facilitate the formation of new partnerships.	Hagedoorn, Roijakkers, & Van Kranenburg, 2006
	- A link will be formed if both agents view the link as beneficial to them. - The network formation as a sequential process - They base their decision on their own characteristics, the characteristics of the potential partner, and on features of the current state of the network, such as whether the two potential partners already have friends in common.	Christakis et al., 2020
	- Network marketing - The Strategic Network Marketing Model (SNMM) typology: firms use intra-firm, social, customer, business, innovation, and marketing and sales networks to leverage additional resources that create value for the firm.	Jones, Suoranta, & Rowley, 2013
	- Information and communication technology (ICT) sector, where the development of competitive offerings often requires a coalition of platform and service providers. - Resource-based view and the value creation system approach - The construction of a strategic network can be divided into parallel, although not necessarily simultaneous, sub-processes based on the required value activities in the entire business concept. - Building a strategic network is not necessary a stage-wise process but can divided into several sub-processes. - Early recognition of value capturing is essential	Partanen & Möller, 2012
	- Local socio-economic context and its social capital - Cluster policies - Social capital can create value for companies by closure of the network structure (bonding), which maintains internal mutual trust but bonding can also over-embed companies in their social context, whereas sparse networks that provide links to other parts of relevant business networks. (bridging) often provide greater innovation benefits. - The importance of bonds between actors - Social reciprocity strengthens network bonds	Eklinder-Frick, Eriksson, & Hallén, 2012
	- Network formation: agents have heterogeneous tastes over links, and allows for anonymous and non-anonymous interaction effects among links.	Menzel, 2015
	- Controlled (or co-ordinated) networks - Uncontrolled networks	Hinterhuber & Levin, 1994
	- Strategic network effectiveness is directly influenced by building actor webs and collective sense making - Strategic network efficiency is directly influenced by developing activity patterns and utilizing resource constellations	Bayne, Schepis, & Purchase, 2017
	- Co-operatives have been likened to a 'network of contracts' or 'coalition'. - Small firms use co-operatives as a strategic network. - Adaptability and the maintenance of member trust and loyalty	Mazzarol, Limnios, & Reboud, 2013
	- Partnerships	Kohtamäki et al., 2006

LITERATURE REVIEW PROCESS		
Main category/keywords	**Derived key concepts**	**References**
	- Trust in network relations (Inter-organizational exchange)	Borch & Arthur, 1995
	- Socio-economic relations of actors within strategic networks	
	- Uni-entity networks vs. multi-entity networks	Fernandes, Relvas, & Barbosa-Póvoa, 2013
	- Relational capabilities and cooperation, both of which affect a firm's competitive position	Lorenzoni, 2010
	- Collaborative networks	Rui & Bruyaka, 2021
	- Strategic nets of domestic and foreign partners	
	- Firms in government-supported strategic networks tend to rely on professional network board members for support and assistance	Thorgren, Wincent, & Anokhin, 2010
	- Ties are not all the same and not all equally strategic	Hite, 2008
	- Multi-zone dispatching	Üster & Maheshwari, 2007
	- Firm adaptations within strategic networks	Kohtamäki, Thorgren, & Wincent, 2016
	- Formation of strategic networks under high uncertainty	Jussila, Mainela, & Nätti, 2016
	- Close network relationships and interdependences of industrial clusters have contributed significantly to the competitiveness of high-technology clusters in the Asia-Pacific region.	Niu, Miles, & Lee, 2008
	- Binary network marketing organizations	Pedrood, Ahmadi, & Charafeddine, 2008
Organizational Network	- Inter-organizational network	Ibarra, Kilduff, & Tsai, 2005
	- The two factors dynamically interact within inter-organizational networks creating a cycle of improvement and contributing to the development of innovation capacity for improved organizational competitiveness.	Szeto, 2000
	- Co-innovation	Peters et al. 2010
	- Network structures	Knoben, Oerlemans, & Rutten, 2006
	- The inter-organizational network was valued by participants as a way to share and transfer knowledge about better practice.	Hartley & Allison, 2002
Organizational network configurations/shape	No relevant results found	-
Network Strategy	- Supply network strategy (role and competence requirements): six network management roles: network structuring agent; co-ordinator; advisor; information broker; relationship broker; innovation sponsor.	Harland & Knight, 2001
	- Social network marketing strategy	Nobre & Silva, 2014
	- Supply network strategy	Yee & Platts, 2006
	- Network R &D Strategy	Håkansson & Laage-Hellman,1984
	- Cooperative strategy	Chang, Chiang, & Pai, 2012

Table 8 presented our results, summarized the network configurations, as well as their salient features, schematic figures, and their relevant dominant strategies.

Table 8. Networks' taxonomy and their corresponding strategies

Network configurations		Salient features	Schematic figures	Relevant strategies
A	Reciprocally Interdependent Networks	Interdependence, binary relationship		Multi-Level Promotion Strategy
B	Sequentially Interdependent Networks	Sequence, linearity, interdependence		Just-In-Time Strategy
C	Partnering Networks	Cooperation, partners' networks		Network Partnership Strategy
D	Complementary (Overlapping) Networks	Partial relationship in/for specific intentions/activities		Compensatory Strategy
E	Supporting (Logistic) Networks	Multiple entities cooperation for a single goal		Network Logistic Strategy
F	Distributing Networks	Maximization of the possibility of distribution		Distributing Network Strategy
G	Co-Innovation Knowledge-Sharing Networks	Innovation and knowledge synergism		Network R & D Strategy

The Reciprocally Interdependent Networks (Configuration A) is based on a binary relationship. This configuration is usually seen among *Multi-Level Marketing* (MLM), or network marketing/pyramidal selling. In this configuration, 'binary relationship' means each member of the network

is only attached to another member that has chronologically joined the network sooner. The prevailing network strategy for this configuration is *The Multi-Level Promotion Strategy*, which is based on a convincing policy. In other words, the newcomers should be convinced that joining the network could be beneficial for them and their businesses.

The second derived configuration (*The Sequentially Interdependent Networks* – Configuration B) is usually witnessed in supply chain and production networks, where sequence, linearity, and interdependence usually prevail. In the sequentially interdependent networks, members should always be arranged in order of appearance; that means a specific place in the sequential chain network for each member (link) is always established and cannot be violated; otherwise, the configuration falls apart. The network usually gains its competitive advantage through *The JIT Strategy*; i.e. the materials and goods are strategically ordered, received, distributed, and stored, once it was the exact time for them. This strategy relies on a sophisticated and experienced strategic timing. In other words, the fittest strategic time for each of the JIT procedural entities; e.g. ordering, receiving, distributing, storing, etc.

The next derived configuration (C) is *The Partnering Networks*. Here, two or more partners join and form the network, and relate to the other partners, by means of cooperation. Partnering networks are likely to emerge in high-tech industries, in which organizations are used to cooperating for the production of sophisticated products. By this network, firms could compensate their strategic weaknesses by the strengths of the joined partner(s). In a more complicated and advanced formation of the partnering configuration, the cooperating entities could also make a close liaison with other networks' entities and expand the network into a humongous one. The corresponding core strategy in the *Partnering Networks* is the *Network Partnership Strategy*. The strategic efficiency and effectiveness of the participating network entities stem from strategic partnership and synergism. For example, one of the entities supplies spare parts, raw materials, or any other supporting backups, then the next entity in the partnering network manufactures, the other with efficient and superb distribution channels distributes, and so forth. Each entity shares its own competitive advantage(s) in the network and, hence, in the big picture they reach an insurmountable competitive synergism, since each entity has put forth and shared its best strategic part.

Furthermore, the *Complementary (Overlapping) Networks* (Configuration D) was derived through the SLR for partial relationships in/for specific intentions/activities and it is usually established among organizations aiming to complement some departments/units, without directly investing in their development. Thus, complementary networks allow partners to compensate each other's needs, weaknesses, and lack of technology, as well as to reach

higher levels of efficiency, as this coexistence also helps organizational lives to be efficiently elongated.

On the other hand, when multiple entities cooperate to pursue a single goal, a *Supporting (Logistic) Network* emerges (Configuration E). The most frequent configuration of the logistic networks involves multiple supporting organizations linked to one leader company/organization (the target company/organization). Thus, in this configuration, we have supporting entities and the leading entity. The former are usually behind-the-scenes and the latter presents the network façade. In the *Network Logistic Strategy*, the prevalent strategy of such networks, the target company selects and arranges a network of supporting/logistic companies to be able to reach its strategic organizational goals, such as the increase in production, or upgrading the quality of its manufactured goods.

Maximizing the chance and scale of distribution is usually the final aim of many distributing networks, inspired via an exclusive distribution philosophy. In these networks, there is a core company that promotes its distribution policy via a dominant strategy, the *Distributing Network Strategy*, in other words, under this strategy, the *core company does its best to* expand the network until it reaches its full potential hence maturity; (i.e., until it was not possible to be expanded or further expansion jeopardizes the efficiency and effectiveness of the core company). A *Distributing Network* (F) forms around the core company and attaches as many distributing channels as possible to the so-called core company.

Finally, Configuration G, or the *Co-Innovation Knowledge-Sharing Network* emerges once the collaboration among the partners aims to foster knowledge sharing and innovation synergism, thus supporting the efficacy of both the actors and the system/network. That is, the innovative companies join a network for the dissemination, promotion, and partial or complete sharing of emerging knowledge. In such circumstances, the *Network R&D Strategies* could dominate the network, allowing organizations to share their scientific research, support each other, and create new outputs due to their co-innovation. *Silicon Valley*, in the southern part of the San Francisco Bay Area in Northern California, as the global center for high technology and innovation, is a good example of such *Co-Innovation Knowledge-Sharing Network*s. What made the difference? According to sociologist Annalee Saxenian (1996), a major factor was the development of a "collective learning" environment in Silicon Valley in which fierce industrial competitors agreed to collaborate and share basic technical knowledge for the benefit of all.

DISCUSSION AND CONCLUSION

As shown by this paper, there is a large array of different ways to define inter-organizational networks and their role in formal organizational settings. The huge amount of available studies and perspectives about the topic fostered confusion and fragmentation, hindering a greater understanding and coherence of the field. The mentioned lack of clarity grows even more when referring to network strategies (Wheelwright & Hayes, 1985), network strategies extending strategic frameworks to larger and more complex network systems in terms of competitive priorities, structure and infrastructure (Harland et al., 1999, Brun & Castelli, 2008). Harland and Knight (2001) assumed that companies may be able to manage networks in which they operate and that it is therefore important to understand and develop an appropriate network strategy. In line with the mentioned, many authors (Kathuria, 2000, Zhao et al., 2006, Miller & Roth, 1994) emphasize the need to investigate firms' strategies through the use of configurations (Kathuria, 2000, Zhao et al., 2006, Miller & Roth, 1994). However, the development of configurations in the field of network strategy seems to be a still unexplored field (Macchion et al., 2015; Vereecke & Van Dierdonck, 2002; Bozarth & McDermott, 1998). As a consequence, this paper aimed to fill the existing gap, by providing a new and valuable framework to classify inter-organizational networks and their corresponding strategies.

In line with the above, an SLR – including literature *acquisition*, *compilation*, *filtration*, *extraction* and finally *generalization* – was managed, resulting in a literature-supported taxonomy of both inter-organizational networks and network strategies. Particularly, *Scopus* and *WoS* were referred in order to collect data and refine them in accordance with each database's functionalities. Next, a wide thematic analysis was employed to derive and form seven strategic network configurations and then to introduce and define their corresponding preponderant network strategies. The authors named these networks as *Reciprocally Interdependent Networks, Sequentially Interdependent Networks, Partnering Networks, Complementary (Overlapping) Networks, Supporting (Logistic) Networks, Distributing Networks, and Co-Innovation Knowledge-Sharing Networks.* Besides, their corresponding network strategies were identified as *Multi-Level Promotion Strategy, Just-In-Time Strategy, Network Partnership Strategy, Compensatory Strategy, Network Logistic Strategy, Distributing Network Strategy,* and *Network R&D Strategy,* respectively.

The theoretical contribution of this study is its presentation of the taxonomy of networks and network strategies in strategic management as a pioneering work. Since existing taxonomies were mainly developed for

production and supply network configurations (Macchion et al., 2015), as well as for specific industries – electronic, machinery, and electrical sectors (Caniato et al., 2009, Brun & Castelli, 2008, Luzzini & Ronchi, 2010) – this is the first research attempting to extend the focus of the analysis to the whole range of networks.

The strength of the study is its reliance on the two major scientific databases of *Scopus* and *WoS,* which include some of the best-published papers on network studies. Moreover, the introduced network taxonomy and its related network strategies present a literature-supported *systematics* or a system of classification for the strategic studies of networks.

Future research that includes more databases could build upon this study by extending its positive features/classes and compensate for its potential shortages. Moreover, the study's implications for research and practice are, first, the classification and labeling of prevalent networks (taxonomy), which provides future researchers with a referential network system with its pertinent strategies in the strategic studies and, second, this classification system could facilitate the teaching and learning of network strategic issues in the academic atmosphere.

We think that this perspective of the study is particularly interesting and can contribute to advancing the research stream on network strategies by providing a complete understanding of the phenomenon within different industries.

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Abstrakt

CEL: *Celem niniejszego artykułu jest wprowadzenie ogólnej, wszechstronnej taksonomii sieci i jej odpowiednich strategii w celu ułatwienia nauczania i uczenia się strategicznych koncepcji sieci w zarządzaniu strategicznym.* ***METODYKA:*** *Aby spełnić swój zamiar, w artykule przyjęto systematyczny przegląd literatury (SLR), gdyż wprowadzona taksonomia i odpowiadające jej strategie powinny być komplementarnym odzwierciedleniem i podsumowaniem aktualnej literatury dotyczącej badań nad sieciami strategicznymi.* ***WYNIKI:*** *W pracy przedstawiono siedem potencjalnych konfiguracji sieci, a następnie przystąpiono do zaproponowania ich odpowiednich strategii w odniesieniu do relacji i form sieci. Wyróżniono sieci wzajemnie współzależne, sieci sekwencyjnie współzależne, sieci partnerskie, sieci komplementarne (nakładające się), sieci wspierające (logistyczne), sieci dystrybucyjne oraz sieci współinnowacji i dzielenia się wiedzą. Odpowiadające im strategie sieciowe zostały zidentyfikowane odpowiednio jako wielopoziomowa strategia promocji, strategia just-in-time, strategia partnerstwa sieci, strategia kompensacyjna, strategia logistyczna sieci, strategia sieci dystrybucyjnej oraz strategia sieci badawczo-rozwojowej.* ***IMPLIKACJE DLA TEORII I PRAKTYKI:*** *Systematyka lub system klasyfikacji jest fundamentalną koniecznością w każdej dziedzinie wiedzy, z której korzystają zarówno środowiska akademickie, jak i osoby uczące się. W związku z tym, artykuł ten dostarcza wyczerpujących, ale zwięzłych sposobów klasyfikacji sieci i ich strategii w nadziei na przezwyciężenie niedostatku wciąż istniejącego w literaturze. Wysiłki te zachęcają do przyszłych badań i rozmów na temat sieci i strategii sieciowych, proponując ramy przewodnie dla debaty.* ***ORYGINALNOŚĆ I WARTOŚĆ:*** *Brak konsensusu co do teorii i konceptualizacji w badaniach sieci strategicznych stał się inspiracją dla tych badań, co pozwoliło na wyjaśnienie wspomnianego istniejącego niedostatku.*

Słowa kluczowe: *taksonomia sieci, konfiguracja sieci, strategia sieci, zarządzanie strategiczne, systematyczny przegląd literatury (SLR)*

Biographical notes

Rossella Canestrino, Ph.D., is Assistant Professor at 'Parthenope' University of Naples, Italy, where she teaches *Business Ethics and CSR* and *Digital Marketing*. She has also been *Visiting Professor* at University of Jaèn, (Spain), from 2018/2019 to 2019/2020. Rossella Canestrino is coordinator of the scientific project '*Teaching Digital Entrepreneurship*' (TED), financed under the Erasmus+ programme (KA203), and she is involved in several international research collaborations. Particularly, her research topics mainly belong to

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Conflicts of interest

The authors declare no conflict of interest.

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Direct and moderation effects on U.S. apparel manufacturers' engagement in network ties

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Abstract

PURPOSE*: Firms do not continue and prosper purely on their own individual endeavors, as each firm is influenced by the activities of others, and thus direct and indirect relationships shape the firm's strategic management. These relationships form the tactics by which knowledge and other strategically important resources are accessed and created. Forming and maintaining ties among members of a network have been the subject of numerous research studies in the social, economic, and business literature. Our work is framed by the resource-based view of the firm perspective along with social capital theory and its shared constructs in network theory. Prior findings suggest that networking ties are strategic actions generated for firm growth and continuance. The ties may be short-term or develop into long-term relationships. The intent of this research is to fill some of the gaps in interorganizational networking strategy by analyzing five antecedents that have been suggested in the literature as individually associated with entrepreneurs' engagement in network ties. In this way, our work provides another research avenue for examining networking's contribution to strategic management. We hypothesized positive connections to entrepreneurs' engagement in network ties from antecedents involving the firm's knowledge absorptive capacity, business goals, entrepreneurial orientation, social interactions, and support from their environment.* ***METHODOLOGY:*** *In our quantitative approach, we tested our proposed macrolevel direct and moderating connections through an online survey of 125 U.S. apparel manufacturing firms. The apparel manufacturing sector in the U.S., as in many countries, has struggled with multiple disrupting factors contributing to the sector's decline in firm continuance.* ***FINDINGS****: The results from*

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OLS regression analyses support our hypothesized connections in that each of the five antecedents significantly contributed to entrepreneurs' engagement in network ties; however, when all five were collectively examined only absorptive capacity, social interaction, and business goals were significant (R^2 = 0.58). Further examination of moderation effects found the entrepreneurs' perceptions of a supportive environment to modify both entrepreneurial orientation and business goals. ***RESEARCH AND PRACTICAL IMPLICATIONS:*** *The effects of a supportive environment on business goals' relationship with network ties were greater when perceptions of a supportive environment decreased, while the effects of a supportive environment on entrepreneurship orientation's relationship with network ties were greater when perceptions of a supportive environment increased suggesting further study of U.S. entrepreneurs' perceptions of their environments. Entrepreneurs' interested in building domestic and international supply chain ties may find network ties provide one solution for adapting the firm's resources for global competitiveness. Future studies may direct attention to other industry sectors or countries for replication with larger sample sizes as we recognize the limitations to generalizability and scale refinement due to our limited sample size.* ***ORIGINALITY AND VALUE:*** *The examination of five constructs to shed light on how an organization's decisions may relate to engaging in networks and provides theoretical as well as practical implications that contribute to the larger organizational system framework.*

Keywords : *absorptive capacity, social interaction, business goals, entrepreneurial orientation, supporting environment, network ties*

INTRODUCTION

A proliferation of research has focused on social capital and entrepreneurial networking (Burt, 1992; Galkina & Atkova, 2020). However, market uncertainty continues to grow, as does interfirm network building as a strategy for advancement of entrepreneurial endeavors. For the entrepreneur, establishing a business strategy involves a balancing of opportunity, resources, and team (Aldrich & Zimmer, 1986; Brush, Greene, Hart, & Haller, 2001; Leyden, Link, & Siegel, 2014; Timmons, 1999). Badaracco (1989) considered the word 'strategy' to describe "a company's basic long-term goals and objectives and the ways in which its managers take action and allocate resources to accomplish these goals" (p. 8). An example of a company strategy examined in this study involves engaging in network ties as an outcome of entrepreneurial decisions involving establishing business goals, building knowledge, developing social interactions, considering the business environment, and their entrepreneurial orientations. In the evolving field of entrepreneurship research, Carlsson et al. (2013) define entrepreneurship from the point of view of the Prize Committee who determines the annual International Award for Entrepreneurship and Small Business Research. They considered

entrepreneurship as, "an economic function that is carried out by individuals, entrepreneurs, acting independently or within organizations, to perceive and create new opportunities and to introduce their ideas into the market, under uncertainty, by making decisions about location, product design, resource use, institutions, and reward systems. The entrepreneurial activity and the entrepreneurial ventures are influenced by the socioeconomic environment and result ultimately in economic growth and human welfare" (p. 914).

Opportunities for fortifying a competitive advantage and firm success, frequently require leveraging networks of internal and external ties that motivate new ways of exchanging and combining resources (Mazzarol, Rebout, & Soutar, 2009; Tretiakov, Bensemann, Sanders, & Golloway, 2019). There has been a long-standing flow of research that views networks as a form of social capital (Burt, 1992; Galkina & Atkova, 2020). Early research on networks focused on social ties as conduits for information and resource sharing (Adler & Kwon, 2002; Burt, 1992; Granovetter, 1985; Portes, 1998; Putnam, 1995; Tsai & Ghoshal, 1998; Uzzi, 1996; Uzzi, 1997). Over the past three decades, a significant body of research has investigated similar dynamics at the organizational level (e.g., Ahuja, 2000; Barzak, 2017; Gulati, 1999; Gulati, Lavie, & Madhavan, 2011; Hakansson & Snehota, 1989), and specifically at the business level (e.g., Moliterno & Mahony, 2014; Todeva, 2014; Zin & Ibrahim, 2020).

Interorganizational networking, as a strategic approach, has been positioned in numerous studies as assisting in firm growth by securing access to resources (Lavie, 2006). To aid in securing resources, a firm is compelled to maintain multiple co-occurring ties that cultivate social capital (Barczak, 2017). Jarillo (1988) considered networks as a strategic means used by entrepreneurs to build a strong competitive stance in the marketplace. Though there is no universally accepted definition of a network organization, Jones, Hesterly, and Borgatti (1997) considered a business network organization to entail an intentionally selected, structured group of individual companies, involved in goods manufacturing and delivery of service, operating under an open-ended agreement that ensures flexibility in meeting the changing environment and utilizes coordinated and protected transactions of change. Management literature has suggested further consideration of advancing traditional strategic management to include the strategic formation of networks as well as the need to alter resource-based concepts to understand better the strategy of interorganizational ties (Krzakiewicz & Cyfert, 2013). Thus, concepts from the resource-based view of the firm (RBV) and social capital theory have served as frameworks for prior strategic management research. The contribution of this study rests in including resource-based view of the firm concepts and concepts from social capital theory and network theory,

to discover relationships that have not been examined together in providing a broader understanding of entrepreneurs' engagement in interfirm network ties. The aim of this present study is to address gaps in interfirm networking by: 1.) analyzing notable management actions or perceptions that have been previously found to be independently associated with entrepreneurial network ties; 2.) examining these antecedents for their collective association with network ties; and 3.) exploring potential interactions or moderating effects of these firm-level antecedents for entrepreneurs' engagement in network ties. Our overall objective in this approach is to widen the focus in examining these antecedents as properties of the firm, which may act as determinants of organizational engagement in network ties, for integrating a broader understanding of strategic network management interactions and implications (Gulati et al., 2011).

We gain greater insights into firm owner networking strategy by examining entrepreneurs' knowledge absorptive capacity, business goals, entrepreneurial orientation (EO), social interactions, and perceptions of a supporting environment. This list of antecedents, examined for their impact on engaging in networking ties as the dependent variable, is by no means comprehensive, but essentially reflects some broadly defined areas where we see some of the greatest potential for applying a network strategy lens. In addition, many of the proposed variables have been described as interrelated; thus we examine concepts for strategic networking in a relational model. Our answer shifts attention away from the more traditional notions involving the study of networking by characteristics of the network and position of the firm in the network, evolution of the network, and effects of networking on business performance. This paper consequently focuses attention in more detail to examine potential interactions among the antecedents in exploring their connections with network tie engagement.

To address our study's aims, we focus on firms in the U.S. apparel manufacturing sector. In a manner not unlike what has affected U.S. manufacturing in general, few have felt the impact of intensive low-cost competition from globalization and increased technology more acutely than the apparel industries. The situation is not isolated to U.S. industries and has been reported in other nations in terms of manufacturing SMEs (Craig, McNamara, Descubes, & Guerin; 2020; Fuller-Love & Thomas, 2004). These disrupting factors have contributed to the large decline in the related industries' employment levels over many decades due to mills and apparel factories going out of business (Anderson, Berg, Hedrich, Ibanez, Janmark, & Magnus, 2018; Gerber Technology, 2019). A significant factor contributing to the decline can be attributed to the number of firms that failed to adopt new technology, cooperate with other firms to reduce costs, and to develop product

innovations that could have provided a competitive position in the global market (Mittelhauser, 1997). Craig et al. (2020) found that informal networks served to build international linkages with suppliers and distributors beyond small, French manufacturing firms. They also found that networking which allowed an exchange of information, thus advancing the firms' knowledge absorptive capacity, was an important factor in mitigating environmental uncertainties. Many apparel manufacturing companies face the formidable task of implementing solutions for staying viable, and are seeking resources and knowledge as to how and with whom they might invest in nearshoring, automation technology, and sustainability (Anderson et al., 2018). Given the challenges, the global apparel industry is still one of the most important industries, generating $450 billion annually, and is one of the most important employers in developing countries (The Apparel Industry, 2017).

Our paper is organized as follows. The literature review elaborates on the introduction, provides a review of the variables and proposed relationships, and advances the formulation of six hypotheses. The next section comprises the research methods, testing of hypotheses, and the results. The final section presents a discussion with reference to the literature and offers conclusions along with limitations of the study and suggestions for further research.

THEORETICAL BACKGROUND AND HYPOTHESIS DEVELOPMENT

The framework for our study follows the work of Lavie (2006) as well as Gulati et al. (2011) and their reformulated version of the RBV that incorporates the impact of efforts and activities to secure network resources. They consider interorganizational networking, as a strategic approach, to assist in firm growth by securing access to resources. In these prior works, the researchers, along with several others, also considered social capital aspects inherent in social networking (Eisenhardt & Schoonhoven, 1996; Greve & Salaff, 2001; Rehman, 2015). Networking research contends that external resources, activities, and participants are likely to hold greater influences on the firm, than its own internal resources and activities (Ford & Mouzas, 2013). We integrate and extend the RBV perspective to examine firm owners' strategies as well as aspects of social capital and networking theory to account for the impacts on engaging in network ties. This study does not attempt to investigate a complete or in-depth compellation of possible relationships of the firms in their actions to buy and sell within the market environment (Barczak, 2017). Further, no claim is made about the type of network or the boundaries, but rather that a firm's multiple forms of effort to enhance their business will coincide with increased engagement in network ties. Our

approach corresponds with Ibarra's (1992) view that macrolevel studies have contributed greatly to network-analytical research.

Resource-based view of the firm perspective

The core of business strategy involves the organization's effectiveness in gathering resources, which is recognized as a function of the match between the characteristics of the environment and the organizations capabilities (Hakansson & Snehota, 1989). The resource-based view (RBV) is a framework in management that has been applied in determining the strategic resources a firm attempts to gather to achieve and sustain competitive advantage (Barney, 1991). From the RBV perspective, the emphasis is on strategic choices that firms employ for securing key resources deployed in the market for maximizing returns. The original RBV perspective focused on the firm's internal resources and capabilities (Barney, 1991), but evolution of the perspective has included the firm's efforts for securing resources through external channels such as interorganizational networking (Barney, Wright, & Ketchen, 2001; Ford & Mouzas, 2013; Guliati et al., 2011; Gulati, Nohria, & Zaheer, 2000). In this current work, we view the firm's attempts to gain tangible and intangible resources from multiple overlapping standpoints grounded in strategic management. We follow Sobolewska's (2020) view that externally gained knowledge is a complementary resource that is considered as an opportunity, accessed through networking, to supplement the firm's own insufficient resources. In entrepreneurship and strategic management, resource management is a dynamic capability necessary for survival and continuance, particularly under conditions of environmental uncertainty and recognized resource scarcity (Brush et al., 2001; Grichnik, Brinckmann, Singh, & Manigart, 2014). We focus on knowledge absorptive capacity as a firm's ability to incorporate new knowledge (Lis & Sudolska, 2017).

Prior related research involving the RBV perspective includes Krieser's (2011) work that considered entrepreneurship orientation (EO) as a resource-intensive strategic approach. He suggested firms use EO to unite new with existing knowledge-based resources through network relationships. This perspective assumes that firms recognize the value of networking as a resource for knowledge garnering and incorporate the concept of networking in their EO.

In this present study we examine the direct roles that both EO and knowledge absorptive capacity play in engaging in network ties, and the potential interaction between EO and absorptive capacity in their relationship with network tie engagement.

Research has also focused on goal setting strategies in terms of acquiring resources for business development. Kelliher, Murphy, and Harrington (2020) found business planning activities and goal setting contributed to strategic learning, enabling the business to identify solutions that enhanced the strategic capability of the organization over time. Their in-depth casework examined relationships between goal-oriented activities and knowledge-based resource absorption. Business goals are considered the direction or motivation leading to the use of knowledge. Thus, we examine the direct roles that business goals and knowledge absorptive capacity hold in engaging in network ties, as well as the potential moderators of these relationships. Williams, Manley, Aaron, and Daniel (2018) found strong support for goals in achievement of firm performance, suggesting business goal setting as an important strategic approach. Their work did not detail the nature of the goals, nor whether the firms were focused on acquiring resources or engaged in network ties. Past work by Locke, Latham, and Erez (1988) emphasizes the long-standing belief that goal setting is supported by goal commitment. Their theoretical work proposed three factors that affect goal commitment involving external influences from authority figures and peers, interactive factors focusing on participation and competition, and internal factors concerning expectancy and internal rewards. Our work will investigate aspects inherent in these three factors, in that network tie engagement may provide the influence of peers, prospects for participation in meeting competitive aspects of the marketplace, as well as the occasion for social interaction opportunities, and evaluation of supportive environments.

From the RBV perspective, we synthesize prior empirical findings to re-examine strategies associated with resource accumulation perceptions of the firm's environment, social interactions, and business goals in tangent with EO and knowledge absorptive capacity. We aim to extend our findings by introducing encompassing variables that moderate the relationship with network tie engagement, specifically, knowledge absorptive capacity, entrepreneurial orientation, and business goals in tangent with social capital concepts involving social interactions and a supportive environment

Social capital theory

Bourdieu (1986) defined social capital, among the various forms of capital, as the sum of actual or potential resources linked to membership in a group, such as a network, providing maintained and reinforced exchanges that accrue material and symbolic profits for the members. Social capital, as defined by Putnam (1995), involves, "features of social life, such as networks, norms, and trust – that enable participants to act together more effectively

to pursue shared objectives" (p. 665). There is also recognition that social capital may be formal or informal in nature as well as holding both individual and collective characteristics (Woolcock, 1998). Social capital is, at its core, about relationships and ties.

Social capital has been found to be both an input to, and an output from, social and economic processes (Gannon & Roberts, 2020). Social capital includes the dimension of social interaction (Tsai & Groshal, 1998). Entrepreneurs develop relationships, particularly interfirm arrangements, to obtain resources such as information or knowledge. The bonds stimulate opportunities for exchange or combining of resources with other firms (Hitt, Dacin, Levitas, Arregle, & Borza, 2000). Organizations with a positive social interaction culture often interact frequently (Connelly & Kelloway, 2003), knowledge is shared, and greater access to resources is provided (Toutain, Fayolle, Pittaway, & Diamanto, 2017). Nahapiet and Groshal (1998) presented three dimensions of social capital – structural, relational, and cognitive. The relational dimension of social capital includes social interaction found to provide advantages for the individuals through information and specific resources (Tsai & Groshal, 1998).

Assessment of the environmental, social, and economic supportive conditions is considered important in overcoming or adapting to uncertainties (Bitowska, 2020). There is a combination of factors involved in the socioeconomic environment that can inhibit or support business advancement. Paliokaite (2019) regarded environmental conditions as affecting the firm's knowledge absorptive capacity. There is agreement among scholars that the more conducive the environment is to aspects of conducting business, the more likely the business will develop and grow (Gynawali & Fogel, 1994). Thorelli (1986) proposed that the most significant part of any firm's environment was other firms; thus interfirm linkages and perceptions of other firms were important to understanding entrepreneurial behavior. Our work examines the perceived presence of social and economic assistance and backing in the entrepreneurial environment, and the provision of a supporting environment to engage in network ties.

While the theoretical origin of social capital has been disputed, the majority of recent scholarship references Coleman's (1988) work (Engbers, Thompson, & Slapper, 2017). Social capital has found a place in a wide array of disciplines. Over the years, a proliferation of research has focused on social capital and entrepreneurial networking (e.g., Burt, 1992; Galkina & Atkova, 2020). Networks have been regarded as sustained relationships between individuals, groups, and organizations such as firms (Dubini & Aldrich, 1991; Thorelli, 1986). Business networks have been defined as an assembly of exchange relationships between companies (Marcela Herrera Bernal, Burr &

Johnsen, 2002). Past research has yielded empirical evidence that social capital holds real effects on the likelihood that the entrepreneur will hold interfirm linkages. These connections enhance performance, innovations, and the prospect of firm continuance, thus contributing to job creation and economic growth (Greve & Salaff, 2001; Ibarra, 1993; Nyuur, Brecic, & Debrah, 2018).

A brief overview offers further understanding of the intricate advancement of social capital's conceptualization of networking, from its focus on the social aspects of interactions, to its adoption for studies of business interactions. Early work proposed by Hakansson and Snehota (1989), presented a network model of organization-environment interface that focused on the functioning of business markets and advanced networking as a business strategy. Borch and Arthur (1995) recommended strategic network frameworks to provide researchers with a broader perspective as to the complex interactions between the firm exchange and the social ties of those involved. They emphasized building a multi-disciplinary theoretical approach. This perspective follows Granovetter's (1992) thinking that the development of a firm resulted, "from socially situated individuals embedded in networks of personal relations with noneconomic as well as economic aims" (p. 47). Thus, business exchange could help the entrepreneur gain social support in maintaining self-confidence, as well as acquiring social networks aiding the acquisition of legitimacy in the marketplace (Johannisson, Alexanderson, Nowicki & Senneseth, 1994).

Studies in organizational change recognized the importance of social networking concepts in meeting the volatile competitive landscape (Tenkasi & Chesmore, 2003). At this same time, social networks were considered the glue in the mobilization of resources for entrepreneurial innovations. This approach by Greve and Salaff (2001) was called corporate social capital. Work in strategic management considered that constructing a resource-based view was, for the entrepreneur, enormously challenging and considered that resources were the keystone for strategy (Brush et al., 2001). Consequently, both business and social benefits characterized why entrepreneurs sought networking opportunities. Ahuja (2000) examined interfirm linkages as opportunities, weighing up the contributions of the resource-based view of the firm (RBV), as well as social, technical, and commercial capitals. He called for empirical steps that included a broader set of factors proposed to influence network development and to recognize the motivations for networking.

Network theory

Management research has considered the effect of social networks on a broad range of organizational practices resulting in an integration to form organizational social network literature (Kim, Oh, & Swaminathan, 2006).

Larson and Starr (1993) proposed, and Miller, Besser, and Sattler Weber (2010) empirically considered, the network approach as an organization of multidimensional socioeconomic links. Moliterno and Mahony (2011) advanced the Network Theory of Organization, recognizing that organizational networks are hierarchically associated within a system of networks. Todeva (2014) considered business networks to be socio-economic configurations of transacting economic entities, involving people or organizations who participate in repeated exchanges. There is also recognition of embeddedness of these transactions in the formation of social relations.

Entrepreneurs are said to assemble networks that combine both social and business concerns with significant and lasting ties that are as often socially oriented as business oriented (Johannisson, 1996). Contemporary research is influenced by complexity theory to understand – effectual networks (Galkina & Atkova, 2020), external and internal interactive learning (Thoma & Zimmermann, 2020), both strategic niche management and social network analysis (Canie & Romijnb, 2008; Gannon & Roberts, 2020), industrial marketing and purchasing (Ford & Mousas; 2013), and proximity and clusters (Camarena-Gil, Garrigues, & Puig, 2020). Pellinen (2014) considered the bulk of entrepreneurship network studies to link network ties, as defined by Granovetter (1973), with firm performance. However, it is just as important to know what induces the entrepreneur to seek and build ties prior to measuring firm or network performance.

Networks are made up of a broad collection of cooperative ties ranging from information links to shared operations with arrangements that often blur company boundaries (Badaracco, 1989). These networks provide the firm with information, resources and advantages from learning that allow firms to achieve strategic goals (Johannisson, 1986; Miller, Besser & Malshe, 2007; Yli-Renko, Autio, & Sapienza, 2001) and enhance business performance (Besser & Miller, 2010; Zin & Ibrahim, 2020). The network is considered as an environment where a combination of resources is exchanged, impacting the individual in learning the entrepreneurial process (Toutain et al., 2017). Thus, the overlap of RBV, social capital, and network theory has been applied in prior studies involving a variety of firm types, sizes, and locations. The contribution of our study centers on examining constructs from many of these prior studies together in assessing their ability to explain entrepreneurs' engagement in network ties

Network ties

In discussing business network theory, Todeva (2014) indicated three distinct levels of focus – the level of the firms' attributes, the level of inter-firm

relationships, and the level of overall network configuration. Our work is at the level of the firms' attributes concerning their efforts toward engaging in network ties. Network ties are considered the bonds that enable groups to act together, often with greater capabilities, in meeting meet uncertainties in the environment.

Tsai and Ghoshal (1998) refer to social ties as conduits for information and resource sharing. Within network strategy, an important focus is geared to the leveraging of a network of internal and external relational ties to assemble, escalate, or expand resources. Kreiser (2011) developed theoretical propositions regarding the role of entrepreneurial orientation and acquisition of knowledge-based resources through networking. Network ties have been examined for factors that may influence when strong versus weak ties generate benefits. Granovetter (1973) suggested that weak ties allow access to a diversity of resources through relationships outside the immediate contacts. Burt (1992) considered these connections as positions of bridging, allowing ties with otherwise unassociated outsiders. Hoang and Antoncic (2003) found support for bridging, in that strategically important information was exchanged sooner via weak ties than firms embedded in networks with strong ties. Uzzi (1996, 1997) understood that firms benefited from a combination of these ties. In the current work, our definition involves engaging in networking ties as a form of business strategy, rather than for the characteristics of the ties such as modalities of strong or weak, or the characteristics of the network structure.

Portes (1998) believed attaining social capital required purposeful investment, particularly in economic-based resources, and underscored the importance of separating the resources from the capacity to obtain them. Liu and Yang (2020) found that by developing ties across the interfirm network, the firm could access diverse resources providing it with competitive advantages. Areas suggested for future studies involving networking resources have included organizational culture (Felipe, Roldán, & Leal-Rodríguez, 2017), absorptive capacity and knowledge acquisition (Limaj & Bernroider, 2017; Norman, 2004; Parra-Requena, Ruiz-Ortega, Garcia-Villaverde, & Rodrigo-Alarcon, 2015). Thus, the focus on the capacity to obtain resources overlaps the resource-based view of the firm with concepts stemming from social capital, and particularly business network theory. The above theoretical perspectives suggest possible interactions between concepts. We highlight and form hypotheses to test the theoretically overlapping concepts of knowledge absorptive capacity, social interaction, business goals, entrepreneurial orientation, and supportive environment that are proposed as explaining a firm's engagement in network ties.

Hypotheses

Measurement of aspects involved with social capital theory is considered extremely difficult (Engbers et al., 2017). Gannon and Roberts (2020) also emphasize the mismatch of social capital theory and empirical measurement in the economics literature. There is agreement that social capital is a multi-dimensional concept with potentially strong associations that, if uncovered, may verify complementary effects (Engbers et al., 2017). Borgotti and Halgin (2011) remind researchers to consider the node attributes or the other contextual factors as the proposed causal agents that, in our case, could interact in a study of firm engagement in networking ties. Investigated in this study are hypothesized relationships between the factors concerning knowledge absorptive capacity, social interaction, business goals, entrepreneurial orientation, and supportive environment, and entrepreneurs' interfirm network tie engagement.

Knowledge absorptive capacity

Knowledge and other strategically important resources are accessed and built, generating relations that are linked to other relations resulting in a system of what is referred to as business networks (McGowan, Cooper, Durkin, & O'Kane, 2015). Knowledge transfer or migration, as a resource, is included in both the RBV perspective and in social capital theory. Knowledge absorptive capacity is referenced as a firm's ability to see opportunities and use information external to the firm to develop product and production methods (Greve & Salaff, 2001; Lis & Sudolska, 2017). Firms reach external information by way of ties suggesting that social capital is embedded in relationships that enhance absorptive capacity. Tenkasi and Chesmore (2003), in examining network ties for enhancing organizational change, referred to problems with knowledge transfer and learning, which are also elements involved in knowledge absorptive capacity. They found strong network ties were likely to promote greater communication and facilitate the exchange of information needed for knowledge transfer and learning. Organizational learning involves the linking of the firm's values and its corresponding behaviors (Garvin, 1993). Anderson, Covin, and Slevin (2009) specified that the two dimensions of strategic learning involved the acquisition of knowledge and the execution of strategic change due to the acquired knowledge. The premise of knowledge absorptive capacity is, according to Cohen and Levinthal (1990), that to be able to acquire and use new knowledge, the firm must have the capacity to recognize or understand how the new information corresponds with the existing firm-level knowledge. In other words, acquisition of knowledge

may not be operationalized if it cannot be executed. In this way, knowledge becomes a crucial strategic resource.

The association of establishing strategic networks of interfirm ties to the accessing of resources and offering advantages has long been supported by the RBV perspective, social capital, and networking theory (Gulati et al., 2000; Lane & Lubatkin; 1998). Thus, we hypothesize that knowledge absorptive capacity is an antecedent for engaging in network ties. Additionally, Paliokaite's (2019) work suggested absorptive capacity seeking facilitated connections for both intra-firm relationships and environmental conditions. In this current study we therefore also examine the moderating effects of absorptive capacity, social interactions, supporting environment, business goals, and EO on network ties. From social capital theory and the resource-based view of the firm perspective we first conclude:

H1: As the firm owners' efforts to gain knowledge absorptive capacity increases, so will their engagement in network ties.

Social interaction

Aldrich and Zimmer (1986) highlighted the uncertain and faulty perceived nature of business environments and specified that a comprehensive description of entrepreneurship must include the social relationships by which resources, information and support are acquired. Work by Linder, Lechner, and Pelzel (2020) considered social interaction as a means of extracting benefits and suggested opportunity recognition was heightened with the process of entrepreneurial interactions. They proposed that the interactions were likely to lead to heterogeneity and constructively altered the exchange of resources.

Social capital, manifested as social interaction, is considered in the network literature to advance ties among the members (Tsai & Groshal, 1998). The social ties are channels for information and resource exchange. The intensity of social interactions of entrepreneurs can be used as an indicator of social capital (Nahapiet & Groshal, 1998). Social interactions overlook the boundaries between entrepreneurs providing opportunities for accessing knowledge resources (Molina-morales & Martinez-fernandez, 2010; Tsai & Ghoshal, 1998). Interactions can occur at social or business-focused events thus, the greater number of opportunities for social interactions with other firms, the greater the likelihood of exchange enhancing network ties. This perspective reflects opportunities from the resource-based view of the firm combined with social capital and network theory. In this present study, we examine the direct and moderating effects of social interactions on network

tie relationships. From the development of social as well as business connections, we first hypothesize that:

H2: As the firm owners' social interaction increases, so will their engagement in network ties.

Business goals

From a long tradition in psychology, it has been established that deliberate behavior is purposeful or focused and is regulated by goals (Latham & Locke, 1991). When describing the vital components of business planning, scholars note that strategic goals need definition as well as alternatives for achieving the goals (Armstrong, 1982; Brinckmann et al., 2010). Smeltzer, Van Hook, and Hutt (1991) found business owners who developed a business plan reported a higher quality and quantity of connections through their networks. Thus, through a combination of interactions and the advancing of common goals predicated upon cooperation among members of the network, the usefulness of the network is amended and furthered (Toutain et al., 2017). Defining goals requires the commitment of resources and thus the RBV perspective plays a role in decisions initiating competitive advantage.

Hakansson and Snehota (1989) noted a more complete understanding of the business organization resulted from a shift in business strategy focus away from the internal processes of firms and towards the interchange of the firm and its environment. Their definition of strategy held that, "the emphasis is on the pattern of activities which has an impact on the achievement of organizational goals in relation to its environment" (p.188). Brinkmann et al. (2010) viewed newer and smaller firms to be more affected by uncertainty in the environment due to limited information when compared to established larger firms. They also ascribed the moderating effect of cultural setting or the degree of uncertainty in the business planning-performance relationship.

Knowledge garnering opportunities and learning behaviors have also been identified as important to goal achievement as well as supporting environments that allow individuals to learn (van Gelderen, van de Sluis, & Jansen, 2005). These prior research results suggest that either or both knowledge absorptive capacity and a supportive environment may hold a moderating effect on attainment of business goals when examining the relationships with network ties.

Within strategy, decisions are often the focused effort that guides the business and unites the team of employees. These decisions are generated from the owner's business goals that are embedded in the business planning (Mazzarol et al., 2009; Williams et al., 2018). This present study serves as

a preliminary examination of how business plans guiding the development of network ties, may precede or direct business networking strategy. We also examine the direct as well as the moderating effects of business goals on network ties. We, therefore, first hypothesize:

H3: As the firm owners' efforts in meeting business goals increases, so will their engagement in network ties.

Entrepreneurial orientation

Entrepreneurial orientation (EO) was defined by Covin and Wales (2019) as "an attribute of organization that exists to the degree to which that organization supports and exhibits a sustained pattern of entrepreneurial behavior reflecting incidents of proactive new entry" (p. 5). Covin and Lumpkin (2011) considered the concept of EO to aid in an understanding of why and how some firms regenerated themselves for persistent growth while other firms did not. EO research has held many definitions with interest in identifying the number of dimensions involved.

Le Breton-Miller and Miller (2011) proposed a unidimensional approach to EO consisting of a set of dimensions involving innovativeness, risk taking and proactiveness. These dimensions were also examined previously by Covin and Slevin (1991) as well as Stam and Elfring (2008). We follow this logic and consider the formative construct of EO as the shared variance among the three dimensions recognizing that multiple components form the single variable. For the purposes of this study we follow the definitions also contained in EO research by Zbierowski (2020) and by Rezaei and Ortt (2018), whereas innovativeness involves the willingness to support originality and the incorporation of change to achieve a competitive advantage for the firm. Risk taking involves the extent to which the firm occasions business-related risks, and proactiveness entails responding to impending or forthcoming demand to amend or shape the environment.

Payne et al. (2011) suggested a multilevel research opportunity existed for examining the relationship between EO and social capital. Kreiser (2011) offered propositions involving the relationships among entrepreneurial orientation, learning, and networking. Stam and Elfring (2008) examined EO by studying the configuration of intra- and interindustry network ties and found the moderating effects of network ties influenced the relationship between EO and firm performance. They suggested further studies examining the determinants of external ties would make important contributions. Covin and Miller (2014) included examination of network ties in assessing the EO on

a national and international level as a promising area in the field of strategy and organizational theory.

Long agreed upon across EO studies are the moderating effects of environmental conditions on the EO to performance relationships (Covin & Lumpkin, 2011; Covin & Wales, 2019). Higher levels of EO were found to influence positively an entrepreneur's strategic learning that was then disseminated through a social exchange process (Siren, Hakala, Wincent, & Grichnik, 2017). These prior research results suggest that either or both knowledge absorptive capacity and a supportive environment may hold a moderating effect with EO when examining the relationships with network ties. In this present study, we examine the direct and moderating effects of EO on network tie relationships. We first hypothesize that:

H4: As the firm owners' entrepreneurial orientation increases, so will their engagement in network ties.

Supportive environment

In turbulent environments, firms cannot easily foresee which resources will be vitally important; thus it is crucial to invest in network relationships that are believed to increase the number and type of available resources (Johannisson, 1986; Sobolewska, 2020). Social and economic supportive environmental conditions were considered by Bitowska (2020) to be important in overcoming or adapting to uncertainties. Grichnik et al. (2014) examined the level of support from the environment as environmental munificence capturing entrepreneurs' responses to the perceived negative more hostile flipside of industry support. Dollinger (1990) defined munificence as the degree of resource abundance and capacity for supporting growth.

MacGregor (2004) submitted that firms with fewer than ten employees often sought networks as one solution for influence over the uncertain market environment. Firms with few resources are more vulnerable to risk, and alliances or networks may have a role in efforts to reduce perceptions of barriers to resource access (Hitt et al., 2000). Research also suggests that social capital increases entrepreneurs' illusions of control and strengthens their willingness to embrace uncertainty (DeCarolis, Litzky, & Eddleston, 2009). Thus, market support, associated with network ties, may resolve uncertainties that have informational value to the entrepreneur and allow strategy adjustments in high EO firms (Grinstein, 2008). Covin and Slevin (1991) considered the external environment as a variety of sociocultural, as well as economic and political, forces consequently holding a moderating effect on the entrepreneur's behavior. Carlsson et al. (2013) judged all entrepreneurial activities and outcomes to

be influenced by one or more facets of the socioeconomic environment. We examine the direct and moderating effects of a supportive environment on the network tie relationships. From the perspective of environmental impacts on firm behavior, we first hypothesize that:

H5: As the firm owners' perceptions of a supportive environment increases, so will their engagement in network ties.

Moderation effects among antecedents

Covin and Slevin's (1991) conceptual model of entrepreneurship as firm behavior included a proposed examination of external variables' moderating effects on the firm's behavior. A moderator is a type of variable that provides added information concerning the association between the predictor variable and the dependent variable. Moderating variables may temper or modulate the magnitude of the effect, thus causing the association to be strong, weaker, or possibly disappear (Allen, 2017). In our study, we consider the possible moderating effects of five variables on their association with firm engagement in network ties, herein referred to in the following hypotheses as network ties.

As stated earlier, in summarizing the literature pertaining to each variable, there are empirical findings suggesting that moderating effects may be present among the antecedents. Again, there are challenges in measuring social capital as several measures could overlap with similar concepts creating issues with multicollinearity. Another challenge could result from the possible association of different concepts with each other that are not easily distinguished but, if measured, may aid in the interpretation of their consequent effects (Engbers et al., 2017). Therefore, we examine and report the correlations among the antecedents and test for multicollinearity. Given previous findings that suggest relationships among examined antecedent variables in their effect on network ties, we hypothesize that:

H6. The relationship with network ties changes for:

a. absorptive capacity depending upon the level of social interaction, or vice versa.

b. absorptive capacity depending upon the level of business goals, or vice versa.

c. absorptive capacity depending upon the level of entrepreneurial orientation, or vice versa.

d. absorptive capacity depending upon the level of supportive environment, or vice versa.

e. social interaction depending upon the level of business goals, or vice versa.
f. social interaction depending upon the level of entrepreneurial orientation, or vice versa.
g. social interaction depending upon the level of supportive environment, or vice versa.
h. business goals depending upon the level of entrepreneurial orientation, or vice versa.
i. business goals depending upon the level of supportive environment or vice versa.
j. entrepreneurship orientation depending upon the level of a supportive environment, or vice versa.

RESEARCH METHODS AND RESULTS

Research context

Analyses involved examination of five variables hypothesized as antecedents to engagement in network ties. First, the variables involving knowledge absorptive capacity, social interaction, business goals, entrepreneurial orientation and supportive environment were examined to determine their ability to explain, individually, their engagement in network ties. Second, the potential overlaps among the antecedents were examined for their mutual ability to explain engagement in network ties. We implemented the testing of these hypotheses with a national sample of entrepreneurial firm owners of U.S. apparel manufacturing firms given the lack of literature addressing networking within the fashion sector (Camarena-Gil et al., 2020). The U.S. apparel manufacturing sector is characterized by intense competition, necessitating firms to develop processes that support maintenance of competitive advantage. Some forms of collaboration, such as engagement in network ties, expediate the firm's success in particularly competitive sectors. Wigley and Provelengiou (2011) examined the market-facing strategic alliance in the fashion industry, whereas this exploratory study is focused on the back-of-house activities involving U.S. apparel manufacturing.

Examination of networking strategy along the textile and apparel industry supply chain is not uncommon. Human and Provan (1996) examined manufacturing in the secondary wool products industry using a combination of qualitative and quantitative research methods. The interview data revealed four categories of resource exchange among member firms they labeled as friendship, information, competency, and business. Jarillo's (1988, 1993) strategic network research involved analysis of Benetton's Italian supply chain

network, and Uzzi (1997) studied exchange of information among members of a New York City women's apparel manufacturers' supply chain. Boschma and Ter Wal (2007) examined knowledge networks among footwear firms in the south of Italy. Their findings linked higher levels of firm knowledge absorptive capacity with higher levels of innovation performance. Camarena-Gil et al. (2020) conducted a qualitative study on two textile clusters in Spain for an examination of innovation in the textile industry and the impact of geographical and institutional proximity. They suggested increasing awareness among firms as to the value of sharing strategic resources and the potential transfer of knowledge. Our current inquiry may therefore hold direct implications for the global textile industry and for firms who are seeking research-generated know-how.

Data collection

The global textile and apparel industry includes processes and production of a wide array of products resulting from fiber, fabrication, and manufacture. In this present study, we narrowed the focus for our exploration to owners of apparel manufacturing firms in the U.S. with less than 250 employees. Our goal was to achieve a representative national sample of firms conducting apparel manufacturing with a focus on smaller-sized U.S. entrepreneurial firms facing growing international competition.

Data was collected in 2019 using Qualtrics® online surveys and by contacting firm owners via their e-mail and requesting participation with no incentives involved other than our indication that we wanted to learn more about their business in the current environment. We generated responses from two sample populations – within a single U.S. state, and a national U.S. sample. In this approach, we were able to capture firms that were geographically close in proximity and those that were geographically dispersed. The state sample was produced from smaller-sized firms who were participants in annual regional apparel and sewn products manufacturing meetings from 2014 to 2018. The national sample was generated from a list of firms who had registered as apparel manufacturers under the U.S. NAICS code 315 (U.S. Bureau of Labor Statistics, 2020). To correspond with the state firm size, the national list contained firms with fewer than 250 employees. Following removal of non-functioning e-mail addresses, 2,350 national firms and 170 state firms were contacted using the Dillman, Smyth, and Christian (2009) method. Responses from the national sample totaled 77 responses for a 3.27% response rate. The state sample totaled 48 responses completed for a 28.23% response rate. The total representative sample involved 125 apparel firm responses for a total response rate of 4.96%. Though several attempts were made to increase the

sample size, a limitation for generalizing the results to a larger population is recognized; however, the exploration of relationships among the variables was considered a first step in advancing understanding of network ties as strategy among U.S. apparel producing firms.

A test for non-response bias was performed to see if early and late respondents significantly differed in their responses (Armstrong & Overton, 1977). Independent *t*-tests were performed on the antecedents and dependent variables including, absorptive capacity, business goals, social interaction, EO, supporting environment, and network ties. No significant differences (all $p <$. 494) were identified between the surveyed early and late respondents. This study additionally relied on self-reported data from entrepreneurs as single informants representing their firm. These single key informants were considered the most knowledgeable individuals within the firm. We follow MacKenzie and Podsakoff (2012) in that, when respondents can and are willing to provide accurate responses, their responses will be less susceptible to common method bias.

There may also be some level of common method bias introduced by having the same respondent provide information for what became the independent and dependent variables in the analyses (Gatignon, Tushman, Smith, & Anderson, 2002; Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). We, therefore, conducted Harman's one factor test as a diagnostic technique for assessing the extent to which common method variance may be a problem (Podsakoff et al., 2003). We found entry of 34 survey items representing the six scales in a principal components factor with the solution set to one factor and with oblique rotation that the single factor accounted for 23.93% of cumulative variance in the items, which is less than the 50% level suggesting a very low risk for the presence of method bias; however, no further steps were taken to remove the presence of common method variance. Given these limitations, our results offer support for the impact of multiple antecedents on engagement in network ties.

Measures of variables

Six scales were produced for the study and for each scale a mean score was created by summing the mean score for each 7-point Likert-type item included (see Table 1 for means, standard deviations, and correlations). For measurement of network ties, we adapted existing questions from the work of Henry and Vollan (2014), Teece (1992), and Yli-Renko et al. (2001). Participating firms were to indicate their level of perceived importance in response to nine statements. The scale labeled NTSCA held a Cronbach's alpha of 0.77. Absorptive capacity was measured from existing items adapted from research by Cohen and Levinthal (1990) and Lane and Lubatkin (1998).

Firms were asked to indicate their level of perceived importance regarding four statements. Cronbach's alpha was 0.73 and the variable was labeled ACSCA. Social interaction was measured using three existing items, with two items measuring level of importance and one item assessing degree of agreement with the statement. Items were generated from the work by Johannisson et al. (1994) and Yli-Renko et al. (2001). Cronbach's alpha for this scale was 0.73 and labeled SISCA. Business goals were adapted from work by Kuratko, Hornsby, and Naffziger (1997) and were measured using seven items assessed for level of importance. Cronbach's alpha was 0.77 and the scale was labeled BGSCA. The scale for EO was adapted from work by Le Breton-Miller and Miller (2011), Covin and Slevin (1991), and Stam and Elfring (2008) involving innovativeness, risk taking and proactiveness. Six items were used with three assessing degree of agreement, and three assessing level of importance. Cronbach's alpha was 0.77 and labeled ENTORIENSCA. The supporting environment scale was adapted from work by Miller, Besser, Gaskill, and Sapp (2003) with five items measuring level of agreement with aspects of social and economic support in the environment. Cronbach's alpha was 0.77 and the scale was labeled SUPENVSCA. Cronbach alpha levels for all scales suggest adequate reliability (Nunnally & Bernstein, 1994).

Examination of the scales found evidence of moderate correlations between NTSCA and the scales involving ACSCA, SISCA, BGSCA, and ENTORIENSCA and a weak correlation with SUPENVSCA with the state and national sample combined. Between the independent variables there was evidence of moderate correlations between ACSCA and each of BGSCA and ENTORIENSCA. The weakest correlations in the combined sample were between BGSCA and SUPENVSCA and between ACSCA and SUPENVSCA.

Table 1. Variable means, standard deviations, and correlations for the combined sample.

Scale	n	Mean	SD	r_{AC}	r_{SI}	r_{BG}	$r_{ENTORIEN}$	r_{SUPENV}
NTSCA	88	4.70	0.94	0.62 <0.001	0.53 <0.001	0.46 <0.001	0.50 <0.001	0.32 0.003
ACSCA	88	5.43	0.89		0.27 0.012	0.53 <0.001	0.45 <0.001	0.06 0.600
SISCA	88	4.77	1.31			0.27 0.011	0.28 0.008	0.35 0.001
BGSCA	88	5.27	0.96				0.30 0.005	0.11 0.347
ENTORIENSCA	87	5.04	1.04					0.20 0.077
SUPENVSCA	81	4.86	1.06					

Theory guided the selection of scales and items from existing scales. The intent was not to refine the scales through reduction of items, but to retain items derived from theory. The sample sizes for the state and the nation did not allow for separate factor analyses by location, though factor analysis was conducted on the combined sample. Location was then entered in all subsequent analyses as a control variable.

Acceptable levels of reliability and consistency were found, with Cronbach alpha values between 0.73 and 0.77 (Nunnally & Bernstein, 1994). A factor analysis was carried out to examine the construct validity of the instrument. We followed the procedure outlined in Tabachnik and Fidell (2007) and used principal component analysis specifying oblique rotation with the six desired factors. Oblique rotation was suggested when factors in the analyses are assumed to be correlated (Gorush, 1983; Sieger et al., 2016). This analysis resulted in six components with Eigenvalues of 8.00, 3.54, 2.90, 1.92, 1.66, and 1.59. The respective variance explained was 24.24%, 10.73%, 8.79%, 5.82%, 5.04%, and 4.72%. The total variance explained was 59.35%, which is just under the suggested threshold of 60% (Hinkin, 1995). For the 34 items, the factorability of the data was confirmed by the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (Kaiser, 1970) at 0.697, thus exceeding the threshold of 0.50 (Kaiser & Rice, 1974). In addition, Bartlett's test of sphericity was significant (chi-square = 1202.6, df = 528, $p < .001$.

Unidimensionality analyses were conducted separately for the six constructs (Danneels, 2016; Gerbing & Anderson, 1988). For components in each of the six, corresponding items loaded on one component only, with the exception of two of the seven business goals (BJSCA) and two of the nine network ties items (NTSCA), with a factor loadings of at least 0.541 (ACSCA), 0.633 (ENTORIENSCA), 0.67 (SISCA), 0.583 (SUPENVCA). Each of the four components accounted for at least 47.5% of the variance in the respective set of items (respectively 58.4%, 47.5%, 65.7%, and 53.4%).

Hinkin (1995) stressed that scales should not be developed by removing scale items based upon the factor analyses results. Further examination of the two items in the business goals scale (BGSCA) and two items in the network ties scale (NTSCA) determined that these items held strong face validity and were critical to content and construct validity (Hinkin, 1995). To check the impact on inter item correlations, if the items were removed, the revised Cronbach alpha scores were lower than with the items included. The items were retained for this early examination of this industry segment but further scale development is warranted with larger representative sample sizes of over 150 for subsequent investigations (Guadagnoli & Velicer, 1988).

ANALYSIS AND RESULTS

Characteristics of the sample

To examine significant differences between the participating firm owners from the state and the national sample, we examined demographic descriptive statistics. Among the state participants, there were more female participants than among the national participants (31.7% versus 20.3 %). The mean age of the state participants was 49 years of age compared to 56 years of age for the national sample. Respondents from the state evaluated their level of prior knowledge as 'more than average' to 'a great deal of expertise' with a mean of 4.92 compared to the national level with a mean of 2.93 indicating 'very little' to 'an average amount of expertise'. No differences were found regarding the state or national location for the level of business success, number of employees, net profit, and level of innovation and entrepreneurship practiced by the firm. Finding significant descriptive differences between the two sample groups, we incorporated a control variable in the statistical analyses regarding the firm's location, labeled as state, and examined the combined sample populations in further analyses.

There were a total of 125 valid combined state and national responses examined for characteristics observed at the owner and the firm level. When asked, 91.8% identified themselves as entrepreneurs and were predominantly business founders (60.8%) or had purchased the business (18.6%). The respondents were almost evenly divided, with 52% males and 48% females. The participant age range was 28 to 83 years of age with a mean age of 53 years. In terms of education, nearly half of the respondents held bachelor's degrees or higher (47.7%), and 72% held knowledge of the production business prior to becoming involved in their current business.

The range of business age was broad, with the youngest in year one of operation and the oldest business in existence 127 years. In quartiles, the first quartile equaled 6.5 years and the third quartile 33 years in business. The majority of the firms was in the growth or mature state of the business lifecycle (92.8%). In terms of size, we found similarity with MacGregor's (2004) work, as the majority of the firms in the present study were small in size with 10 or less employees, averaging four full-time and two part-time employees. The participating firms in our study were consistent with the Small Business Administration's (2018) figures suggesting 80% of small business employed approximately six employees.

Direct effects

Ordinary Least Squares regression models were fit predicting NTSCA with a state indicator (1 indicated the manufacturer was located in the state, 0 indicated the national sample) and the scales ACSCA, SISCA, BGSCA, ENTORIENSCA, SUPENVSCA (Table 2). Model 1 included only the state location indicator as a predictor. Models 2–6 included the state indicator, and each of the scales, individually, as predictors. Model 7 included the state indicator and all five scales as predictors. Model 8 included the state indicator, all five scales, and all two-way interactions between scales as predictors. Before fitting the models, variance inflation factors (VIF) were calculated for the model with all predictor variables, excluding interactions. All variance inflation factors were less than 2, therefore, the model was fit as specified above without multicollinearity concerns (Aiken & West, 1991).

Evidence was found that increases in each of the scales when entered individually were significantly associated with increases in NTSCA, while accounting for location using the state indicator. Support was therefore found for H1 ACSCA (Model 2, $B = 0.633$, $p < 0.001$, Adj. $R^2 = 0.377$), H2 SISCA (Model 3, $B = 0.366$, $p < 0.001$, Adj. $R^2 = 0.271$), H3 BGSCA (Model 4, $B = 0.425$, $p < 0.001$ Adj. $R^2 = 0.216$), H4 ENTORIENSCA (Model 5, $B = 0.437$, $p < 0.001$ Adj. $R^2 = 0.279$), and H5 SUPENVSCA (Model 6, $B = 0.234$, $p = 0.012$, Adj. $R^2 = 0.122$). When all five antecedents were entered (Model 7), evidence was found for ACSCA ($B = 0.320$, $p = 0.004$), SISCA ($B = 0.195$, $p = 0.004$) and BGSCA ($B = 0.270$, $p = 0.007$), but not ENTORIENSCA ($B = 0.128$, $p = 0.118$) and SUPENVSCA ($B = 0.126$, $p = 0.070$).

Knowledge absorptive capacity, social interaction, and business goals were found to be significantly associated with the apparel producing firms' engagement in network ties. These findings offer support for the RBV perspective involving knowledge absorptive capacity and for social capital and network theory involving social interaction and interfirm networking. Perceptions of a supportive environment and possession of entrepreneurial orientations, though not found to be significant when all five variables were examined in the analyses, were examined further for their interactions in the analysis of potential moderating effects.

Moderation effects

In terms of examining moderation, there was not strong evidence of interaction effects between the pairs of predictors on NTSCA. The amount of variance in NTSCA explained by fitting the additive model with all five predictors controlling for state location (Model 7, Adj. $R^2 = 0.565$) and by

fitting the model with all five predictors and their two-way interactions controlling for state location (Model 8, Adj. $R^2 = 0.579$) were similar (R^2 change = .14). There was no evidence of interactions between ACSCA and SISCA (*B* = 0.059, *p* = 0.564; H6a), ACSCA and BGSCA (*B* = 0.033, *p* = 0.744; H6b), ACSCA and ENTORIENSCA (*B* = -0.120, *p* = 0.252; H6c), ACSCA and SUPENVSCA (*B* = -0.067, *p* = 0.566; H6d), SISCA and BGSCA (*B* = 0.040, *p* = 0.699; H6e), SISCA and ENTORIENSCA (*B* = -0.022, *p* = 0.796; H6f), SISCA and SUPENVSCA (*B* = 0.054, *p* = 0.468; H6g), or BGSCA and ENTORIENSCA (*B* = 0.086, *p* = 0.457; H6h). There was some support for interaction effects between BGSCA and SUPENVSCA (*B* = -0.221, *p* = 0.067; H6i) and between ENTORIENSCA and SUPENVSCA (*B* = 0.201, *p* = 0.043; H6j). Simple slopes were examined to explore these two interaction effects on NTSCA (see Figures 1 and 2).

In terms of examining the moderation effect of a supportive environment on business goals' relationship with network ties, we found at the first quartile of SUPENVSCA (Q1 = 4.2, Low SUPENVSCA) NTSCA increased by 0.433 (SE = 0.142, *p* = 0.003) for each one unit increase in BGSCA. This evidence suggested that NTSCA increased as BGSCA increased at low values of SUPENVSCA. At the third quartile of SUPENVSCA (Q3 = 5.8, High SUPENVSCA) NTSCA increased by 0.079 (SE = 0.141, *p* = 0.574) for each one unit increase in BGSCA. Therefore, there was no evidence of a relationship between NTSCA and BGSCA at high levels of SUPENVSCA. These findings regarding H6i suggest that when entrepreneurs perceived low levels of support from the environment, the association of business goals with network ties appeared stronger than when the support from the environment was perceived as higher. Thus, stronger perceptions of social and economic support are suggested to lessen the business goal efforts toward engagement in network ties, and inversely low perceptions of social and economic support are suggested to increase the business goal efforts to engage in network ties.

Regarding the moderation effect of a supportive environment on entrepreneurship orientation's relationship with network ties engagement, we found at the first quartile of SUPENVSCA (Q1 = 4.20; Low SUPENVSCA), NTSCA increased by 0.017 (SE = 0.111, *p* = 0.877) for each unit increase in ENTORIENSCA. This evidence suggested that NTSCA was relatively constant at all values of ENTORIENSCA at low values of SUPENVSCA. At the third quartile of SUPENVSCA (Q3 = 5.8; High SUPENVSCA), NTSCA increased by 0.338 (SE = 0.121, p = 0.007) for each unit increase in ENTORIENSCA. This evidence suggested that NTSCA increased as ENTORIENSCA increased at high levels of SUPENVSCA. These findings regarding H6j suggest that perceived support from the environment may hold an effect on the business orientation and network tie relationship, and when high levels of support from the environment were perceived the effect of business orientation on network ties was stronger

than when the support was weaker. Further exploration into the interaction effect between ENTORIENSCA and SUPENVSCA on NTSCA2 (H6j) should be considered in future studies.

Table 2. Unstandardized coefficients (B), standard errors (p), and p-values for all regression models fit to determine the relationship between NTSCA and the scales ACSCA, SISCA, BGSCA, ENTRIENSCA, and SUPENVSCA, accounting for location

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
Variable	*B (SE)* *p*	*B* (*SE*) *p*	*B* (*SE*) *p*	*B* (*SE*) *p*	*B* (*SE*) *p*	*B* (*SE*) *p*	*B* (*SE*) *p*	*B (SE)* *p*
Intercept	4.508 (0.130) <0.001	1.179 (0.497) 0.020	2.890 (0.327) <0.001	2.337 (0.501) <0.001	2.357 (0.418) <0.001	3.438 (0.442) <0.001	-0.686 (0.567) 0.231	-0.191 (3.798) 0.960
Location (State/Nat'l)	0.441 (0.198) 0.029	0.197 (0.164) 0.234	0.149 (0.182) 0.416	0.284 (0.183) 0.124	0.374 (0.168) 0.029	0.369 (0.194) 0.060	0.074 (0.142) 0.607	0.212 (0.154) 0.175
ACSCA		0.633 (0.092) <0.001					0.320 (0.106) 0.004	0.767 (1.145) 0.505
SiSCA3			0.366 (0.069) <0.001				0.195 (0.065) 0.004	-0.478 (0.614) 0.439
BGSCA				0.425 (0.095) <0.001			0.270 (0.097) 0.007	0.554 (0.981) 0.574
ENTORIENSCA					0.437 (0.080) <0.001		0.128 (0.081) 0.118	-0.521 (0.826) 0.531
SUPENVSCA						0.234 (0.091) 0.012	0.126 (0.069) 0.070	0.388 (0.693) 0.577
ACSCA x SICA								0.059 (0.102) 0.564
ACSCA x BGSCA								0.033 (0.100) 0.744
ACSCA x ENTORIENSCA								-0.120 (0.104) 0.252
ACSCA x SUPENVSCA								-0.067 (0.116) 0.566

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
SISCA x BGSCA								0.040 (0.102) 0.699
SISCA x ENTORIENSCA								-0.022 (0.085) 0.796
SISCA x SUPENVSCA								0.054 (0.074) 0.468
BGSCA x ENTORIENSCA								0.086 (0.114) 0.457
BGSCA x SUPENVSCA								-0.221 (0.119) 0.067
ENTORIENSCA x SUPENVSCA								0.201 (0.097) 0.043
n	88	88	88	88	87	81	81	81
Adj. R^2	0.043	0.377	0.271	0.216	0.279	0.122	0.565	0.579

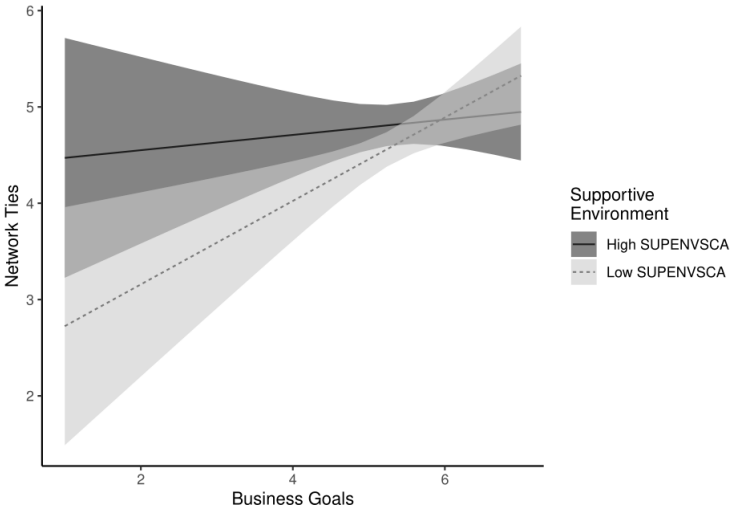

Figure 1. Interaction plot illustrating the relationship between BGSCA and NTSCA at different values of SUPENVSCA with 95% confidence bands

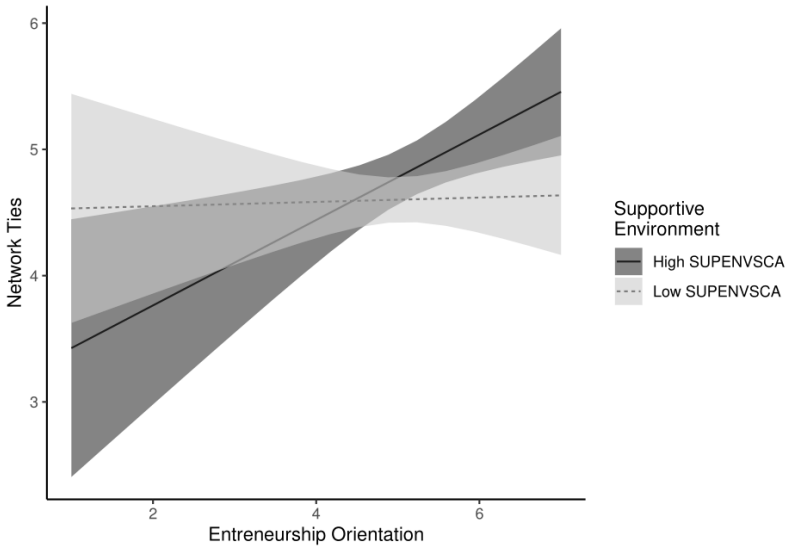

Figure 2. Interaction plot illustrating the relationship between ENTORIENSCA and NTSCA at different values of SUPENVSCA with 95% confidence bands

DISCUSSION AND CONCLUSIONS

Discussion of findings

The intent of this research was to fill some of the research voids in interorganizational networking strategy by analyzing potential antecedents and their level of association with entrepreneurial network ties. We considered engagement in network ties a strategy for addressing uncertainties and meeting competition in the business environment as previously suggested by Lavie (2006), Mazzarol et al. (2009), and Tretiakov et al. (2019). To achieve our aim, we conducted a macrolevel examination of the relationship between five management constructs and firm engagement in network ties among smaller-sized entrepreneurs in the U.S. apparel manufacturing industry. Theoretical constructs from the RBV perspective and from social capital's application to network theory were considered for a broader understanding of firm management efforts for leveraging networks of external ties that, with further research, may reveal new ways of exchanging and combining resources.

In our first five hypotheses, each managerial construct was examined as an antecedent for predicting the firm's level of engagement in external networking ties, while controlling for the firm's location. Findings support

hypotheses 1 through 5 in that a firm's absorptive capacity, social interaction, business goals, EO, and perceptions of a supportive environment were each found to predict network ties significantly. We thus offer findings suggested as needed in future studies (Limaj & Bernroider, 2017; Norman, 2004; Parra-Requena et al., 2015), particularly highlighting the importance of the firm's procurement of knowledge absorptive capacity and their engaging of network ties as a strategy for achieving knowledge resources as well as processes necessary for implementing knowledge.

With further analysis, when all five antecedents were entered in the regression analysis, we did not find evidence that EO and supportive environment continued to contribute to network ties significantly. In light of these findings, it appears that the search for knowledge and the firm's ability to incorporate the information (absorptive capacity), along with the firm's level of social interaction facilitating the exchange and gathering of ideas and resources, and the firm's established business goals are perceived to each contribute to the investment in engaging network ties as a strategy. Further research should be conducted on EO and supportive environment to determine in what manner they relate to network ties. There are many possibilities for why they may not be significant in the model with all five antecedents, including the potential for insufficient power due to small sample size.

Our findings confirm that each of the five management variables under consideration are associated with engagement in network ties for entrepreneurial U.S. apparel manufacturers, and that some factors moderate the strength of the relationships. It is interesting to note that EO and supportive environment held a significant moderating effect in their relationship with network ties (H6j). Perceptions of a supporting environment moderated the firm's EO, which was defined previously as risk taking, innovation, and proactiveness. Higher levels of perceived support from the environment increased the association of EO with network ties. This finding suggests that even under supporting conditions, firms perceived engaging in networking ties to address their needs for managing risk, innovation, and proactiveness. Support was also found for H6i. Findings give evidence that the perceived supporting environment holds a moderation effect with the firm's business goals in predicting network ties, suggesting that when levels of support are low the association between business goals and engaging in network ties is higher. These findings add strength to a belief that social and economic supportive environmental conditions are important in overcoming or adapting to uncertainties (Bitowska, 2020), and firms, operating under market conditions of uncertainty, seek to engage in co-occurring network ties that cultivate social capital (Barczak, 2017).

This research provides new insights into the benefits of directing efforts to engage in network ties as a strategy managing market challenges. From the RBV perspective, network ties are facilitated as firms seek knowledge absorptive capacity resources. Social capital theory is supported in that social interaction external to the firm serves to build network ties. Empirically determining that engagement in business network ties was greater when entrepreneurs perceived lower levels of environmental support, reinforces the long-proposed importance of social and economic influences on networking. Network theory is advanced in that business network ties were evidenced as greater when entrepreneurs held stronger entrepreneurial orientations and perceived stronger levels of environmental support. Thus, social and economic influences were found for the entrepreneurial orientation dimensions of innovativeness, risk taking, and proactiveness. These findings support conclusions from numerous prior studies and affirm that entrepreneurs perceive multiple gains to investing in relationships outside the firm. We advance the soundness of incorporating engaging in network ties as a strategy in pursuit of advantages, particularly under varying conditions of supporting environments.

CONCLUSIONS

Each of these constructs, independently and in various combinations, has been the focus of research efforts. However, understanding how the constructs specifically relate to entrepreneurial engagement in network ties as a strategic activity is important for theoretical and practical reasons. First, the contribution we believe this research makes to the literature is to link theoretically and to test empirically the relationships among five important constructs that have been conceptualized and tested independently but not examined together as multiple dimensions in relationship to network ties as a strategy for advancing the entrepreneurial firm. We shed light on how an organization's entrepreneurial decisions may contribute to engaging in networking as an entrepreneurial strategy. Second, unraveling these constructs in a theoretically driven approach is important because there were interactions among the constructs proposed to exist in practice that thus far had not been examined empirically. Our findings suggest that examination of singular antecedents may not provide a full representation of relationships with network ties. This study's approach permitted zooming in to address potential antecedents in network tie engagement as well as zooming out to see the antecedents as parts of a larger system in entrepreneurial management research.

The substantive management constructs for entrepreneurial engagement in network ties we address here, suggest several practical applications as well as avenues for further inquiry. Next steps could include Covin and Miller's (2014) suggestion to examine network ties in assessing the EO on a national and international level as an important area in the field of strategy and organizational theory. We also see further integration of social capital and network theory with other leading perspectives in management research, for example institutional theory or resource dependence theory. There is recognition that further work is needed providing exploration into the interaction effect between entrepreneurial orientation and perceptions of a supporting environment in relation to firm engagement in network ties. We also suggest future studies are needed into the interaction among business goals and supporting environment perceptions in relation to network tie engagement. As a follow-up to this study, we recommend extended study of business goals with additions to the seven goals examined herein.

The network itself can be dynamic in that both exogenous and endogenous forces shape how networks evolve. The present study examines a defined portion of the perceived exogenous and endogenous forces shaping the entrepreneur's networking efforts. The specific networks' rules, routines and procedures requiring adherence is not part of this current study but does warrant further consideration. There are also concerns involving embeddedness, where ties or exclusivity with one firm places constraint on developing ties with other firms. Future studies could examine the firm's limits in time and resources devoted to satisfying expectations of partners in the network. Alliances made early in the firm's lifecycle may lock a firm into or out of another network. Even when a firm holds an ability to forge network ties that represent real benefits, the value of those benefits may vary as the firm or the network evolves. Future research could involve the life cycle stage of a firm in terms of implementing a network tie strategy.

Providing theoretical and practical understanding beyond the academic world provides a more comprehensive viewpoint for taking strategic actions. Our current inquiry holds direct implications for the global textile industry and for firms who are seeking research-generated know-how. Findings from this study offer impetus for building collaborations along the supply chain that align with the firm's knowledge absorptive capacity, business goals, and entrepreneurial orientation by engaging in network ties as a managerial strategy. This study offers further support that engagement in network ties is also related to social interactions and environments that support the entrepreneur. One perspective, that has offered potential solutions for small-sized apparel manufacturers in any area of the world, involves development of agile supply chains. Agility is not a new idea (Maskell, 2001) but is

increasingly applicable in unpredictable environments and is proposed in multiple studies as an approach for strengthening supply chain relationships (Potdar, Routroy, & Behera, 2017; Moradlou & Asadi, 2015; Rauch, Dallasega, & Matt, 2017). This unpredictability in environments has contributed to intensive relationship-driven operations that are information-based often employing entrepreneurial supply chain arrangements that are network-based (Christopher, Lowson, & Peck, 2004; Galkina & Atkova, 2020). Given the difficulty in predicting apparel market demands, apparel companies like Zara and Benetton have employed agility strategies that involve working with specialists who are often small manufacturers (Aftab et al., 2018; Jarillo, 1993). Only those cost-efficient operations are completed in-house, while other activities, often more labor intensive, are completed by networks of small manufacturers who work collaboratively with the larger company. To achieve time and quality targets, the smaller companies are provided with technological and logistical resources. The networking strategy as applied to agile supply chain relationships warrants further examination.

This work is not without limitations. Borch and Arthur (1995) underlined one problem with the objectivist tradition of quantitative network research as studying the organization in pieces rather than overall. Therefore, a subjectivist research design using qualitative research methods or mixed methods are suggestions for future studies of concepts and relationships explored in the present study. Another risk involved in this study involves ethnocentricity in that one socio-cultural venue was examined. Due to limitations of survey research, the data collection methods may not have provided access to data that could have contributed to a broader understanding, and is not generalizable to other industries, cultures, or social economic venues. Additional study is required with participants from other countries, markets, and industries. Our measurements suffer from deficiencies and the generalizability of any findings based on a single, small sampling scheme, and these should also be considered grounds for re-examination. Further to the problem of small sample size, comes the forced restriction on the number of variables we could incorporate into the analysis. Future studies could improve the quality and reliability of findings through replication in multiple apparel manufacturing organizations within or beyond the U.S., or with entrepreneurs in other industries.

Despite deficiencies, this study represents an attempt to move from a conceptual view of interfirm social capital and network theory and a resource-based view of the entrepreneurial firm to a more concrete perspective of entrepreneurial network tie antecedents. The work offers additional confirmation that network ties offer one stratagem for enduring environmental threats. These findings are promising, and it is our hope this

study has magnified the usefulness of incorporating a multi-disciplinary approach in combining business and social perspectives to further understanding of networking as strategic management.

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Abstrakt

CEL: *Firmy nie rozwijają się i nie prosperują wyłącznie dzięki własnym indywidualnym wysiłkom, ponieważ każda firma jest pod wpływem działań innych, a zatem bezpośrednie i pośrednie relacje kształtują strategiczne zarządzanie firmą. Relacje te tworzą taktykę, dzięki której wiedza i inne strategicznie ważne zasoby są dostępne i tworzone. Nawiązywanie i podtrzymywanie więzi między członkami sieci było przedmiotem licznych badań w literaturze społecznej, ekonomicznej i biznesowej. Nasza praca opiera się na zasobowym spojrzeniu na perspektywę firmy wraz z teorią kapitału społecznego i jej wspólnymi konstrukcjami w teorii sieci. Wcześniejsze ustalenia sugerują, że powiązania sieciowe są strategicznymi działaniami generowanymi na rzecz rozwoju i kontynuacji firmy. Więzi mogą być krótkotrwałe lub przerodzić się w relacje długoterminowe. Celem tego badania jest wypełnienie niektórych luk w strategii sieci międzyorganizacyjnych poprzez analizę pięciu poprzedników , przedstawionych w literaturze jako podmioty indywidualnie związane z zaangażowaniem przedsiębiorców w powiązania sieciowe. W ten sposób nasza praca zapewnia kolejną ścieżkę badawczą do badania wkładu sieci w zarządzanie strategiczne. Postawiliśmy hipotezę o pozytywnych powiązaniach z zaangażowaniem przedsiębiorców w powiązania sieciowe z poprzednikami obejmującymi zdolność do przyswajania wiedzy firmy, cele biznesowe, orientację na przedsiębiorczość, interakcje społeczne i wsparcie ze strony otoczenia.* ***METODYKA:*** *W naszym podejściu ilościowym przetestowaliśmy proponowane przez nas bezpośrednie i moderujące powiązania na poziomie makro za pomocą ankiety internetowej przeprowadzonej wśród 125 amerykańskich firm produkujących odzież. Sektor produkcji odzieży w Stanach Zjednoczonych, podobnie jak w wielu krajach, boryka się z wieloma zakłócającymi czynnikami, które przyczyniają się do*

spadku kontynuacji działalności tego sektora. ***WYNIKI:*** *Wyniki analiz regresji OLS potwierdzają nasze hipotetyczne powiązania, ponieważ każdy z pięciu poprzedników znacząco przyczynił się do zaangażowania przedsiębiorców w powiązania sieciowe; jednak, gdy wszystkie pięć zostało zbadanych łącznie, istotne były tylko chłonność, interakcje społeczne i cele biznesowe (R^2 = 0,58). Dalsze badanie efektów moderacji wykazało, że postrzeganie przez przedsiębiorców środowiska wspierającego modyfikuje zarówno orientację przedsiębiorczą, jak i cele biznesowe.* ***IMPLIKACJE DLA TEORII I PRAKTYKI:*** *Wpływ otoczenia na relacje celów biznesowych z więzami sieciowymi był większy, gdy postrzeganie otoczenia jako wspierającego zmniejszyło się, podczas gdy wpływ otoczenia na relacje orientacji przedsiębiorczej z więzami sieciowymi był większy, gdy postrzegano otoczenie jako wspierające, co sugeruje dalsze badanie postrzegania otoczenia przez amerykańskich przedsiębiorców.Przedsiębiorcy zainteresowani budowaniem krajowych i międzynarodowych powiązań w ramach łańcucha dostaw mogą uznać, że powiązania sieciowe są jednym z rozwiązań umożliwiających dostosowanie zasobów firmy do globalnej konkurencyjności. Przyszłe badania mogą skierować uwagę na inne sektory przemysłu lub kraje w celu replikacji z większymi rozmiarami próbek, ponieważ zdajemy sobie sprawę z ograniczeń w uogólnianiu i udoskonalaniu skali ze względu na naszą ograniczoną wielkość próby.* ***ORYGINALNOŚĆ I WARTOŚĆ****: Zbadanie pięciu konstruktów, które rzucają światło na to, jak decyzje organizacji mogą odnosić się do angażowania się w sieci, oraz przedstawienie teoretycznych i praktycznych implikacji, które przyczyniają się do większego zrozumienia systemu organizacyjnego.*

Słowa kluczowe: *chłonność, interakcja społeczna, cele biznesowe, orientacja przedsiębiorcza, środowisko wspierające, powiązania sieciowe*

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Conflicts of interest

The authors declare no conflict of interest.

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Mapping of a science and technology policy network based on social network analysis

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Abstract

PURPOSE: *The main purpose of this paper is to define a science and technology policy network in the form of a social network, from the perspective of policy documents, and then analyze it using the social networks analysis (SNA) method.* ***METHODOLOGY:*** *As a case study, the science and technology policymaking network in Iran is analyzed using the suggested framework in this research. The data used in this study were collected through the content analysis of 25 policy documents and an interview with 20 Iranian science and technology policy elites, before being interpreted using the social network analysis method and software such as NetDraw and UCINet.*

FINDINGS: *The most pivotal science and technology policymaking institutions in Iran and the interactions between them were determined from the network viewpoint. This was achieved by performing a two-dimensional core-periphery analysis, identifying the cut points and blocks, and measuring the structural power of each institution using the degree centrality, closeness centrality, and betweenness centrality methods.* ***IMPLICATIONS FOR THEORY AND PRACTICE:*** *The most important practical implications of this research are: the integration of a number of policymaking institutions, the division of clear and precise work between policy institutions, the design of vertical and horizontal coordination mechanisms between institutions, the elimination of interferences of some institutions in the tasks of the others, the design of complementary mechanisms to control the role of cutting points, and paying attention to the important activities in the margins of the network.*

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ORIGINALITY AND VALUE: *The most important contribution of this research is to develop a framework for studying science and technology policy and then to develop a method for studying science and technology policy based on SNA. Therefore, the framework for studying science and technology policy in a cycle consists of three stages: 1- Agenda setting and prioritization (at two levels of mega policies and meta policies); 2- Design and implementation or executive policies (in three parts: demand-side policies, supply-side policies, and networking and interconnection infrastructure policies); 3- evaluation and policy learning.*
Keywords: *science and technology policy, policy network, social network analysis, SNA, structural power, Iran*

INTRODUCTION

Since the 1960s, results of science and technology studies have been gradually applied to science and technology policy, and this has been seriously addressed by policy makers entering the third millennium (Ahlqvist et al., 2012). The participation of different actors in science, technology and innovation policy is one of the essential features of this system (Wojnicka-Sycz, 2020). The "institutions" and "institutional interactions" are the concepts that gradually emerged during the maturity period of science and technology policy studies through the works of a number of scientists (Martin, 2012). Therefore, institutional mapping is used, analyzed and studied to investigate the national innovation system in some countries (Organization for Economic Co-operation and Development (OECD), 1999; Capron & Cincera, 2001; Bikar et al., 2009). The evolution of the innovation models from the linear model of science, technology, and innovation to the systematic model (innovation system) (Edquist & Hommen, 1999), as well as the establishment of the policy networks concept in public policy studies, have created a growing emphasis on the importance of institutions and the interactions between them, especially from a network perspective (Kalantari et al., 2021; Blanco et al., 2011; Wasserman & Faust, 1999). Thus, the importance of policymaking institutions, and especially the interactions between them from the perspective of innovation literature and policymaking literature, is also emphasized. Moreover, the concept of systematic failure (affected by the viewpoints of evolutionary economics) signifies that any lack or deficiency in structures, institutions, and rules affecting the availability and production of the required knowledge is due to economic failure. This is due to the lack or inefficiency of the required relationships between the institutions in the innovative system. Furthermore, it is indicative of insufficient rules, lack of presence or a limited number of key players, weak harmony among sectors, and lack of knowledge progress (Niosi, 2002; Teubal, 1993). From another

point of view, it emphasizes the necessity and importance of the science and technology policymaking institutional network.

In this paper, by reviewing relevant articles, a framework for the network analysis of science and technology policymaking institutions is designed. Thus, in the first phase, a framework is formulated for a science and technology policymaking process and then, in the next phase, another framework is formulated to divide the labor between science and technology policymaking institutions. Third, analyzing the method of social networks and the way of establishing the science and technology policymaking network is discussed. Afterward, the analysis of the science and technology policymaking network in Iran is discussed as a case study. Lastly, the paper is finalized with a discussion, conclusion, and some suggestions about the reformation of the science and technology policymaking network in Iran.

LITERATURE REVIEW

Mapping of the policy networks with the social network analysis (SNA)

Various studies have been conducted by other researchers, in which policy networks in different policy fields have been mapped using the SNA method (Kalantari et al., 2021). Normann (2017) uses the SNA method and the concept of policy networks to study stakeholders and actors in energy and climate policy in Norway. Two fields of carbon capture and storage, and offshore wind plant have been investigated in this study as case studies. The data of this study were collected through existing empirical studies and semi-structured interviews with 42 policymakers, civil activists, industry representatives, research organizations and other stakeholders. In this research, first, the policy network in the field of carbon capture and storage in three consecutive time periods has been drawn and analyzed. Then, the policy network of power plants is drawn and analyzed in two consecutive time periods; and then these networks were compared with each other.

In another study, Rogelja and Shannon (2017) used SNA to describe the network of actors involved in the Serbian anti-corruption forest policy network. The Serbian Anti-Corruption Policy Network consists of 16 actors (organizations), of which only five have a strong and reciprocal involvement in anti-corruption activities. Most of the central actors are state-owned enterprises and public companies, which themselves form a sub-network. The data collection method is semi-structured interview and the sampling method is the snowball method, which is done in three steps. In this research,

in addition to drawing a policy network, a number of network characteristics, including network density and network degree, have also been calculated. In addition, Browne et al. (2017) describe the network structure of influential organizations in the field of health policy in the Torres Islands. In this policy network, 61 influential organizations have been identified. In this research, in addition to drawing the network with the SNA method, indicators of the network, including network density and average degree have been calculated.

In addition, another study (Mikulsliene & Pitrenaite-Zileniene, 2013) was conducted to evaluate the education and science policy network in Lithuania and to identify barriers to collaborative management in this network. This study is based on a case study in decision-making groups within the Ministry of Education and Science in Lithuania from 2007 to 2010. In this study, the education and science policy network in Lithuania has been mapped using the SNA method. Also, in a study conducted by Mohammadi Kangarani and Rafsanjani Nezhad (2015), the power structure in the water policy and management network in the Islamic Republic of Iran has been mapped and analyzed. In order to achieve the purpose of this study, the SNA method is used to draw a network of the legal tasks and powers of institutions, determine the centers of power, and establish how the power is distributed among the institutions of this network. Using the SNA method, we can first describe the dependencies and relationships between institutions involved in water policy, secondly, we can determine the degree and importance of an institution or a set of institutions and show the distribution of power among different institutions, and third, we can show the sensitivity of the water policy network structure in the absence of certain institutions.

Despite the mentioned research and other research that has used the SNA method to map the policy networks in various fields of policy, so far, no suitable research has been done to map the science and technology policy network by the method of social network analysis. Therefore, in this study, the researcher's goal is to map the science and technology policy network in Iran by the SNA method and then analyze this network with the help of SNA indicators. For this purpose, and before analyzing this network, we are looking for a framework for mapping this network. Therefore, in the continuation of this section, by reviewing the literature of science and technology policies, an attempt is made to establish a framework for mapping the science and technology policy network in Iran.

Science and technology policymaking process

Science, technology and innovation policymaking consists of three main activities including (OECD, 2005; Hjelt et al., 2005; Polt, 2005) "agenda setting

and prioritization," "design and implementation" and "evaluation and policy learning." In terms of policymaking levels, Dror (1971) divides such policies into two categories:

A) Mega policies consisting of postures, assumptions, strategies, and main guidelines special policies must obey. The mega policies are the same as master or umbrella policies showing the purposes and priorities of a country. Even though they are few in number, from the perspective of scope and time horizon, they are very large and lengthy. They are the main guidance framework for the activities of governments and are usually sources for secondary policies, as well as the establishment basis for performing policy instruments (Akinsanya & Ayoade, 2013).
B) Meta policies formulate the state of policymaking structure to reach considered policies (Dror, 1971). On the other hand, they focus on the policymaking structure and procedure. The main subject of meta policies is the improvement of the methods, techniques, and tools of designing policies and policymaking processes in governmental firms (Akinsanya & Ayoade, 2013). The meta policies are strategic policies explaining the performance of main policies.

The purpose of these phases is to design and manage the policymaking system as a whole as well as to set overall principles and rules for policymaking based on the concepts of meta and mega policies. Miyakawa (1999) suggests the following frameworks for policymaking:

A) Preliminary, comprehensive policymaking (mega policies and meta policies).
B) Detailed specialized policymaking: (operational policies).

Therefore, general and executive policies have specific characteristics detailed in Table 1.

After defining policies and priorities at the first level of science and technology policymaking (studied in two levels of mega and meta policies), at the second level, there are institutions that design and implement executive policies or plans. The plans are practical designs and implementation aspects of executive policies formulated and set for a specific period. In each policy plan, beside setting goals and priorities (previously done at the first level), other issues should also be taken into consideration (Bartzokas & Teubal, 2002): main groups or institutions of purpose, administrators and their approaches, time period, necessary sources and expected outputs of the plan, and the plan's relative situation regarding other plans.

Table1. The Difference between General and Executive policies

Row	Features	General Policymaking		Executive Policymaking
		Mega Policies	**Meta Policies**	**Operational Policies or Plans**
1	Definition	Mega policies contain standards, theories, strategies, and main instructions that operational policies must obey.	Meta policies formulate the state of methods and the structure of policymaking to reach the considered policies.	Operational policies contain the formulation and implementation of small and operational actions based on the method and structure of the formulated policy to reach political purposes.
2	Main Emphasis	Policy main purposes	Policy methods and structures	Operational policy instruments
3	Main Question(s)	What?	Who? How?	How?
4	Main Actions	Selection of the general political purposes	Selection of methods and administrative structures for formulating and performing operational policies. Evaluation of feedback information sent by operational policymakers and consideration of retesting general political purposes.	Selection of operational actions (such as formulation and performing policies) based on the chosen methods and structures. Giving feedback to general policymakers about the feasibility of general political purposes, impacts, and outputs of policy operation.
5	Policymaking Level	Macro	Macro	Micro
6	The Volume of Policies	Small	Small	large
7	Policymaking Scope	Large	Large	Small
8	Policies time horizon	Long-term	Long-term	Short-term

Source: Research findings.

Lastly, after setting the policies and priorities at the first level, and designing and implementing them at the second level, the evaluation of policies and the political learning are performed at the third level. The "policy evaluation" is a systematic, programmed and purposeful process, which involves the collection of data on the question and problems of society in general, and policies and plans in particular. The evaluation is a knowledge strengthening and decision making process; whether these are decisions to improve or reform a plan or policy, or to continue and expand it, there are some aspects of judgment about merit, value and worth of the subject under evaluation in each of these decisions (Preskill & Russ-Eft, 2005).

Different kinds of science and technology policies

The study of the science, technology, and innovation policymaking field shows that the researchers divide science and technology policy into three groups (Leith et al., 2018; Edler & Yeow, 2016; OECD, 2012; UNCTAD, 2011; Taylor, 2008; Sarewitz & Pielke, 2007; Clark & Guy, 1998; Kim & Dahlman, 1992) of supply-side policies, demand-side policies, and networking and interconnection infrastructure policies. The supply-side policies are those that support innovation offerings in companies (European Commission, 2015). These policies, which are also referred to as "technology push policies" (Hansen et al., 2015; Mowery et al., 2010), seek to identify and resolve failures in the market (Elder et al., 2013). The supply-side policies are related to the linear model of innovation and support the linear processes of innovation (Edquist, 2001). The supply-side policies can be considered as the first generation of science, technology, and innovation policies. Gradually, with the advent of interactive innovation models, another broader set of policies in science, technology, and innovation was formed, which became known as demand-side policies (Edquist, 2001). Such policies, which appear as the second generation of science, technology, and innovation policies, seek to shape the context in which companies innovate (European Commission, 2015). These policies usually try to make demand and use innovation through the determination and removal of defects in the ability and willingness of the potential users (Elder et al., 2013).

Recently, several scholars have emphasized the necessity of the existence of policies linking supply and demand in the national innovation system, and have proposed a third group of science, technology, and innovation policies. In an interesting interpretation, Sarewitz and Pielke (2007) and Leith et al. (2008) expressed the reconciling of supply and demand for science as the "neglected heart" of the science policy. Elder et al. (2013) divides science, technology, and innovation into three groups:

A) The policies that are strictly on the supply side including fiscal incentives for R&D, direct support to R&D and innovation in firms, access to finance, publicly supported venture capital and loan guarantees, policies on training and skills to improve innovation capabilities in firms, human resources migration and employment protection, support measures for exploiting intellectual property, policy, technical services, and device, cluster policy on innovation, policies to support collaboration for R&D and innovation, and innovation network policies.
B) The policies that are strictly on the demand side including measures to stimulate private demand for innovation and public procurement policies.

C) The policies existing on both sides of supply and demand sectors including pre-commercial procurement, innovation inducement prizes, standardization and standards, regulation, and technology foresight.

Tailor (2008) divides technology policies into three groups of "upstream investment policies" (supply-side policies), "market creation policies" (demand-side policies), and "interface improvement policies." In the case of upstream policies, the supply of new knowledge in specific technologies is supported by the government through policymaking in R&D and the procurement of initial investment. Moreover, in market creation policies, the government provides specific technologies to new customers. Lastly, in interface improvement policies, the government promotes the innovative function of players who are between the technology creator and final users in the innovation chain. Clark and Guy (1998) divide innovative policies into three groups:

A) Supply-side policies: the policies stimulating the technology supply.
B) Demand-side policies: the policies that stimulate the demand for technology.
C) Networking and developing research infrastructure policies: the policies related to the improvement of information through the development of networks or national infrastructures.

The OECD (2012) categorizes innovative policies into three groups: A. The supply-side innovation policies; B. The demand-side innovation policies; C. The cohesive supply and demand-side policies.

Moreover, based on the studies conducted by other scholars, the science, technology, and innovation policies are grouped into three categories as follows:

A) Supply-side policies: The policies creating technological and scientific knowledge supply.
B) Demand-side policies: Such policies facilitate the use of technological and scientific knowledge.
C) Networking and interconnection infrastructure policies: The policies that seek to provide an appropriate infrastructure to establish a link between different players of the innovation system (suppliers and demanders).

Table 2 shows the division of science, technology and innovation policies based on the supply-side, demand-side and infrastructure policies.

This division can be used as the basis for the Division of labor between the science and technology policymaking institutions.

Table 2. The Division of science, technology, and innovation policies

Kinds	Row	Science, Technology and Innovation Policies	Description	Source
Supply-side Policies	1	Higher education promotion	Investment in higher education to develop human resources	Edler et al. (2013); OECD (2012)
	2	Training promotion	Investment in training to develop human resources	Roolaht (2011); Edler et al. (2013); OECD (2012)
	3	Direct support via public R&D	Financial support of public sector R&D; e.g. tax reduction on public firms in proportion to the budget spent on R&D	Hansen et al. (2015); Mowery et al. (2010); Edler et al. (2013); Roolaht (2011); OECD (2012)
	4	Direct support via private R&D	Financial support of the private sector; e.g. tax reduction or facilitating the availability of financial validity for private firms in proportion to the R&D cost	Mowery et al. (2010); Hansen et al. (2015); Edler et al. (2013); Roolaht (2011); Clark & Guy (1998); OECD (2012)
	5	Facilitate access to venture capital, loan guarantees, and other financing approaches	Public support to facilitate the accessibility of firms to finance approaches, and to provide necessary financial resources to firms for creating technology and innovation	OECD (2012); Edler et al. (2013)
	6	Entrepreneurship policies	Actions encouraging economic and social activities that are carried out by individuals	Edler et al. (2013)
	7	Cluster policies	Actions such as aiming and choosing geographical regions and specific technological activities	Clark & Guy (1998); Edler et al. (2013)
	8	Strengthening intellectual property rights	Supportive actions to benefit intellectual property rights and invention	Edler et al. (2013); Roolaht (2011); Clark & Guy (1998); OECD (2012)
Demand-side Policies	9	Public procurement	Public procurement of technology and innovation products, and R&D services	Tsipouri (2013); Hansen et al. (2015); Mowery et al. (2010); Edler et al. (2013); Roolaht (2011); Clark & Guy (1998); OECD (2012)
	10	Stimulating the private sector demand	Actions to simulate the private sector innovation	Roolaht (2011) ; Edler et al. (2013); Tsipouri (2013); Clark & Guy (1998)
	11	Regulation	A regulation that inclines demand to use the substituting technologies	Hansen et al. (2015); Mowery et al. (2010); Edler et al. (2013); Roolaht (2011) ; Tsipouri (2013); OECD (2012)
	12	Standardization	Actions leading to the confirmation of regulations and instructions to gain the best degree of regularity in a specific field	Clark & Guy (1998); Edler et al. (2013); Roolaht (2011); OECD (2012)

Kinds	Row	Science, Technology and Innovation Policies	Description	Source
Networking and interconnection infrastructure Policies	13	Network policies	Actions including facilitating the adjustment of relationships between knowledge suppliers and demanders, and co-operative activities between them such as skill training, technological development, production design, marketing, skills sharing, facility sharing and co-research plans	Mowery et al. (2010); Hansen et al. (2015); Edler et al. (2013); Roolaht (2011); Clark & Guy (1998); OECD (2012)
	14	Offering technical and consulting services	Technological and innovation consulting services such as information, technical aid, consulting, education, and other supportive services helping the firms in the adaption and implementation of new technology and innovative commercialization	Edler et al. (2013); Roolaht (2011); Clark & Guy (1998)
	15	Technology demonstration	Technological and innovation exhibitions and technology trial implementation	Hansen et al. (2015); Mowery et al. (2010)
	16	Innovation prize awarding	Stimulate the creation and use of innovation through technology awareness and innovation prizes	Hansen et al. (2015); Mowery et al. (2010); Edler et al. (2013)
	17	Creating the innovation culture	Measures to promote the culture of creation and the use of technology and innovation	Roolaht (2011)
	18	Science and technology foresight	Science and technology foresight that not only does play the role of news transmission but also has a creative role	Edler et al. (2013)
	19	The improvement of university-industry relation	Promotion of mutual co-operation between university and industry	Clark & Guy (1998)

Source: Research findings.

Theoretical framework of science and technology policymaking

Based on the three-step model of science and technology policymaking proposed by the OECD, the general and executive policymaking levels and the three-step division of science, technology and innovation policymaking extracted from the literature, the following framework is suggested (Figure 1).

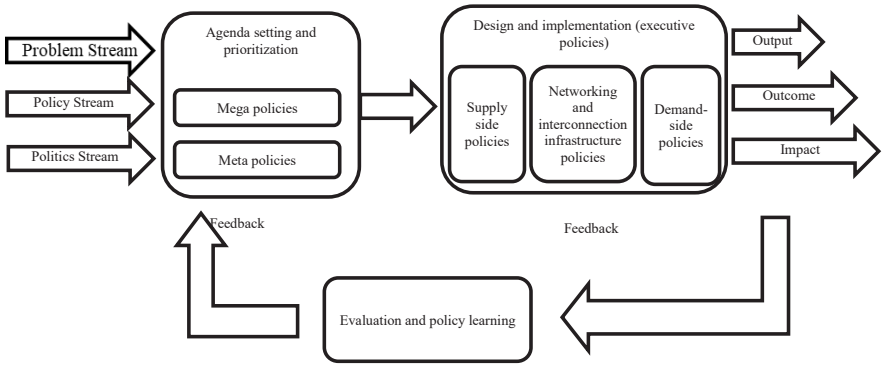

Figure 1. Suggested framework of science and technology policy

Source: Research findings.

As shown in Figure 1, the policies result from the merging of three streams:

A) Problem stream: Along this stream, after the problem is raised, the policymaker tries to focus their attention to find the cause and the definition of the problem.
B) Policy stream: In this stream, different solutions to which the policy should obey are determined. Researchers, specialists, masters, and professional groups have an important role in this stream.
C) Politics stream: In this stream, a list of problems for which the policymakers should find solutions is arranged and formulated by officials and politicians.

Figure 1 shows that when policies and priorities are determined in two policy levels of meta and mega, they must be delivered to executive institutions to be implemented. In this phase, the policymaking is commenced in three groups of supply-side policies, demand-side policies, and networking and interconnection infrastructure policies. Each policy has outputs at three levels; "outputs" that are tangible and intangible policy interventions, "outcomes" that are short-term and medium-term policy intervention outputs, and "impacts" that are long-term positive/negative, primary/secondary, direct/indirect, intentional/unintentional policy intervention outputs. The evaluation of the outputs for each policy at the above-mentioned levels provides feedbacks to the policy determination phase and, subsequently, the cycle of policymaking repeats.

Thus, by reviewing the literature, a framework for science and technology policy was designed. Based on this framework, science and technology

policymaking is done in three stages: 1) agenda setting and prioritization (including two sub-stages of formulating mega policies and formulating meta policies); 2) Design and implementation of executive policies (including 19 types of policies in three categories of supply-side policies, demand-side policies, and networking and interconnection infrastructure policies); 3) Evaluation and policy learning (at three levels of outputs, outcomes, and effects). This framework, including 24 policy levels or activities (two levels of policy formulation in the first phase, 19 types of policy in the second phase, and three levels of policy evaluation in the third phase), is the basis for mapping the science and technology policy network. Therefore, by mapping the science and technology policy institutions in Iran in each of these 24 cases, the science and technology policy network in Iran is mapped. In the following section, after explaining the methodology considerations, the science and technology policy network in Iran is mapped. Then, based on a number of indicators and methods of social network analysis (SNA), the science and technology policy network in Iran is analyzed.

METHODOLOGY

Based on the research onion model of Saunders et al. (2012), the methodology of this study is formulated at six levels. Its philosophy paradigm is based on interpretivism, and its rational approach is based on induction. The methodology of this study is based on a mixed method. Its strategy follows a case that focuses on the analysis of science and technology policymaking in Iran in 2018. According to Yin's (1994) typology, this research is an exploratory case study. Thus, the purpose of this study is to discover new perspectives on the science and technology policy network in Iran and to construct new meanings and new insights about science and technology policymaking institutions in Iran and the interactions between them. This study tries to answer the main question of "how is the science and technology policymaking network in Iran?" Other questions discussed in this study are as follows:

A) What are the main players in the science and technology policy network in Iran, from the perspective of policy documents?
B) What are the interactions between the main players of Iran's science and technology policy network, from the perspective of policy documents?
C) Which of the players have more structural power in the science and technology policy network in Iran, from the perspective of policy documents?

The methodology of social network analysis (SNA) was used for this study. The SNA method is an appropriate method for analyzing policy networks that are used in many studies (Yun et al., 2014). It is based on the basis of "network theory" and "graph theory" (Hanneman & Riddel, 2005). The most important feature of network theory is to change the focus from actors and their features to each pairing of them and their relations (Parkhe et al., 2006; Wellman & Berkowitz, 1998). The graph theory is also a summary of the structural aspect of any model, and simulates the network mathematically (Brandes & Erlebach, 2005). The key assumption in social network analysis is that the relationships between actors have considering characteristics (Wellman & Berkowitz, 1998). Hence, the theoretical framework of studies in social network analysis should be based on the relationships between actors; moreover, for collecting relational data, experimental actions should be designed. In this research, a number of SNA tools are used in accordance with the research questions. Thus, to answer the first question, core-periphery analysis is used. Also, to answer the second question, a network is drawn (with NetDraw); and to answer the third question, the centrality index (degree centrality, closeness centrality, and betweenness centrality) is used. The network analysis studies are validated via a structural assessment in which the collection of evidence is achieved through multiple sources such as questionnaires, interviews, observations, documents, and others. It is also possible to consult with the experts in the field to examine the accuracy of the results and data sources (Helms et al., 2010). Denzin and Lincoln (2003) also suggest different types of triangulation methods to increase the credibility of qualitative research, in which a data triangulation method has been used. This means that multiple sources of data (policy documents, semi-structured interviews, national and international reports such as the UNCTAD (2016) report, and researcher observations of the interactions of science and technology policy institutions in Iran) have been used.

The science and technology policymaking organizational network in Iran is the network this study focuses on. Moreover, the science and technology policymaking organizations of Iran are the nodes of the network under study. The nodes are the building blocks and representatives for the entities in the network (Estrada, 2013). Furthermore, the communicational relations or the relationships in the network are those along which the messages and information are exchanged between the actors (Knoke & Kuklinski, 1990). The scope of the analysis in this network covers the whole network. To determine the network boundary, the nominal approach is used based on the research purpose (Wasserman & Faust, 1999). In this study, 25 science and technology policy documents of the Islamic Republic of Iran were identified, including the constitution, general policies announced by the Supreme Leader, laws

approved by the parliament, approvals of the Supreme Council of the Cultural Revolution, and approvals of the cabinet. A list of these documents is provided in Appendix. In order to validate the collected data, an open interview with 20 science and technology policymaking experts in Iran was conducted. The experts were chosen based on the snowball sampling method with eight of them having a theoretical specialty in science and technology policymaking and the rest having professional experience in science and technology policymaking in Iran. More precisely, the combination of experts was: three from previous ministers of science, research and technology, one of the previous health ministers, eight university professors with expertise in science and technology policies (from University of Tehran, Tarbiat Modares University, Allameh Tabatabaei University, Sharif University of Technology, Amir Kabir University of Technology and University of Shiraz), six heads of large universities (University of Tehran, Tarbiat Modares University, Sharif University of Technology, Amir Kabir University of Technology, University of Teachers and University of Islamic Education), one of the members of parliament and a member of the Supreme Council of the Cultural Revolution. The main purpose of interviewing experts was to validate data analysis that was extracted from policy documents. Thus, since the main purpose of this research is the mapping of the science and technology network in Iran, the questions raised from experts around the two main axes were; what are the most important actors of Iran's science and technology policy and, second, what are their interactions with each other? In this way, the ambiguities of policy documents were resolved and modified with the help of experts. The interviews performed were also semi-structured. Furthermore, to analyze data, a social network analysis method using UCINet and NetDraw software was used.

The list of science and technology policymaking organizations in Iran was extracted based on the study of 25 science and technology policy documents in Iran. Using this list and the research's conceptual framework (i.e., 24 policy levels or activities according to Figure 1 and Table 2), the organization-task matrix for science and technology policymaking in Iran was designed. This matrix consists of 19 rows (according to the number of science and technology policy organizations in Iran) and 24 columns (according to the number of levels and activities of science and technology policy in Iran). Thus, in this matrix, each corresponding organization is considered with a row and each corresponding task with a column. The matrix cells are filled with the numbers 0 or 1. In this study, by studying and analyzing the above-mentioned 25 policy documents, proportionate to the conceptual framework of the research, 86 nodes were recognized. Each node is proportionate to a task that is described for an organization in the science and technology policy documents of Iran. The cell value in the organization-task matrix is 1 when the institution

mentioned in the science and technology policy documents is required to do the corresponding task; otherwise, the cell value is 0. Upon entering this matrix into the UCINet software, by applying appropriate commands to the software, a two-mode, core-periphery analysis and calculation related to centrality (degree, closeness, and betweenness) was performed. Also, Iran's science and technology policy network was drawn with the help of NetDraw software, which is a software add-on.

RESULTS

Using the data from the matrix, the organization-task network of science and technology in Iran was plotted in Figure 2.

As demonstrated in Figure 2, this is a two-mode network that consists of nodes representing institutions and tasks. The red circular nodes are science and technology policymaking organizations in Iran, while the blue squared ones denote the levels and activities of science and technology policymaking based on the conceptual framework of the study. According to this figure, and what has been previously mentioned, some levels and activities of science and technology policymaking are performed by various institutions. Moreover, some of the policymaking institutions contribute to different levels and activities of science and technology policymaking in Iran.

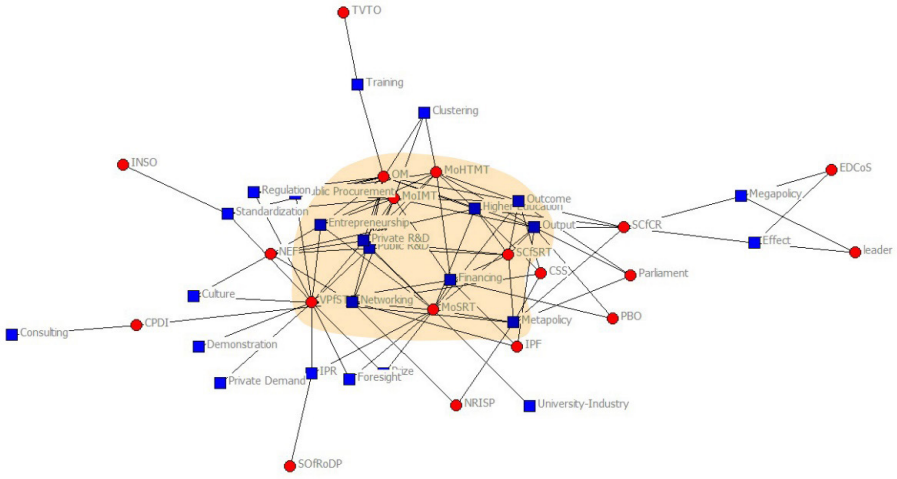

Figure 2. Organization-task network for the science and technology policymaking organizations in Iran

Source: Research findings.

The two-mode, core-periphery analysis simultaneously categorizes the players and the tasks into two groups (Hanneman & Riddel, 2005):

A) "Core": this includes a group of players who have a close relationship with each task, as well as a group of tasks that have a close relationship with the core. Thus, the core is a cluster of players and tasks, often interacting with one another simultaneously;
B) "Periphery": this includes a group of players who do not meet in the same task, as well as tasks that are not related to each other, as they do not have a common player.

From the viewpoint of documents, and based on the two-dimensional core-periphery analysis, six institutions such as the ministry of industry and mines, ministry of health, ministry of science, research and technology (MoSRT), other related ministries, the supreme council of science, research and technology, and the vice presidency for science and technology (VPfST), have the highest co-ordination capability in policymaking levels. These levels include 1- formulating meta policies, 2- designing and implementing plans such as higher education activities, supporting public and private R&D, facilitating financing, entrepreneurship and network policies, and 3- outcomes and outputs evaluation. The density matrix index of the core block is 0.784. This is a large value; thus, these six institutions form the core of the science and technology policymaking network in Iran. However, the coordination capability between other science and technology policymaking institutions is significantly poor, especially at policymaking levels 1-mega policies formulation, 2-designing and implementing plans such as training, cluster policies, intellectual property rights, technical and consulting services, technology demonstration, university–industry relationship, public procurement, stimulating private demand, regulation and standardization, and 3-the evaluation of policy impacts. The density matrix index for the periphery block is the small value of 0.054. In Figure 2, the core of the science and technology policymaking network is illustrated with an orange background.

The two-mode, organization-task matrix is converted to a one-dimensional, organization-organization matrix using the cross-products method. Figure 3 shows the science and technology policymaking interactions in Iran.

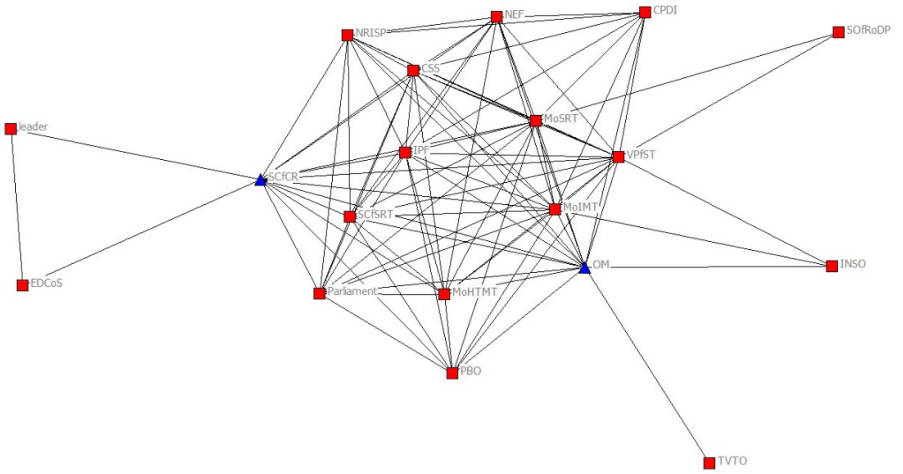

Figure 3. Interactions network for the science and technology policymaking organizations in Iran

Source: Research findings.

The size of this network is 19, meaning that there are 19 institutions with a serious effect on science and technology policymaking in Iran. There are 180 edges in this network. Each edge is a representative for a relationship between two institutions (Hogan, 2007). Furthermore, each institution, on average, has 9.47 relationships with others. As shown in Figure 3, in order to accomplish its tasks, each institution should have a relation to another. In each network, the density is the sum of relationships existing in the network (Hansen et al., 2011). The density of the science and technology policymaking network in Iran is 0.526. Therefore, 52.6% of all possible relationships are predicted in the policy documents.

In the analysis of social networks, the "cut point" is the actor whose deletion leads to the division of the whole network structure into several distinct substructures called the "block" (Wasserman & Faust, 1990; Hanneman & Riddle, 2005). As illustrated in Figure 3, the science and technology policymaking network in Iran has two cut points that divide it into three distinct blocks. The "supreme council of the cultural revolution," as the first cut point of science and technology policymaking, connects the supreme leader and the expediency discernment council of the system (EDCoS) to the network. The "other related ministries" as another cut point forms the connection between the Iran technical and vocational training organization (TVTO) and the network. In Figure 3, the cut points are shown by blue triangles

connecting the left block (the supreme leader and EDCoS), the bottom block (TVTO), and the right block (other policymaking policies) to one another.

Using three approaches, the strength of Iranian science and technology policymaking institutions are compared with each other. According to the degree centrality index of the Bonacich's approach, the centrality of each actor is a function of its relationships number and also that of its adjacent actors (Hanneman & Riddle, 2005). In Table 3, the degree centrality of each actor is calculated based on Bonacich's approach. As seen in Table 3, the highest Bonacich power values are respectively related to MoSRT (with a value of 14820), other related ministries (with a value of 14139), and ministry of industry, mines, and commerce (with a value of 13902). In this table, the related degree centrality of these three institutions is shown in bold.

The closeness centrality is another power index for each actor in the network (Hanneman, 2001; Brandes & Erlebach, 2005). The closeness centrality of each actor is calculated using the Eigenvector method. Finding the most central actors with regard to the general structure of the network is the purpose of this method. Moreover, it applies less importance to patterns with a more local concentration (Hanneman & Riddle, 2005). In Table 3, the closeness centrality of the science and technology policymaking institutions of Iran is shown using the Eigenvector method. As shown, the highest amounts of closeness centrality belong to MoSRT (with a value of 0.423), other related ministries (with a value of 0.404), and ministry of industry and mines (with a value of 0.397). In Table 3, the related amounts of closeness centrality of these three institutions are shown in bold. The closeness centrality results of science and technology policymaking in Iran are in close concordance with those of Bonacich's approach.

Another approach for evaluating an actor's power is the betweenness centrality. In this approach, an actor is in an ideal condition from the viewpoint of power when the shortest, geodesic distance connects other pairs of actors in the network. In other words, the more individuals depend on an actor for establishing relationships with others, the more power that actor possesses (Hanneman 2001; Hanneman & Riddle, 2005). Table 3 shows the betweenness centrality of the actors in the science and technology policymaking network of Iran using the Freeman method (Hanneman & Riddle, 2005). As Table 3 shows, the largest amounts of betweenness centrality respectively belong to the Supreme Council of the Cultural Revolution (with a value of 32), other related ministries (with a value of 22), and the vice presidency for science and technology (with a value of 14). The betweenness centrality of these three organizations is shown in bold in Table 3. The results of the betweenness centrality for the Iranian science and technology policymaking differ from those resulting from using other approaches to degree and closeness centrality.

The Supreme Council of the Cultural Revolution (SCfCR), with a remarkable difference, has the most power from the viewpoint of betweenness centrality. This shows that a lot of actors depend on SCfCR for connecting to others. This is rational as SCfCR has an important role in connecting the supreme leader and EDCoS (active at the macro policymaking level) with other organizations (active at the operational policymaking level, plan design, and implementation). The key role of SCfCR is appreciated for linking the institutions with regard to the place of SCfCR as a cut point in the network.

Table 3. Centrality of science and technology policymaking institutions in Iran based on different methods

Row	Institution Name	Symbol	Power		
			Degree Centrality	Closeness Centrality	Betweenness Centrality
1	The Supreme Leader	Leader	234	0.007	0
2	Expediency Discernment Council of the System	EDCoS	234	0.007	0
3	The Supreme Council of the Cultural Revolution	SCfCR	5654	0.161	32.5
4	The Supreme Council for Science, Research and Technology	SCfSRT	10020	0.286	0.56
5	Parliament	Parliament	4104	0.117	0.33
6	Vice Presidency for Science and Technology	VPfST	13690	0.391	14.3
7	Iran's National Elites Foundation	NEF	7878	0.225	0.74
8	Ministry of Science, Research and Technology	MoSRT	14820	0.423	9.0
9	Ministry of Health	MoHTMT	12166	0.348	0.33
10	Ministry of Industry, Mine and Trading	MoIMT	13902	0.397	5.8
11	Other ministries like Ministry of Information and Communication Technology; Ministry of Defense; ...	OM	14139	0.404	22.8
12	Iran Technical and Vocational Training Organization	TVTO	271	0.008	0

Row	Institution Name	Symbol	Power		
			Degree Centrality	Closeness Centrality	Betweenness Centrality
13	Plan and Budget Organization	PBO	2892	0.083	0
14	Innovation and Prosperity Fund	IPF	4361	0.124	1.5
15	Center for Progress and Development of Iran	CPDI	1498	0.043	0
16	Center for Strategic Studies	CSS	5347	0.153	0.98
17	Nation Research Institute for Science Policy of Iran	NRISP	2525	0.072	0.74
18	Iran National Standard Organization	INSO	798	0.023	0
19	Iran Registration of Documents and Real Estate Organization	SOfRoDP	545	0.016	0

Source: Research findings.

Lastly, in order to compare the power of policymaking institutions, the average of the above-mentioned index was calculated and the final power of the institution was determined. Therefore, before calculating the mean power of each organization, based on a Likert scale (very high, above average, average, below average, very low), the power of each organization in each power index was organized. Table 4 indicates the power of each organization.

Table 4. Structural power of science and technology policymaking institutions

Row	Institution Name	Power			Final Power
		Degree Centrality (Bonacich)	Closeness Centrality (Eigenvector)	Betweenness Centrality	
1	The Supreme Leader	Very low	Very low	Very low	**1**
2	Expediency Discernment Council of the System	Very low	Very low	Very low	**1**
3	The Supreme Council of the Cultural Revolution	Below average	Below average	Very high	**3**
4	The Supreme Council for Science, Research and Technology	Above average	Above average	Very low	**3**
5	Parliament	Below average	Below average	Very low	**1.67**
6	Vice Presidency for Science and Technology	Very high	Very high	Average	**4.33**

Row	Institution Name	Power			Final Power
		Degree Centrality (Bonacich)	Closeness Centrality (Eigenvector)	Betweenness Centrality	
7	Iran's National Elites Foundation	Average	Average	Very low	**2.33**
8	Ministry of Science, Research and Technology	Very high	Very high	Below average	**4**
9	Ministry of Health	Very high	Very high	Very low	**3.67**
10	Ministry of Industry, Mine and Trading	Very high	Very high	Very low	**3.67**
11	Other Ministries Like Ministry of Information and Communication Technology; Ministry of Defense;	Very high	Very high	Above average	**4.67**
12	Iran Technical and Vocational Training Organization	Very low	Very low	Very low	**1**
13	Plan and Budget Organization	Very low	Very low	Very low	**1**
14	Innovation and Prosperity Fund	Below average	Below average	Very low	**1.67**
15	Center for Progress and Development of Iran	Very low	Very low	Very low	**1**
16	Center for Strategic Studies	Below average	Below average	Very low	**1.67**
17	Nation Research Institute for Science Policy of Iran	Very low	Very low	Very low	**1**
18	Iran National Standard Organization	Very low	Very low	Very low	**1**
19	Iran Registration of Documents and Real Estate Organization	Very low	Very low	Very low	**1**

Source: Research findings.

As shown in Table 4, other related ministries within science and technology, including the ministry of information and communication technology, ministry of power, ministry of petroleum, and others, by achieving 4.67 out of 5 have the largest structural power in Iran. Following them, VPfST and MoSRT respectively, with scores of 4.33 and 4 have more structural power in comparison to the other institutions.

DISCUSSION, CONCLUSION, AND POLICY RECOMMENDATIONS

In spite of Iran's rising trend in science and technology, which has been mentioned in numerous international reports (Montazer & Kalantari, 2019; Nourizadeh et al., 2018; Cornell University et al., 2018; NUCTAD, 2016;

Kalantari et al., 2015; Kalantari & Charkhtab Moghadam, 2015; INSEAD et al., 2011), serious institutional problems exist in science and technology policymaking in Iran. This research's findings address two basic problems in science and technology policymaking in Iran (Kalantari et al., 2019; Montazer et al., 2019). The first one is the multiplicity of policymaking institutions in the field. Even though the large number of players had previously been considered as a serious problem in science and technology policymaking by researchers, the existence of 19 institutions that play a role in different levels of science and technology policymaking in Iran has caused some problems for the division of labor among them. The large number of decision-maker institutions in science and technology policymaking (Soofi, 2017), the existence of numerous players in science, technology and innovation policymaking (UNCTAD, 2016), the existence of different institutions in science and technology policymaking (UNESCO, 2010), the existence of different attendants in science and technology policymaking (Soltani et al., 2017), the multiplicity and overlapping of policymaking institutions and the weakness of policymaking institutions (Soltanzadeh et al., 2017), the existence of parallel institutions in science and technology policymaking (Zaker Salehi, 2012), the numerous effective organizations on science, technology and innovation system (Danaeifard, 2004), are all the evidence that other researchers have alluded to, implying there are numerous problems with the science and technology policymaking organizations in Iran.

The lack of interaction mechanisms among policymaking institutions in the science and technology field of Iran is the other problem. Despite the association of a number of institutions in some tasks, interaction mechanisms among them have not been predicted in policy documents, and most of the times, despite the prediction, they are not performed correctly. There are several studies in the literature referring to such cases. Different and complicated vertical and horizontal relations (UNCTAD, 2016), the necessity of complicated mechanisms of co-ordination and division of labor (UNESCO, 2010), recommendations for the improvement of co-ordination and coherence in innovation policymaking institutions (Soltani et al., 2017), lack of scientific, industrial and technological networks (Norouzi et al., 2016), island, disorganized, inconsistent structures devoid of purposeful relations, fragmented decision-making and policymaking centers, lack of coherence and unity (Zaker Salehi,2012), little communication among different players, the important role of government in policymaking without involving different interested parties (Haji Hosseini et al., 2011), lack of co-ordination and macro and national policymaking (Ghazinoory & Ghazinoori, 2008), lack of communication and mutuality of policymaking centers, lack of effective interaction between policymakers and scientists (Manteghi et al., 2010), lack

of communication among science and technology policymaking institutions, lack of techniques in this field (Tabatabaeian and Bagheri, 2003), are all evidence that other researchers have pointed to, indicating the lack of relation and co-ordination among the different players involved in science and technology policymaking in Iran.

In addition to the two main mentioned problems, other institutional problems are also considered in science and technology policymaking in Iran. First, some activities in the core-periphery analysis that are grouped as periphery activities can pose a serious threat to science and technology policymaking in Iran. For example, "the determination of mega policies" and "the evaluation of the policy impacts," which have an important role in determining meta and operational policies and are based on policy documents from EDCoS, are put into the periphery of the network. The inattention to the policy impacts and relying only on the evaluation outputs and the policy outcomes (which is usually performed by the parliament and public ministries) can gradually lead to mere attention to a quantitative output index and, consequently, a deviation from the policies. Second, the implication of some tasks by several institutions without designing the necessary coordinating mechanisms among them causes parallel work, neutralizes policies and wastes resources. For example, based on document policy, the public ministries, VPfST, and SCfSRT are in charge of supporting private R&D. However, there is no clarification available on the role and task of each organization. Another example is the financial resources support for the science and technology field, which, in addition to the public ministries, is done by a plan and budget organization and an innovation and prosperity fund.

Third, according to the policy documents, there is a very high interaction density among some of the science and technology policymaking institutions, especially those having roles in the planning and implementation levels. This interaction density leads to the complications and complexity of interactions leading to a serious weakness in the division of labor among the institutions. Consequently, even using relationship-analyzing software such as UCINet would fail to identify institutions and would partition them into groups with more interactions in certain tasks. Thus, the serious interferences among the tasks of these institutions and the consequent disorders are considered as a major threat. Fourth, SCfCR as a supreme institution that plays an important role in the policymaking level and determination of national priorities and policy impacts evaluation, have an active role in planning and plan implementation levels. Therefore, the presence of an institution in all three-fold levels of policymaking causes an overlap in its activities with those of many other institutions, especially the ones responsible for planning. Fifth, the existence of two cut points in the network increases the possibility of

vulnerability in the network. SCfCR, as the cut point for the supreme leader and the EDCoS with other institutions, connects the policymaking level and national priorities with the level of planning and implementation of plans. Moreover, other related institutions such as the ministry of information and communication technology of Iran, the ministry of defense and armed force logistics, and the ministry of power, are the cut points for TVTO with other organizations connecting the training with other tasks. If the mentioned interactions are disconnected for various reasons, such as the weakness of the organizations acting as cut points in the network, the science and technology policymaking network will fall into a fragmentation process. To overcome the mentioned problems, the following policy recommendations are suggested:

A) The institutions with considerable overlap in their tasks should gradually, over the medium term (for example, one or two five-year programs), merge into one another. If, based on the experts' opinion, the merging of these institutions would face a lot of institutional resistance and have a vast negative result, the tasks of each institution must be clearly and accurately defined through the accurate and clear division of labor among them.
B) The interaction and coordination mechanisms among institutions should be determined clearly and accurately especially for 1- institutions which are in various vertical levels (for example, the interaction mechanisms among institutions determining the policy formulation and national priorities with the institutions playing roles in the planning level and implementation of executive programs); 2- institutions which are active in a certain task (for example, interaction among institutions, such as EDCoS and SCfCR, that formulate mega policies).
C) A mechanism should be designed to transfer the key activities of the science and technology field from the periphery to closer to the network core. For example, two activities of "the determination of mega policies" and "the policy impact evaluation," which determine the main direction of science and technology policies, are in the periphery of the network and have little effect on the overall course of the science and technology policies. Hence, designing a mechanism to place these two activities in a more central region of the network is of great necessity.
D) The redundant interaction mechanisms predicted in policy documents must be omitted. Such mechanisms are mostly caused by the interference of some institutions in the tasks of others. Consequently, they lead to a decrease in the effectiveness and efficiency of policies. For example, the intricate relationships among policymaking institutions in the field of higher education cause a weakness in the efficiency and effectiveness of the policies. Therefore, it is necessary to eliminate the redundant

interaction mechanisms by the accurate division of labor between institutions.

E) The interaction mechanism among institutions connected to the network only through cut points should be strengthened. The existence of cut points in the network decreases the risk of vulnerability in the network and in some cases, could cause a deviation in policies. Hence, it is necessary to design complementary mechanisms in the network in a way that limits the role of cut points in the network.

The findings and results of this research are based on the analysis of science and technology policy documents in Iran. Since, sometimes, policy documents are different from what is happening in reality, one of the limitations of this research is the analysis of the science and technology policy network in Iran from the perspective of policy documents. Therefore, in future research, it is recommended that researchers map the science and technology policy network in Iran in reality, for example, based on mere interviews with experts, and compare and analyze the differences between that network and the document-based network.

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Appendix: List of science and technology policy documents in Iran

#	Name of the policy document in the field of science and technology	approving body	year of approval
1	Constitution of the Islamic Republic of Iran	Assembly of Constitutional Experts	approved in 1979 and amended in 1989
2	Position, goals and tasks of the Supreme Council of the Cultural Revolution	The Supreme Council of the Cultural Revolution	1997
3	Leadership rulings in determining of the members of the seventh period of the Expediency Discernment Council of the System	The Supreme Leader	2017
4	Detailed Description of Tasks and Powers of the Supreme Council of Science, Research and Technology	Cabinet	2004
5	Rules of Procedure of the Parliament	Parliament	2016
6	Basic Goals and Tasks of the Vice Presidency for Science and Technology	Vice Presidency for Science and Technology	2017
7	Articles of Association of the National Elite Foundation	The Supreme Council of the Cultural Revolution	2005
8	Law on Removing Barriers to Competitive Production and Improving the National Financial System	Parliament	2015
9	Law on Maximum Use of Production and Service Capacity in Meeting the Needs of the Country and Strengthening in Export and Amending Article 104 of the Law on Direct Taxes	Parliament	2012
10	Law on Tasks and Powers of the Ministry of Oil	Parliament	2012

#	Name of the policy document in the field of science and technology	approving body	year of approval
11	Law on Goals, Tasks and Organization of the Ministry of Science, Research and Technology	Parliament	2004
12	Law on Organization and Tasks of the Ministry of Health, Treatment and Medical Education	Parliament	1998
13	Articles of Association of the Technical and Vocational Training Organization	Cabinet	-
14	Law on Concentration of Industry and Mining and Establishment of the Ministry of Industries and Mines	Parliament	2000
15	Separation of the Program and Budget Organization and the Administrative and Employment Organization	Supreme Administrative Council	2016
16	Articles of Association of the Innovation and Prosperity Fund	Cabinet	2017
17	Tasks of the Center for Progress and Development	Not approved	-
18	Articles of Association of the Center for Strategic Studies	Not approved	-
19	Articles of Association of the Nation Research Institute for Science Policy of Iran	Ministry of Science, Research and Technology	2012
20	Law on Amending the Laws and Regulations of the Institute of Standards and Industrial Research of Iran	Parliament	1992
21	Tasks of the Iran Registration of Documents and Real Estate Organization	Not approved	-
22	Law on Support of Knowledge-Based Companies and Institutions and Commercialization of Innovations and Inventions	Parliament	2010
23	Law on Tasks and Powers of the Ministry of Communications and Information Technology	Parliament	2003
24	Law on the Establishment of the Ministry of Defense and Support of the Armed Forces	Parliament	1989
25	Law establishing the Ministry of Power	Parliament	1974

Source: Research findings.

Abstrakt

CEL: *Głównym celem tego artykułu jest zdefiniowanie sieci polityki naukowej i technologicznej w postaci sieci społecznej z perspektywy dokumentów politycznych, a następnie jej analiza metodą analizy sieci społecznych (SNA).* ***METODYKA:*** *Jako studium przypadku, sieć polityki naukowej i technologicznej w Iranie jest analizowana przy użyciu sugerowanych ram w tym badaniu. Dane wykorzystane w tym badaniu zostały zebrane poprzez analizę treści 25 dokumentów politycznych i wywiadów z 20 przedstawicielami irańskich elit polityki naukowej i technologicznej, zanim zostały zinterpretowane przy użyciu metody analizy sieci społecznej i oprogramowania, takiego jak NetDraw i UCINET.* ***WYNIKI:*** *Najważniejsze instytucje kształtujące politykę naukową i technologiczną w Iranie oraz interakcje między nimi zostały określone z punktu widzenia sieci. Udało się to osiągnąć poprzez przeprowadzenie dwuwymiarowej analizy rdzeń-peryferia, zidentyfikowanie punktów cięcia i bloków oraz pomiar siły strukturalnej każdej instytucji przy użyciu stopnia centralności, centralności bliskości i centralności pośredniczącej.* ***IMPLIKACJE DLA TEORII I PRAKTYKI:*** *Najważniejszymi praktycznymi implikacjami tych badań są: integracja szeregu instytucji tworzących politykę, podział wyraźnej i precyzyjnej pracy pomiędzy instytucje polityczne, projektowanie mechanizmów koordynacji pionowej i poziomej między instytucjami, eliminacja ingerencji jednych instytucji w zadania innych, projektowanie komplementarnych mechanizmów kontroli roli punktów cięcia oraz zwracanie uwagi na ważne działania na marginesach sieci.* ***ORYGINALNOŚĆ I WARTOŚĆ:*** *Najważniejszym wkładem tych badań jest opracowanie ram badania polityki naukowej i technologicznej, a następnie opracowanie metody badania polityki naukowej i technologicznej opartej na SNA. W związku z tym ramy badania polityki naukowej i technologicznej w cyklu składają się z trzech etapów: 1- Ustalanie agendy i ustalanie priorytetów (na dwóch poziomach megapolityki i metapolityki); 2- Projektowanie i wdrażanie lub polityki wykonawcze (w trzech częściach: polityka po stronie popytu, polityka po stronie podaży oraz polityka dotycząca infrastruktury sieciowej i wzajemnych połączeń); 3- ewaluacja i nauka polityki.*

Słowa kluczowe: *polityka naukowo-technologiczna, sieć polityczna, analiza sieci społecznych SNA, władza strukturalna, Iran*

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Conflicts of interest

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Synergetic effects of network interconnections in the conditions of virtual reality

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Abstract

PURPOSE: *The disclosure of the content of the synergetic effect, as a result of network interactions of development institutions in a new economic virtual reality, and the presentation of the general characteristics of their relationships through knowledge of the functioning of clusters, which in the XXI century occurs during the digitalization of the economy, resulting in digital products/services and various platforms.* ***METHODOLOGY:*** *On the basis of dialectical, systemic and matrix methods and using the institutional-network approach, the characteristic features of network interactions of cluster formations in the conditions of virtual reality are studied, which are becoming the norm today, a good quality and effective rule for the practical implementation of various sectors of the economy in the course of digitalization of the economy. The method of comparison is used in terms of conditions for the formation of an innovation-digital cluster from the standpoint of the theory of institutionalism.* ***FINDINGS:*** *Network cooperation in the conditions of virtual reality demonstrates synergetic effects through new forms of qualitative accumulation and an increase of new knowledge, which occur through their network replication (division), and innovative growth is the result of the formation in the economy and society of a new, network model of coordination of connections, network cooperation of new quality, constantly adjusted by digital tools. The synergistic effect of networking creates a new phenomenon of growing marginal utility and growing marginal productivity from innovative glocalization and digital globalization. The greater the scale of innovation*

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and digital activities is in the conditions of virtual reality, the greater the efficiency is of the use of additional resources. The effect of scale is especially pronounced within the network, which uses the standards produced and tested by it. ***IMPLICATIONS FOR THEORY AND PRACTICE:*** *It is proved that the synergetic approach used in the formation and development of innovation-digital clusters is considered through the prism of the relationship "subject – subjective relationship of innovation-active organizations and digital enterprises." In addition, in our case, this effect lies in the plane of restructuring the "old" development institutions in the "new", under the influence of the relevant institutional and legal basis, systemic and comprehensive modernization and diversification of all sectors of production, improvement of the innovation and investment situation, construction of effective innovation and digital virtual-real infrastructure of the European standard, implementation of clustering of the economy using the opportunities of network cooperation..* ***ORIGINALITY AND VALUE:*** *The content of a virtual slice of network interaction of cluster formations in the conditions of virtual reality offered by the authors is revealed; the authors' vision of its structural elements is given, as from a digital network augmented and virtual socio-economic reality; the taxonomy and categorization of terminology with the help of which it is possible to reveal the formation of network cooperation in the conditions of virtual reality and its further development are investigated; on the basis of the conducted deep theoretical and methodological analysis and the presentation of a retrospective of innovation and digital changes, a step-by-step transformation of cluster formations is shown. The basis of network economy is network institutions, entities, organizations, in addition, it forms an environment in which any business entity or individual, which, no matter where it is in the economic system, has been able to communicate easily and at minimal cost with any other company or individual about working together, trading issues, or know-how, or just for fun in the conditions of the new virtual reality.*

Keywords: *virtual reality, network economy, network cooperation, cluster formations, augmented reality, synergetic effects, digitalization of the economy, cluster network structures, quality of network interconnections*

INTRODUCTION

Given the existing scientific developments in the field of knowledge of network economics, what have remained unexplored are the qualitative transformation of network relationships, new conditions for the formation of innovation-digital clusters and cooperation of clusters in virtual reality, in order to obtain a synergistic effect based on innovative changes in activities at all levels of economic aggregation in the direction of the formation of Industry 4.0. The practical side of universal functions is not fully disclosed, which are inherent in all subjects of cluster formations, namely: regulatory; integrative; broadcasting; communicative (this feature has its own feature – informal

communication); consolidation and reproduction of public relations on the basis of virtual-real network interconnections.

The era of the network economy, which manifested itself in the transition to the third millennium, affected all aspects of economic and social life. Global development of the network economy can be seen as expanding the base of post-industrial society. This allows us to characterize confidently the processes taking place in the global economy and the world community as a manifestation of a "paradigm shift." Modern civilization is characterized by a sharp increase in the dynamism of socio-economic spheres of life and the growth of risks, uncertainty in the development of all aspects of society, and the formation of virtual reality. This state of affairs in the world is called the "era of turbulence."

Institutionally, the complication of the formation of both network and innovation, digital, virtual economies is associated with the emergence of a new method of coordination and harmonization of interests. Thus, in the industrial age (industrial paradigm) the world community was based on two ways of coordination: a hierarchical order with a system of vertical subordination and a center of administrative management (rigid model of coordination); and a market system with price signals, as some deviation from the rigid and clear hierarchy (flexible, but quite atomistic). The post-industrial paradigm is characterized by a non-hierarchical order or the so-called network coordination mechanism. The world economy and all its subsystems are stratified into cluster-network structures with horizontal connections and a collaboration mechanism (hybrid model – flexible and integrated at the same time).

LITERATURE REVIEW

In recent decades, the idea of creating clusters based on networking and quality cooperation within this type of entity has found its application in virtually all countries, including not only the EU, USA, Japan, but also South America, Eastern Europe, and Africa. Today, the cluster model, filled with quality network connections, is characterized by a high synergy effect and is one of the most effective forms of achieving competitive advantage. The concepts of creating clusters are quite diverse. Yes, in Canada, Spain, Germany – this is an innovation system; in Austria, Belgium, the Netherlands, Norway, the USA, Switzerland – production and innovation networks and their interaction on the basis of cooperation; in Denmark – resource zones; in Italy, Finland – intersectoral flows of knowledge; in the UK – regional innovation systems.

The creation and consolidation of such development institutions through government programs are specific to Argentina, Chile, and Canada. Effective functioning of network platforms is typical of Belgium, France, South Africa, Switzerland (through the interaction of research centers), Colombia, Poland, Portugal, Argentina, Australia, Germany (through public–private partnership), Denmark, Spain (interaction within industries networks). Internationalization based on the program of competitiveness clusters is inherent in the economies of Japan, Ireland, and Austria. The process of knowledge-based clustering is observed in Israel, Great Britain, Germany, Ireland, Finland, Estonia, Spain, the Czech Republic, Austria, Poland (OECD, 2014; OECD, 2012).

In Ukraine, economic network cluster formation occurs mainly spontaneously, under the influence of market forces. This influence is quite natural but theoretical, methodological, and applied aspects are not fully realized. The theory of management of such formations, regulation of the process of their creation and functioning has not been properly developed in the economic science and practice of Ukraine, and unadopted application of foreign experience does not provide the desired effect in the socio-economic and institutional conditions of the country.

The current institutional structure of Ukraine's economy does not meet new challenges of economic transformation due to significant systemic contradictions caused by the low adaptation to modern market realities of institutions, as well as a weak ability to participate actively in the reproduction process of institutions generated by transformational change (Holian, 2006).

Names of foreign scientists (Boudeville, 1966; Boshchma, 2005; Richardson, 1973; Richardson, 1974; Porter, 2005; Perroux, 1950, 1967; Spilling, 2006; Winter, 1984; Chesbrough, 2007) are connected with the study of general aspects of structural restructuring and complex modernization of the economy in the direction of its regional network and innovative clustering. Well-known researchers (Andriichuk, 2010; Androschuk, 2009; Britchenko, 2019; Gareev, 2012; Deliia, 2011; Dombrovskyi, 2011; Zhdanova, 2008; Karetin, 2009; Katukov, 2012; Kraus, 2019, 2018; Kryvoruchko, 2018; Lukianenko, 2008; Napolskikh, 2012; Prigochin, 2005; Pishulin, 2020; Odyagailo, 2006; Ratner, 2011; Tatarkin, 2011; Togunov, 2009; Tishchenko, 2010; Usov, 2009; Haken, 2005; Fedorov, 2010) have dealt with the formation of virtual reality in the world, innovative modernization, its strategic guidelines and mechanisms for their implementation, structural modeling of the institutional environment of the innovation cluster, self-organization as a new methodology for studying economic systems, and economic development of regions. (Zaremskyi, 2010; Ivanov, 2013) were engaged in the development and implementation of the cluster strategy of innovative development of regions in the context of global economy, and clarification of

the social context of innovative development. But many issues, such as the formation of clusters in virtual reality and the formation of a quality network economy in global digital space, the development of network relationships and cooperation, remain insufficiently disclosed.

The work of NAAS academics is devoted to theoretical principles of clustering (Sabluk, & Kropyvko, 2010), as well as foreign researchers (Enright, 1992; Cappellin, 2003; Cappellin, 2007; Cooke, 2006; Cooke, & Martin, 2006; Rallet, & Torre, 2001; Owen-Smith, & Powell, 2004; Lagendijk, & Oinas, 2005). Another researcher proposed a conceptual approach to cluster organization, and substantiated the conditions for the formation and effective functioning of clusters (Kropyvko, 2010). In a number of scientific papers (Mazniev, 2015; OESD, 2003; Cooke, 2006; Cooke, & Martin, 2006) in different periods, it was argued that cluster theory in modern conditions is developing not only on the theory of competitive advantage, but also using the achievements of synergetics, logistics, homeostatics, and other scientific concepts.

But many issues, such as the formation of clusters in virtual reality and the formation of a quality network economy in general within global digital space, the development of network relationships and cooperation, remain insufficiently disclosed. Based on the generalization of literature sources, experience and own research, based on system-synergetic positions and using a logistical approach, the authors' aim is to achieve a synergy in virtual reality through the network interaction in clusters. To present a visualization of the model of creation and effective functioning of innovation clusters.

In order to form an innovative cluster complex on the basis of the cluster approach, it is necessary to consider, first of all, the existing methodological approaches to cluster identification proposed by foreign and domestic scientists. The most well known should be considered the methodology for the allocation of clusters (Porter, 2005), which includes three stages:

1) The composition of the cluster is determined, namely: first, the core of the cluster is detected – a large company or group of similar; secondly, there is a building of vertical links between the core and related companies; third, main horizontal relationships are formed relative to the core of the cluster, for this purpose, the production involved through common channels or those that create by-products or services are identified; and on the basis of determining the use of common factors of production, supply, technology, etc., additional horizontal links are established.
2) The composition of organizations within the cluster that provide specialized services, technologies, information, capital, and infrastructure is determined.
3) Power structures, legislative institutions that have an impact on the activities of the cluster are identified.

Porter (2005) also developed the so-called "competitive diamond" or "diamond" to determine national preferences. We share the conceptual approaches of research to the basic features of clusters and their typification (Fedorenko, Tugay, Goyko, & Dzhabeylo, 2008). These methods contain only a qualitative analysis of the preconditions for the formation of an industrial complex based on a cluster approach. A number of domestic researchers suggest the use of quantitative analysis to determine the directions of cluster formation. One of such directions is the calculation of coefficients of localization and specialization of regions (Dlugopolskyi, 2003).

Another analytical approach to cluster identification (Tarasova, 2007) is based on the calculation of coefficients that are divided into groups. In particular, the level of specialization of the region's economy, the level of development of small and medium enterprises, the level of development of investment activities, the level of imports (exports) in the region's economy. In our opinion, for the formation of networks of innovation clusters it is most appropriate to apply an approach that uses a comprehensive assessment. In addition, at the present stage of development of innovation clusters, it is necessary to apply an approach that can not only take into account the sectoral characteristics of operating activities but also their impact on the formation of market segments of national economy and the interests of all participants.

METHODOLOGY AND RESEARCH METHODS

The aim is to disclose the content of the synergetic effect as a result of network interactions of development institutions in new economic virtual reality and present the general characteristics of their relationships through knowledge of the functioning of clusters, which in the XXI century occurs during the digitalization of the economy, which results in digital products/services and various platforms. The objectives of the study are: to reveal proposed by authors the content of virtual slice of network interaction of cluster formations in terms of virtual reality; to offer the authors' vision of its structural elements, both from a digital network augmented and virtual socio-economic reality; to study the systematics and categorization of terminology, which can be used to identify the formation of network cooperation in virtual reality and its further development; on the basis of the conducted deep theoretical and methodological analysis and presentation of a retrospective of innovation and digital changes to show the step-by-step transformation of cluster formations in the section: formation of a network of informal and formal relations between economic agents; plurality of economic agents; territorial concentration; high-quality specialization; common institutional,

socio-economic, virtual-economic environment; using a synergetic approach to consider innovation-digital clusters through the prism of the relationship "subject – the subjective relationship of innovation-active organizations and digital enterprises".

During the writing of the article, general and special research methods were used, namely methods of deduction and induction, methods of synthesis and analysis, unity of historical and logical in clarifying the essence and role of clusters and mechanisms of coordination of interests of cluster interaction, based on a new format of network relationships in virtual reality. On the basis of dialectical, systemic and matrix methods and using the institutional-network approach, the characteristic features of network interactions of cluster formations in the conditions of virtual reality are studied, which are becoming the norm today, a good quality and effective rule for the practical implementation of various sectors of the economy in the course of digitalization of the economy. The method of comparison is used in terms of conditions for the formation of innovation-digital cluster from the standpoint of the theory of institutionalism. The method of grouping and generalization is applied to studying the experience of functioning and development of innovation clusters in Ukraine, and also innovative-digital hubs. Some statistical data on advanced technologies by types of activity produced by Ukrainian clusters are presented and an empirical analysis of network relationships between educational institutions, enterprises, research institutions, customers, suppliers of equipment, materials, components, software. A process and system approach was used in the formation of practical recommendations in terms of enhancing synergetic effects as a result of new quality of interaction of all participants in cluster systems in virtual reality.

RESULTS AND DISCUSSION

The representative of the institutional-sociological school in France, economist Fransua Perroux in 1950, proposed the theory of growth poles (Perroux, 1950; Perroux, 1967), which is based on the idea of the leading role of the sectoral structure of the economy and, above all, the leading industries that create new goods and services. According to him, all economic entities are unequal at the initial stage of relations, connected by subcontracting relations, which are formed naturally. Once in a polarized space, a networked firm must take into account direct and indirect coercion from the dominant unit, that is, economic units no longer behave as interdependent partners, but as part of a single system, a network.

Jean-Francois Perrault proved that the formation of poles of economic growth occurs in the locations of enterprises of dynamically developing industries. Such industries become the "poles of attraction" of factors of production, which leads to the emergence and growth of industrial centers, the emergence of a synergistic effect of network interconnections. This theory laid the foundations for regional programs in many countries around the world on the basis of network cooperation.

The ideas of Jean-Francois Perrault were developed by the French scientist Jake Boudeville (Boudeville, 1966). He gave a regional aspect to the economic category of "growth poles", distinguishing three types of economic spaces: homogeneous, polarized, and planned. The underdeveloped territory has a homogeneous appearance of space, but during the development of network connections the space inevitably becomes polarized. For Jake Boudeville, not every regional center is a pole of growth, but only one in which propulsive industries have developed. This theory of economic development of the region determines the search for industries that will give impetus to the development of the entire regional system with its network connections. In his research, the scientist showed that the poles of growth could be considered not only a set of leading industries, but also specific areas (settlements), which perform in a country's economy as a source of innovation and progress.

The scientific works of English researcher Henri Richardson (Richardson, 1973; Richardson, 1974) are devoted to the ideas of the formation of accumulated cities, which become large industrial centers, a kind of poles of growth. This stimulates technical progress and productivity growth, has a significant impact on network processes, and the location of enterprises. In addition to the energy effect of the agglomeration and the personal preferences and preferences of investors, key elements of regional growth in the model of Henri Richardson are technical progress and socio-political component. In essence, Henri Richardson's model realizes the same functional relationships that are characteristic of models of the neoclassical school between the rate of growth and the rate of capital accumulation, increasing labor supply and the speed of technological progress. The functions of the studied model depend on the effect of agglomeration, the advantages of localization, networking and branching of cooperation, the difference in factor prices in the region and in the country as a whole, and other features of the regions (Richardson, 1974; Kuznetsova, 2002).

American economist Sidney Winter (Winter, 1984) in his research identified two technological modes in which an innovative company operates, namely: routine and entrepreneurial. Entrepreneurial regime is characterized by high technological capabilities – investment in innovation can lead to tangible success. At the same time, this success is not guaranteed.

The regime is characterized by a significant variety of ideas and a large network of firms operating in it (medium, small), which are based on more applied and hidden knowledge than on the results of research protected by patents. The entrepreneurial regime is characterized by a low level of cumulativeness, the main type of evolution is an industry or cluster, and the main metaphor is "expansion."

In a routine mode, main actors are large firms. Technological opportunities in it are small, but at the same time, there is a high probability of incremental innovations as a result of research. The mode is characterized by high cumulative qualities, due to which the barriers to entry are quite high. Patents that protect the results of scientific developments are an important condition for the assignment of innovative rent. Knowledge in a routine mode is highly specific and less accessible. The primary type of cluster (or branch) evolution is "creative accumulation," and the main metaphor is "deepening" (Panyushkin, 2011, p. 59; Spilling, 2006).

In his work "Open innovations. Creating Profitable Technologies" (Chesbrough, 2007), Professor Henry Chesbrough of the University of California proposed a paradigm of closed and open innovation. He calls new approaches to effective innovation "open innovation", understanding that in managing innovation processes, organizations should not be "closed" in the internal environment, and it is necessary to build network relationships and interact. Comparing the features of innovation, which is carried out on the principles of openness and closedness, the scientist demonstrates the contrast of old and new approaches to the development and implementation of innovations.

Along with a comparative description of the old foundations and new, including network, approaches to the implementation of innovations, Henry Chesbrough provides a scheme of open and closed innovations, which has become world famous. The author uses the tunnel to describe the innovation process, the continuous and intermittent boundaries, which clearly demonstrate the essence of yesterday and today's foundations of open networking. According to the author, today's business enters a new stage of innovation, when the sources of innovation potential of companies lie in the plane of synergetic effects as a result of network cooperation (Chesbrough, 2007; Trifilova, 2008, p. 73). Open innovations are a new structure of organization of innovation processes, moving them abroad into an open, free field of high technology transfers through network interactions, and new organizational forms of integration of knowledge-intensive commercialized technologies that work in global markets (Fedorov, 2010, p. 117).

Exploring the models of open and closed innovations, Henry Chesbrough paid special attention to the following question: How, without the help of central laboratories of industrial enterprises (which were key to innovation in

the past), will there be a diffusion of technologies suppliers, consumers, and industry consortia? Closing itself in the internal environment, and not being a member of network formations, the company spends only its resources, duplicating innovative developments. Hiding the results of research, organizations do not make a profit, unlike those companies that allow other businesses to use their own technology (Trifilova, 2008, p. 74).

Unused innovations lose their appeal and relevance over time. Henry Chesbrough calls the principle extended to the period of closed innovations (when companies preferred to "put" unused technologies on the "shelf") "naphthalene." In his opinion, today it is impossible to treat the ideas and people who created them as "warehouse stocks of the company." The big risk threatens those who postpone the implementation of developments "until better times for business" and is that they can once and for all lose people and innovative ideas that they have developed for the company (Trifilova, 2008, p. 75).

Having studied entropy (from the Greek – "turn," "transformation") as a tool for analyzing innovation and considering through the prism of entropy to predict its effectiveness, the Russian professor Leonid Usov proposed his concept (Usov, 2009, p. 38). The entropy of stability of production systems should show the main consequences of economic activity. In this sense, Leonid Usov understands changes in the entropy of production systems as the main criterion of network efficiency of innovation. He pointed to three qualities of entropy as a tool for analyzing innovation, namely: in closed systems, entropy is constantly increasing; increasing entropy means eliminating differences; the more freedom, the greater the entropy.

These qualities of entropy partially reveal the paradigms of closed and open innovations by Henry Chesbrough. According to the concept of Leonid Usov, in an open system, which is filled with network connections, there is, first, its own entropy, which, as in closed systems, always grows. Second, entropy penetrates an open system from the environment (imported entropy). Third, from the open system, entropy moves to the external environment, where high quality, inter-corporate relationships are very valuable and bring increased profits (Usov, 2009, p. 39).

Examining the genesis of the formation of the theory of innovation, one cannot ignore the emergence of the theory of self-organization (Illia Prigochin, 2005) and synergetics (Herman Haken, 2005). According to the theory of self-organization, innovation-digital activity is provided only under the condition of high flexibility of structure in modern conditions of virtual reality. For this reason, the self-organization of the network economy system begins with the formation of a structure in which each source of external impulses corresponds to an element that generates internal innovation

and digital products/services. At the next stage, the system evolves in the direction of a more orderly state, which is achieved under the influence of the struggle for existence. An additional hierarchical level is formed, at which the feedback loop with the external environment is closed (Deliia, 2011, p. 17).

The triple helix model of Professor Henri Etzkowitz of Stanford University is an example of a harmonious combination of organization and self-organization in innovation processes in network systems. The state, by determining the "rules of the game" of economic entities, supporting institutional transformations, exerts influence on the innovation process. "Business, academic universities and institutes, interacting with each other in the process of generation and commercialization of innovations, show an example of self-organization" (Erokhina, 2011, p. 79–80).

Institutional transformations form a "critical mass" in public opinion to understand the need for large-scale modernization of social order in the direction of the network economy or its important subsystems, and especially innovation (Tatarkin, 2011, p. 16). Modernization is an ongoing process of expanding the opportunities of socio-economic and general social development using new and updated institutions and forms (relationships) between actors, including network. This type of modernization is called and qualified as institutional (point, local, limited), which is a prerequisite for bringing macroeconomic and other non-modernized institutions and forms in line with the needs of a particular stage of social development.

The complex and systemic nature of modernization provides a consistent solution to problems of socio-economic development that hinder the formation of the network economy in Ukraine. Modernization of the economy will not be effective and complete without changes in political, social, and environmental spheres. You can increase and develop innovative developments as much as you want, but if you do not create an innovative network environment, the effect of innovation will happen in other countries, where this environment is formed and is operated (Tatarkin, 2011, p. 17).

The resumption of economic growth, which is being pursued in power structures and production circles, now requires active mastery of its national innovative path of development. Ensuring the transition to an innovative type of development is a prerequisite for preserving the economic and political sovereignty of Ukraine. It is generally accepted that an economy characterized by a high level of resource and energy consumption of its products, which is typical for Ukraine, even without the influence of external factors is doomed to gradually deplete the reserves of extensive growth and further increase the threat of economic depression. Therefore, the implementation of the synergetic effect of innovative development, based on network cooperation,

becomes for Ukraine the only way to reduce the technological and economic lag behind developed countries (Andriichuk, 2010, p. 4).

The process of economic agglomeration of interconnected enterprises in a separate territory has been known since the time of handicraft production. Beginning in the 1980's, it received a new impetus in the form of the development of network formations, clusters, as an important factor in the economic growth of the region. Today, it can be stated that regions where clusters are emerging are becoming leaders in economic growth. Such leading regions determine the competitiveness not only of regions but also of national economy. The increase in research in this area suggests that the geographical proximity of the relevant economic areas contributes to a higher level of capital use and innovation. Development institutions, which are in direct contact with end users, suppliers, research laboratories, educational institutions, form important factors in the development of regional and national economies (Karetin, 2009, p. 320).

Network economics is a form of information and communication in the digital economy. Network economy is an economy in which activities are carried out through electronic networks. The basis of a network economy is network entities and organizations. However, the network economy creates an environment in which any business entity or individual, no matter where it is in the economic system, has been able to communicate easily and at minimal cost with any other company or individual about working together, exchanging ideas, trade issues, or know-how, or just for fun.

The formation of a network society and network economy (mesh economy) lies in the plane of the emergence of new, more flexible means of managing companies and communities, complemented by the development of network technologies and spread of solutions based on blockchain technology (chain of transaction blocks). The network company provides for the elimination of various intermediaries in the registration or accounting of property rights to any property, as well as in the conclusion of any agreements with tangible or intangible assets. This leads to colossal changes in the state and corporate bureaucracy, as well as to full-scale democratization of the financial sector (Pishulin, 2020, p. 41).

From the point of view of the institutional-network approach, a cluster is a new form of organization – a heterarchy that has no pronounced hierarchical features and is only partially a market, characterized by organizational heterogeneity. Such a structure is a network that operates on the basis of institutional mechanisms of coordination and cooperation. Its formation presupposes stable connections between participants due to various reasons, including both geographical proximity and the presence of institutions, the

interaction with which is not always, and in some cases is partially, regulated by the market (Tishchenko, 2010, p. 74).

Among key factors that shape the institutional environment of the territory are: improving regional and municipal regulatory frameworks for innovation policy; investment and economic climate and image of the region; efficiency of the system of regional and local government bodies, competence of the management; mentality of the population, innovative culture of entrepreneurs, traditions and habits of the local scientific community; the level of development of informal development institutions, communication channels and innovative, digital virtual-real platforms for cooperation (Napolskikh, 2012, p. 43; Kryvoruchko, 2018, p. 30).

Clusters were studied in detail by Michael Porter in the 1980's. The approach used by the scientist is called the classical liberal or Anglo-Saxon approach. This approach is based on the self-organization of economic agents within the mechanisms of a free market in the absence of direct state intervention. The Modern European approach emerged in France in 2008. It is called the "pole of competitiveness" and is based on a partnership of business, central and local government. The government is a stakeholder in the global competitiveness of the whole country and in achieving the "pole of competitiveness" at a world level, which is expressed through various forms of state support (Napolskikh, 2012, p. 42).

Michael Porter's research attention is objectively focused on the phenomenon of "cluster," as a group of geographically close interconnected companies and, through different types of networks, organizations connected with them, operating in a particular area and characterized by common activities and complementarity. The cluster, as a new model of enterprise integration, allows competitive advantages to be obtained from a combination of factors such as geographical location, interaction, specialization, innovation, and networking. According to Michael Porter, "clusters use important connections, complementarity of industries, dissemination of technologies, experience, information, marketing better than industries… Cluster is not a technology park, not a business incubator, not an industrial park and not a free economic zone – it would not be correct to say that a cluster is a territorial production complex or a research and production association. However, the elements of infrastructure that exist today, or newly created elements of infrastructure, can be part of clusters…" (Porter, 2005, p. 265).

Nowadays, there are many approaches to understanding the essence of cluster. We agree with the opinion of Russian scientist Serhii Karetin, who emphasizes that clusters are concentrated by geographical groups of interconnected companies, specialized service providers, firms in relevant fields, as well as organizations related to their activities (universities,

standardization agencies, trade associations) in certain industries that compete but carry out their work (Karetin, 2009, p. 320).

In our opinion, it should be added to the above definition that innovation clusters are vertically integrated structures that are designed to produce competitive innovative products, using the unrealized internal potential of the region, ensuring the connection of production with the spread of new technologies and innovations.

Economic relationships within the cluster create new opportunities for production development, its innovative renewal. Enterprises in the cluster in the process of interaction and "convergence" of interests, gradually overcome disunity, inertia and isolation on internal problems, which positively affects the growth of their technical level and competitiveness of products (Zhdanova, 2008, p. 268). This allows the cluster to obtain a potential that exceeds the sum of its potential of individual structural components (economic agents) and allows innovation enterprises to carry out digital, investment, and innovation activities stably (Tishchenko, 2010, p. 76).

Modern clusters, uniting a significant number of formally independent enterprises and social institutions, act as a single economic entity. Clusters are an environment for the formation of an innovative approach to public and corporate governance. The purpose of the state cluster innovation policy should be to increase the competitiveness of territorial economic systems, and competitiveness factors – components of the so-called "Cluster Complex" – "4C" (by analogy with the "Marketing Complex" – "4P") (Napolskikh, 2012, p. 41).

Foreign scientist Dmytro Napolskykh considers that the "Cluster Complex" – "4C" refers to concentration, competition, cooperation, competitiveness. Another foreign researcher, Timur Gareev (Gareev, 2012, p. 12), proposes that the cluster complex should be considered through its five typical characteristics, and accordingly calls it "5C", namely:

- Concentration (geographical concentration of organizations that form a cluster portfolio);
- Competition (competitive basis of a general type of economic activity and competition between firms, i.e. the creation of a dynamic network of domestic market suppliers);
- Cooperation of firms horizontally and vertically and the formation of a specialized economic and market infrastructure around the cooperative firms;
- Communication (information, including advertising strategy) common with the external environment;
- Competence of human capital in a portfolio sphere of the cluster.

Ukrainian scientist Borys Odiagailo points to such institutional bases of cluster relations as: socialization, collectivism, alienation, mediation, measure of usefulness, measure of value, level of networking, measure of trust (Odyagailo, 2006, p. 344).

Based on the classic features of a cluster according to Michael Porter, we can talk about the cluster as a group of geographically localized interdependent companies, equipment suppliers, components, specialized services, infrastructure, research institutes, higher education institutions (HEIs), and other organizations that complement each other and strengthen the competitive advantages of individual companies and the cluster as a whole. That is, a cluster is a group of organizations (companies, enterprises, infrastructure facilities, research institutes, and free economic zones) related to the relationship of territorial proximity and functional dependence in the field of production, sales, and consumption of resources.

The Swedish scientist Ron Boshchma pays special attention to the understanding of "territorial (geographical) proximity" in the study of clusters in his research (Boshchma, 2005). He argues that it is important to distinguish between forms of proximity in the functioning of economic systems. Geographical proximity, in his opinion, is not a specific form. Researcher proved that there are problems of "excessive" proximity, which are expressed in the form of various blockages that can hinder innovation. Ron Boshchma considers geographical proximity as a complementary factor in the formation of institutional, social, organizational, and cognitive proximity (Table 1).

Table 1. Analysis of forms of "intimacy" by Ron Boshchma

Forms of "intimacy"	Dimension	Intimacy insufficiency	Excess intimacy	Workarounds
Institutional	Institute-based trust	Opportunism	Locking and inertia	Institutional audit and balancing
Organizational	Control		Bureaucracy	Systems with "weak" relationships
Social	Social-based trust		Lack of economic justification	Mixing "en-enered" and market relations
Cognitive	"Gap" in knowledge	Misunderstanding	Lack of sources of novelty	Knowledge base with different but complimentary features
Geographical	Distance	No spatial external effects	Lack of geographical openness	Change local and internal links

Source: Boschma (2005, p. 71).

Scientists, analyzing the role of institutional factors, consider it as a set of social, organizational and directly institutional forms of "intimacy" (Boshchma, 2005, p. 68). In addition, we believe that the COVID-19 pandemic has provoked new challenges for business and demonstrated the importance of the ability to work in augmented and virtual reality, to digitize business activities. Thus, we interpret virtual reality as a space between reality and virtuality, between which there is augmented reality (closer to reality) and augmented virtuality (closer to virtuality). We believe that virtual reality of the multiplayer world is based on the exchange of virtual goods within the on-line environment. It creates an opportunity to interact with the artificial world with the help of virtual platforms with the available information funds of the on-line innovation market, the ability to work with cloud technologies. Augmented reality as a component of mixed reality is a combination of virtual and real spaces through hardware and software, telecommunications, computer networks, and actually shaping the digital economy.

Within the theme of the article, we consider an innovation-digital cluster as a voluntary informal, institutionalized association of economic entities in terms of not only their territorial proximity, but also their virtual-real "proximity," sectoral similarity and cultural-mental unity in order to obtaining a synergetic effect due to complementarity of processes, resources and interconnectedness of financial, information, knowledge, digital, material flows.

Thus, an innovation-digital cluster is a highly developed virtual-real institutional infrastructure that forms a certain system of dissemination of new knowledge and technologies, accelerates the transformation of inventions into innovations and innovations into competitive advantages, and the development of high-quality stable network connections between all participants. The emergence of such clusters is a natural process in the presence of common digital platforms, scientific and production base. A cluster includes institutions–organizations and institutions that both cooperate and compete with each other. It is a knowledge institution that produces innovations and digital products/services. The main characteristics of innovation-digital clusters are (Zaremskyi, 2010):

- territorial concentration (close location of institutions and organizations creates conditions for rapid economic cooperation, capital exchange);
- the plurality of economic agents (clusters and their activities cover not only the firms in the cluster, but also public organizations, academies, financial intermediaries, institutions that promote cooperation) (Tishchenko, 2010, p. 78–79);

- formation of a network of informal and formal relations between economic agents (clusters are a complex system, the elements of which are combined by direct and inverse network connections: material, information and financial flows);
- long-term perspective of the cluster life cycle on the basis of the triads "business – university – government" and "venture enterprise – supplier – consumer of digital product/service";
- involvement in the innovation process (venture firms and digital enterprises that are part of the cluster, included in the processes of market/marketing, product, technological, and organizational innovation);
- common institutional, socio-economic, virtual-real environment, characterized by a high level of trust, norms of cooperation, regional traditions and values in communication, innovative culture;
- availability of research work in combination with the dynamic process of digitized learning;
- high quality specialization;
- creation of a special form of innovation – "aggregate innovation and digital products" based on clustering.

Thus, in today's virtual reality, a cluster is a different form of organization of economic relations based on the principles of digitalization. It is characterized by an internal in-depth flow of innovative ideas, digital knowledge and information. During the formation of the network economy in Ukraine, a cluster was used to solve a wide range of tasks, in particular to strengthen the competitiveness of the state, region, industry and the development of regional digital development programs; as a basis for stimulating innovation and digital activities and interaction of large and small businesses; as an important mechanism for the implementation of national industrial policy in the direction of the formation of Industry 4.0 (Dombrovskyi, 2011, p. 241; Kraus, 2018, p. 132).

Conditions for the formation of an innovation-digital cluster from an institutional point of view are presented in Table 2. We agree with the views of Ukrainian researcher Oksana Hryvkivska, who argues that the creation and operation of innovation-digital cluster requires a number of components (Grivkivska, 2011, p. 31):

- innovation, because only new, original, non-standard ideas and know-how can interest the investor;
- information on the potential of a region, its priorities, investment attractiveness and prospects for development through virtual-real interaction;

- interest, since only the economic benefit from the invested capital is key to the implementation of real investment projects;
- integration – unification through network interaction of government, business and universities.

Table 2. Conditions for the formation of innovation-digital cluster from an institutional point of view

Institute level	Institute type	Characteristics of the environment of formation of innovative clusters
The purpose of the Institute	Collective ideas about the technological level of nation and quality of its resources	Agents believe they themselves, the products they create and the organizations they create can be "best in the world"
	State of empathy in society: stereotypes and installations of agents relative to each other	High levels of empathy that stimulate cooperative behavior
National Formalized Institutes	Legislation on the protection of property rights	Developed law and enforcement practice, judicial protection
National informalized institutes	Distribution of power and property, level of corruption	Corruption at the permissible level within the framework of historical features and evolution of market relations
Local formalized institutions	Specially stimulating legislation and regional state order	Risk of stimulus deformation (may exist in early stages)
Local informalized institutions	Level of trust and exchange of special knowledge	The level of trust is sufficient for the mutual exchange of special knowledge that stimulates innovation
Local institutions	The role of local reputation	Loss of reputation is equivalent to the loss of business (or profession)

Source: Gareev (2012, p. 25).

The "triple spiral" is more critical for the formation of a mature innovation-digital cluster in the conditions of virtual reality, more precisely – "the collaboration of three types of participants in the innovation game, representing science, business and the state… members of the cluster can use complementary assets and competencies in a variety of combinations, which allows you to expand the benefits created, i.e. increase productivity in its modern sense, typical of the post-industrial economy… Collaboration takes the innovative production culture of the cluster beyond it (through outsourcing, creation of new firms, spillover effects), which leads to the emergence of new network nodes, increasing the competitive strength of the cluster and forming a network environment of virtual reality (Katukov, 2012, p. 26).

The experience of cluster initiatives in post-industrial countries shows the diversity of mechanisms for the formation and stimulation of innovative cluster formations. Thus, if in the United States the "triple helix" was formed on the basis of a "double helix," namely, "university – business," in European countries with traditional participation of the state. This means a "double spiral" of the "state – business" type. For this reason, in order to implement the vector of modernization of Ukraine's economy on the basis of clustering, there is a need to develop a model of the institutional environment of innovation and digital clusters, which could be applied within the framework of economic practice and current economic downturn in the country, which is also complemented by the challenges of virtual reality. Cluster methodology is based on the consideration of forms of economic relations and directions of creation of "modern innovative and digital products" as a whole set of elements that are in constant interconnection. Accordingly, the foreign scientist Mykhailo Dombrovsky speaks of the cluster as a complex economic system with its own special network connections (Dombrovskyi, 2011, p. 242).

A cluster, as a dynamic system, consists of specific elements, which have the following main characteristics (Togunov, 2009, p. 4):

- form, expressed in the form of specific structure;
- content hidden in the relationship of cluster elements;
- spatio-temporal location, which characterizes the relationship of external and internal institutional environment;
- probable state, which determines the choice of the path of development of a cluster system from all those possible.

The institutional elements and characteristics of a cluster structure are interdependent and interrelated. In our opinion, the highest degree of stability of the internal environment of a cluster is provided by the construction of the cluster, in which the institutional elements that make up and fill it are interdependent.

Such a cluster design is an absolute structure of chiral symmetry (approximate symmetry of strong interaction with respect to transformations and changes). The functional dynamics of the cluster are related to the violation of the symmetry. Such a violation is inherent in the very essence of chirality (a property that consists in difference between right and left), as well as the contradictions of respective pairs of institutional elements that "fill" a cluster structure. The contradiction of two specific institutional elements of a cluster system is resolved through the essence of a third element, which is in a certain pattern of relations with these institutional elements.

Cluster systems are highly deterministic institutions. The term "determinism" means that a cluster system defines the structure and content, information and energy of this system, the scale of time in it, and therefore its future as a closed or locally closed system is given in specific time and space, despite the possibility of insignificant errors in the real trajectories of the system. That is, the real existence, evolution, and vital activity of a cluster system are impossible without a specific correspondence with the evolution, development, transformation (in the broad sense of the term – movement and change) of the external environment (Togunov, 2009, p. 15) in new conditions of virtual reality of the XXI century.

Currently, the vast majority of Ukrainian clusters, which according to various estimates reach 50, are in the process of formation. The most popular for their creation are the tourism industry, food and engineering industries, while science-intensive – electronics, alternative energy, nanotechnology and pharmaceuticals – are represented (Figures 1 and 2). The leader of clustering in the field of high technologies and existing organizations that perform scientific and technical work is the Kharkiv region and the city of Kyiv (Table 3) (Bila, 2011, p. 25).

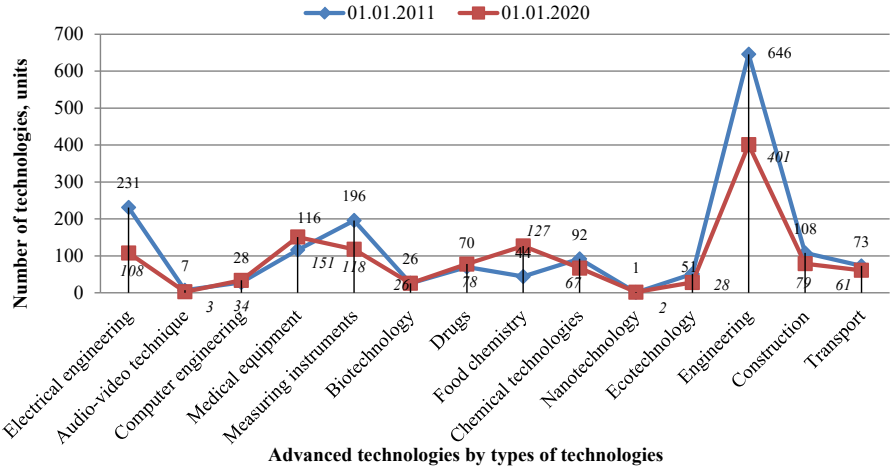

Figure 1. The number of advanced technologies created by Ukrainian clusters in the main technical areas in different sectors of the economy

Source: Built by authors based on source 69.

The pioneer of clustering in Ukraine is the Khmelnytsk region, where construction and sewing clusters have been operating for over 10 years, and in 2002 the first tourist cluster in Ukraine "Oberig" was launched, designed

as a public organization. It included more than 50 representatives of agriculture, farmers, fishermen and craftsmen. In the Zaporozhia region the machine-building cluster of LLC "AgroBUM" successfully operates. It unites 20 companies and develops cooperation on the principles of subcontracting. In the Ivano-Frankivsk region there is a well-known Tysmenytsia fur cluster on the basis of OJSC "Tysmenytsia Fur Company." In the Rivne region, there is a woodworking cluster named "Polissya Rokytnivshchyna," which was created in 2003 (Bila, 2011, p. 26).

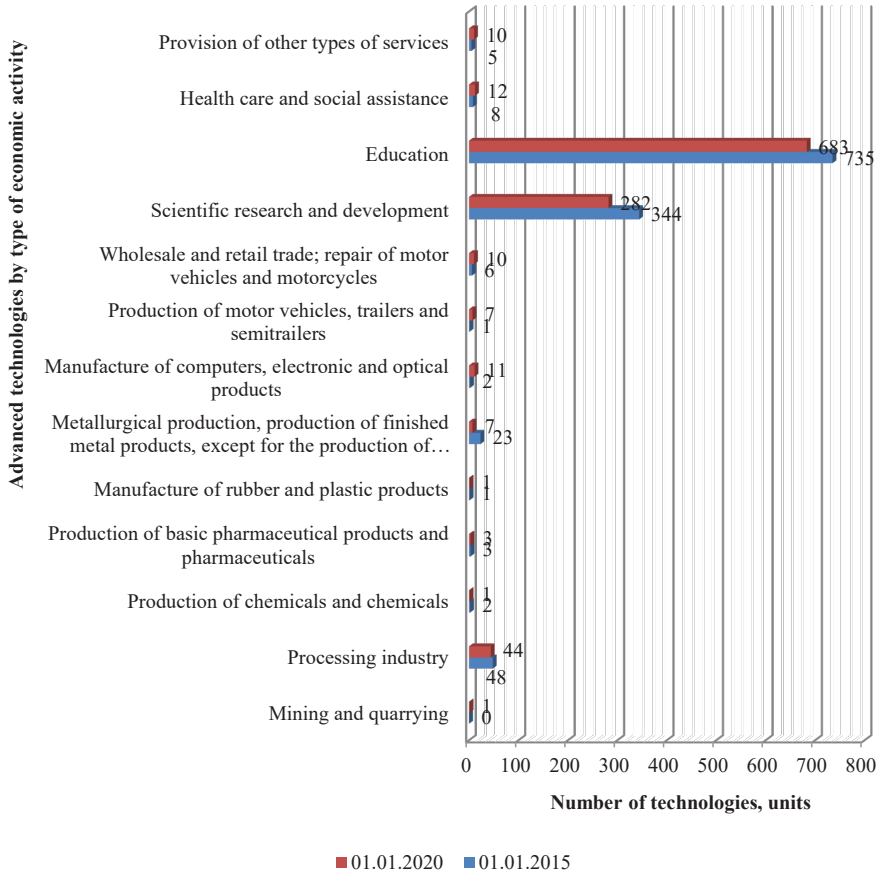

Figure 2. The number of advanced technologies created by Ukrainian clusters by type of economic activity

Source: Built by authors based on source 69.

A promising direction for Ukraine is the creation of cross-border clusters. Given that 19 of the 25 oblasts are border regions, Ukraine has every opportunity to cooperate with foreign companies within cross-border

clusters. An example of such cooperation is the Ukrainian-Romanian "First Agrarian Cluster," established in 2009 in the Chernivtsi region. Within the framework of the Cross-Border Cooperation Program Poland–Belarus–Ukraine for 2007–2013, a Ukrainian–Polish tourist and recreational cluster was formed (Bila, 2011, p. 27).

Table 3. The share of the number of innovation-active enterprises involved in innovation cooperation, by type of partners by region

(% to the total number of innovation-active enterprises of the respective region)

	Total		Including									
			Within the enterprise		Suppliers of equipment, materials, components, software		Clients		Higher education institutions, education		Scientific institutions	
	01.01.2017	01.01.2019	01.01.2017	01.01.2019	01.01.2017	01.01.2019	01.01.2017	01.01.2019	01.01.2017	01.01.2019	01.01.2017	01.01.2019
Ukraine	34.4	58.3	14.3	31.1	26.1	52.0	13.7	16.4	5.9	5.8	8.4	9.6
Vinnytsia region	51.9	75.8	29.1	56.1	25.3	54.5	11.4	9.1	5.1	4.5	5.1	21.2
Volyn region	33.3	80.4	9.5	10.7	30.2	78.6	3.2	5.4	-	1.8	1.6	1.8
Dnipropetrovsk region	28.5	58.1	12.2	25.9	19.9	54.1	11.9	25.2	6.5	5.2	9.2	10.4
Donetsk region	46.9	76.1	18.4	64.2	32.7	59.7	20.4	23.9	12.2	13.4	18.4	26.9
Zhytomyr region	24.7	62.5	4.5	31.3	20.2	60.0	10.1	11.3	5.6	3.8	9.0	10.0
Zakarpattia region	46.5	75.4	23.3	21.1	37.2	70.2	25.6	8.8	-	-	2.3	1.8
Zaporizhia region	25.4	28.8	10.9	17.6	18.1	23.2	10.1	15.2	7.2	10.4	10.9	12.0
Ivano-Frankivsk region	28.8	25.0	11.0	8.3	19.2	22.2	12.3	6.9	1.4	-	8.2	2.8
Kyiv region	47.0	63.0	19.7	37.0	42.4	59.1	26.5	15.6	12.1	6.5	12.9	11.0
Kirovohrad region	22.9	86.2	12.9	60.9	18.6	81.6	5.7	13.8	1.4	2.3	2.9	5.7
Lugansk region	53.8	92.3	26.9	34.6	46.2	76.9	15.4	15.4	11.5	-	19.2	15.4
Lviv region	30.4	56.1	10.6	43.9	27.5	53.5	13.5	13.9	7.2	5.3	7.7	7.5
Mykolaiv region	26.8	71.9	12.7	43.9	18.3	71.9	9.9	14.0	5.6	5.3	8.5	8.8
Odessa region	32.5	66.1	18.8	38.3	24.4	60.0	13.1	8.7	6.3	10.4	10.0	12.2
Poltava region	20.9	53.2	1.8	12.8	16.4	39.4	6.4	20.2	4.5	6.4	6.4	8.5
Rivne region	47.3	72.2	20.0	44.4	43.6	44.4	14.5	33.3	0.9	-	1.8	5.6
Sumy region	33.3	58.9	13.0	46.6	27.5	38.4	20.3	23.3	7.2	6.8	10.1	19.2
Ternopil region	30.9	66.7	13.2	28.7	25.0	56.3	14.7	14.9	2.9	1.1	2.9	1.1
Kharkiv region	31.7	55.8	12.3	16.2	24.6	49.7	16.0	14.1	6.0	5.5	7.3	5.5
Kherson region	38.0	50.0	12.0	35.0	32.0	47.5	14.0	7.5	-	7.5	10.0	12.5
Khmelnitskyi region	29.5	60.7	4.5	25.0	27.3	41.1	11.4	3.6	4.5	-	4.5	-
Cherkasy region	17.6	18.6	7.4	12.9	11.8	15.7	2.9	1.4	1.5	1.4	2.9	4.3
Chernivtsi region	42.9	26.7	14.3	13.3	33.3	20.0	14.3	13.3	-	-	14.3	13.3
Chernihiv region	34.0	54.1	18.0	32.4	20.0	51.4	10.0	13.5	4.0	8.1	6.0	5.4

Source: Kuznetsov (2019, p. 105).

Most of the hubs and coworking centers operating in Ukraine are private. Today there are about 200 coworking spaces in Ukraine, some of which have become meeting places for startups. A successful example is the Kyiv coworking center "Magazine", where business trainings, master classes, educational lectures, conferences, and competitions in the field of innovation are held. In 2012, the Cabinet of Ministers approved a resolution on the national project "Technopolis," which provides for the construction of innovation parks in Kyiv, Kharkiv, Lviv, and Dnipro and the creation of 70–75 thousand jobs for specialists in IT, biotechnology, energy conservation, nanotechnology. The Ukrainian Silicon Valley was supposed to be the Bionic Hill Innovation Park, near Kyiv. However, the project failed due to a lack of adequate government and financial support (Tarasova, 2007).

Today, the activity of the Association "Innovative Development of Ukraine" can be considered successful, as it promotes the implementation of promising Ukrainian innovation projects and is working on bills on industrial parks and providing benefits to their members. In 2015, the opening of the California in Ukraine innovation center in Kyiv was announced. In the premises provided for use by the Kyiv administration, master classes on the implementation of innovative projects, hackathons are held. A network of innovations and entrepreneurship support centers called iHUB is operating effectively in Ukraine. iHUB was initiated by the global network of national non-profit foundations Seed Forum in 2014. iHUB operates with the support of the Norwegian Ministry of Foreign Affairs and the Embassy of the Kingdom of Norway in Kyiv, with additional funding from the development institutes of Finland, Sweden and England. From the grant funds, iHUB pays the rent and work of research staff in Kyiv, Chernihiv, Lviv, Vinnytsia, Ivano-Frankivsk, where a number of structural centers operate within the framework of the public–private partnership iHUB. Already today, more than 50 experts from 20 countries work in structural centers in 40 areas of educational and innovative events. iHUB invests in reconstruction, equipment and project management, and assumes all operational and financial risks during the partnership term. According to experts, about 20 thousand people showed interest in this project and became its participants in order to gain knowledge to create startups (Vlasenko, 2015).

We believe that in order for innovation hubs to develop, government agencies should provide orders and innovation projects to hub participants on a competitive basis. Examples are the automation of urban processes and the introduction of electronic administrative services, both relevant in the light of government-initiated reforms. In addition, from 2016, the Seed Forum plans to launch e-government and E-parliament Electronic Services projects on the basis of iHUB. It is assumed that part of the resources of the

innovation center will be used for the development of electronic services of government agencies, funded by a grant from the Norwegian government.

The international innovation cluster "Competitiveness" functions effectively in Ukraine. It is a voluntary association of Ukrainian, foreign educational and scientific institutions and industrial formations of various forms of ownership on the principles of common interests in order to promote the effective scientific, educational, organizational, and entrepreneurial activities of its founders and participants.

The creation of this cluster is due, firstly, to the need to ensure the innovative breakthrough of individual industries; secondly, traditional science and education are unable to respond in a timely manner to existing acute problems – society is developing faster than knowledge; thirdly, the need for an innovative economy based on the active use of the results of science and best practices and knowledge, which are formed on the basis of continuing education.

The main activity of the cluster "Competitiveness" is to create the foundations for effective research and educational activities, so as to ensure the alternative development of priority industries and the implementation of projects such as "Formation of a business incubator and recruitment agency for targeted use of youth potential," "Improving educational level", and "Retraining and advanced training of specialists in market specialties (for market needs)" (International Innovation Cluster "Competitiveness," 2011).

Scientific and educational institutions and industrial formations are involved in the cluster, which actively use innovations in their activities and intend to continue such activities to intensify the process of combining science with production. The participants of the international innovation cluster are:

- Institute of Economics, Technology and Entrepreneurship;
- Ternopil Institute of Agricultural Production of NAASU;
- Khmelnytsk University of Economics;
- Podolsk State Agrarian Technical University;
- University of Economics and Entrepreneurship;
- Ternopil Institute of Social and Information Technologies;
- Bukovynna State Financial Academy;
- King Danylo Halytsky University of Law;
- Panstwowa Wyzsza Szkola Techniczno-Ekonomiczna im. ks. Markiewcza in Yaroslavl;
- Agricultural Advisory Service "Agronauka;"
- Small enterprises in the field of innovations.

Among the products created by the cluster "Competitiveness" are: remote production (research schools, training and retraining of scientific

and professional staff, conducting research and testing in their own research and production journals "Innovative Economy" and "Sustainable Economic Development" and information-consulting newspaper "Consultant", conducting scientific and practical Internet conferences, seminars, round tables to improve the educational and professional level of the population using competitions of scholars in various fields) and organization in the cluster system of an innovation bank, implementation of innovation transfer and diffusion innovative business projects.

The scientific school of the cluster is working on the development of international competitive projects under the cross-border cooperation program: "Poland–Belarus–Ukraine" and "Romania–Ukraine–Moldova." The defined conditions of the cross-border cooperation program "Poland–Belarus–Ukraine" stipulate that the minimum amount of the tender project is € 100 thousand, the maximum – € 3 million.

Already today, the international innovation cluster "Competitiveness" initiates the implementation of educational, scientific and technological innovation and investment projects in the regions of Ukraine. The implementation of these projects is based on the cooperation of scientific, educational, industrial institutions and local governments in the following areas:

- formation of competence and employment of the population (innovative-educational project, the activity of which is based on the business personnel incubator "Universal" and the personnel recruitment agency);
- improving the management and technological structure of production to intensify innovative business activities;
- creation of an innovative technopark "Agroecological", the purpose of which is: reproduction and rational use on an ecological basis of the productive potential of rural areas as the main means of solving the food and energy problem of the country and increase its global competitiveness (International Innovation Cluster "Competitiveness", 2011).

Based on the above theoretical and methodological analysis and our own observations, Figure 3 visualizes a slice of network interaction of cluster formations in the conditions of virtual reality. "The innovative and digital nature of modern clusters is determined not by the actualization of their specialization, but by their unique institutional design. Based on a spiral model, they form a striking contrast (difference) with structural formations of other types of territorial-industrial agglomerations" (Katukov, 2012, p. 27).

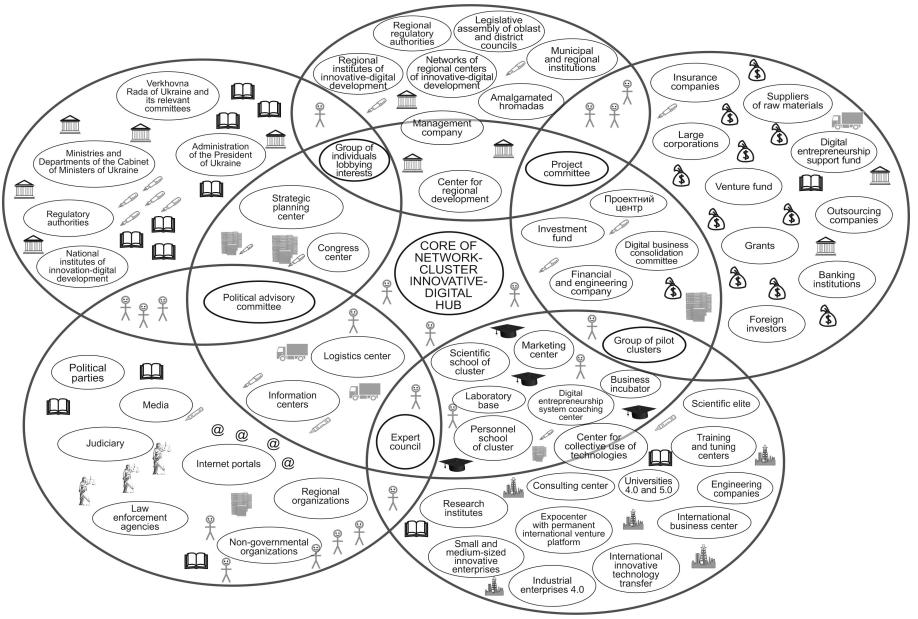

Figure 3. Visualization of network interaction of cluster formations in the conditions of virtual reality

Source: Compiled by authors on the basis of sources Togunov (2009); Napolskikh (2012, p. 42); Kraus (2014); Kraus (2019); Britchenko (2019, p. 452) and own developments.

It should be noted that in addition to solving their specific problems, each subject of the institutional environment of the innovation-digital cluster (Figure 3) performs universal functions that are inherent in all institutions of cluster formations. Among these functions are: regulatory; integrative; broadcasting; communicative (this feature has its own feature – informal communication); consolidation and reproduction of social relations (Napolskikh, 2012, p. 43).

Superimposed on other circles and forming a so-called "spiral," the center circle in Figure 3 illustrates the effects of synergy on the joint interactive network interactions. These actions are aimed at achieving in the innovation-digital cluster "the effect of digital development and innovative growth, which are based on the dynamism of constant renewal and continuous growth of digital production" (Katukov, 2012, p. 26). At the intersection of the inner circle of the innovation-digital cluster (which demonstrates its internal environment) with five other circles (circles that conditionally demonstrate the external institutional environment), there are informal and formal institutions-institutions of cluster (Napolskikh, 2012, p. 42) with their virtually real relationships.

The interaction of the principles of the "triple spiral" is built at the level of each new cluster, and it then spreads like a matrix, on the scale of the economy as a whole. "There is network repeatability: each cluster generates similar structures, with a similar synergistic effect of innovation, which makes economic growth innovation oriented" (Katukov, 2012, p. 27).

We agree with Dmytro Napolskykh that "the institutional environment of innovation and digital clusters, including the system of social institutions, organizations and their relationships, is a key part of the institutional environment of the territory that is developing most dynamically" (Napolskikh, 2012, p. 42). The scholar emphasizes that the institutional environment of territories necessarily consists of formal and informal institutions. He refers to the formal as only hierarchically built regulatory frameworks, public authorities and local governments, budget, commercial and public organizations. Dmytro Napolskykh defines informal institutions as "forms of social interactions that have developed on the territory as a result of a long process of social evolution" (Napolskikh, 2012, p. 42). Among such forms, he names religious, moral and ethical, economic.

It is worth noting that fully fledged clusters, which are designed for innovation-digital types of growth, received an impetus for development only in the post-industrial era. Their competitive advantages are associated not only and not so much with territorial proximity of participants, but with their functional interdependence and complementarity (Katukov, 2012, p. 28).

- Cluster systems are characterized by the following features (Dombrovskyi, 2011, p. 242):
- the existence of a corporate management system, control over a business process, collective economic monitoring;
- the presence of a leading enterprise that determines long-term economic, innovative and digital strategy of a regional economic system;
- territorial localization of the bulk of business entities–members of a cluster system;
- stability of strategic economic ties within a cluster system, including its regional, interregional, domestic and international relations;
- creation by members of a cluster of a non-profit association, voluntary membership, the presence of a coordinating organization;
- long-term coordination of interaction of participants of a cluster system within its national and intraregional programs of digital development, investment projects, network processes Cluster systems can bring together large, small and medium-sized enterprises. Basis on the success of such associations is the synergetic effect of geographical proximity to each other and to consumers. They can be formed by

industry profile, i.e. sectoral. Economic agents of cluster systems have every chance to become (Orev, 2011, p. 320):

- research institutes and educational organizations;
- organization of innovation infrastructure and infrastructure to support small and medium enterprises (business incubators, special economic zones, technology parks, venture funds, knowledge transfer centers);
- firms specializing in specialized, usually competitive, digital activities;
- firms–suppliers of raw materials, goods or services for profile enterprises;
- non-profit and public organizations, associations of entrepreneurs, chambers of commerce and industry;
- enterprises that provide access to information, engineering, transport, energy and other infrastructures.

A synergetic approach used in the formation and development of innovation-digital clusters is considered through the prism of the relationship "subject – the subjective relationship of innovation-active organizations and digital enterprises" (Andriichuk, 2010, p. 44). In addition, in our case, this effect lies in the plane of restructuring "old" development institutions in "new" under the influence of the relevant institutional and legal basis, systemic and comprehensive modernization and diversification of all sectors of production, improvement of the innovation and investment situation, construction of an effective innovation and digital virtual-real infrastructure of the European standard, implementation of clustering of the economy using the opportunities of network cooperation.

It is the theory of finite sets, studying the rules: how, knowing the number of elements of some sets, gives the answer – how to calculate the number of elements of other sets that are composed of the first sets with some operations. The basic space of a self-organized socio-economic system on the way to building an innovation system can be qualified as a kind of network set. This network set is based on:

- formation by institutes–organizations of the innovative development of network structures based on relations of trust and systems of interaction, first of all, horizontal;
- complicating the functioning of a modern socio-economic system in the context of globalization and the formation of a digital economy.

Returning to the analysis of Figure 1, it should be noted that we made an attempt to conditionally represent network economic space, which implies the presence of many "new" institutions of innovation and digital development, which determine new rules for the formation of network

interaction. From the standpoint of set theory, the peculiarity of innovation-network structures is that they allow you to create a variety of mechanisms of interaction. Under these mechanisms, institutions–organizations of innovation and digital development, which are part of the network structure, retain the status of legal entities. It should be noted that in innovation-network structures, there is not just cooperation of different institutions-institutions and institutions-organizations, but their coherent interaction when they function as a whole, increasing their economic and institutional capabilities and forming a synergetic effect or synergism. Synergism is the result of a complex interaction of measures that provide additional efficiency of digital enterprise more than the simple arithmetic sum of the effects of individual measures/methods. This concept is also called the synergetic effect "2 + 2 = 5" (Redina, 2009, p. 155).

As a result of such an interaction, a "new" institutional structure in the innovation sphere is constantly emerging, which provides for the presence of digital enterprises that carry out their risky activities both within existing development institutions and within the framework of "new" institutes of innovation and digital development created by them in the conditions of virtual reality. These institutes will make the internal organization of an innovation and network structure (cluster structure, technical and technological zone, technopolis, technopark, innotech).

During digital economic development, in the conditions of institutional uncertainty, the enterprises of the sphere of innovation can make collective decisions concerning new rules of network interaction and produce their own institutions. These institutions are "born" and founded to:

- structuring of new directions of collective interactions;
- creating opportunities to find new rules and norms of these interactions;
- developing effective compromise solutions, the adoption of which leads to the benefit of all participants in the innovation-digital process.

Based on this, we can safely say that having made its choice in favor of a European vector of development, the national economy of Ukraine has become transitional, as it joins the conditions of forming contours of a global network-digital economic system. That is, it is characterized by transitional institutional states. This opinion is shared by Ukrainian scientist Dmytro Lukianenko (Lukianenko, 2008).

The high degree of interaction between universities and business and the state, shown in Figure 1, is based on new organizational principles – network structures that unite once isolated innovation centers in universities,

industrial firms, and government agencies. These networks can consolidate the intellectual, material and financial resources of several universities, public research centers, and innovation structures of private firms located in the same region or in different regions of the country. Moreover, on a virtual-real basis, they can unite research, educational and commercial organizations in different countries (Ivanov, 2013, p. 18). Qualitatively, a new nature of organizational forms of interaction of innovation-digital structures creates an incubation effect – universities and research organizations of the state and business are transformed into incubators of new innovation firms, digital enterprises and research organizations. Prerequisites for this are (Ivanov, 2013, p. 18):

- selection of the most promising ideas in the field of technology;
- sufficient funding in the form of grants and interest-free loans;
- outsourcing;
- training of staff of future companies during practical work;
- inclusion of firms with professionally trained staff in a common network with potential partners and investors.

The basis of the architecture of the network economy is formed by innovation-digital organizations and industry clusters – groups of closely related enterprises on the production principle, localized territorially, and jointly promoting innovative products and digital services to the innovation market. Factors such as mutual trust, partnership, use of a common information field, joint scientific and technical centers, marketing structures and sources of funding, support of local chambers of commerce and regional administration are of key importance. Ensuring such a high level of cooperation is impossible without clear legal norms governing the behavior of all subjects of the joint innovation and digital network and their relations with external business structures and authorities (Ratner, 2011, p. 20).

The activity of innovation-digital structures operating in the conditions of virtual reality is based on four principles (Androschuk, 2010, p. 323–324):

- maximum convergence of science, production, commerce;
- creation of the most favorable conditions for the development of science-intensive production, innovative business, digital entrepreneurship;
- associations of firms that develop and provide commercial sales of various types of science-intensive products and promote accelerated processes of exchange of scientific and technical information;
- formation of scientific conditions for the incubation period of formation of small innovative firms, carrying out the first, most scientific stage of scientific and technical developments.

Global experience has already shown that the conditions for successful partnership in the internal environment of the cluster in virtual reality based on network interaction are openness, transparency and the high professionalism of partners. With reference to the professionalism of partners, it should be noted that in the implementation of socio-economic programs and investment projects, their performers are dealing with living people, nature or the law. Unprofessionalism and low ethical standards can harm target groups to which the beneficial effects of programs or projects are directed. The issue of implementing ethical norms and professional standards within the partnership should be taken into account by all partners. Effective partnership is impossible without a special intellectual and cultural environment (in innovative business and digital entrepreneurship it is called corporate culture), that is, a collective system of business principles, norms of behavior, traditions, symbols, rituals and beliefs, which would be understood by most economic agents (Khomenko, 2007, p. 167–168).

- Cluster systems based on network cooperation are formed on the basis of three principles, depending on the structure, size, and type of activity (Dombrovskyi, 2011, p. 242):
- concentration – location convenient for regular contacts;
- common interests of potential participants – the same, or interdependent areas of activity, common market or area of activity;
- interaction – relationships, interdependence with a large variety of formal and informal relationships.
- As a result, it should be noted that at a mesoeconomic level we already see how financial-industrial groups of enterprises, research and production networks, cluster structures, interregional complexes, technology parks, megacities, free economic zones, business incubators, and venture enterprises interact. If we consider the transformation of the economic complex of the region to combine all intermediate formations within one middle level and leave the regional economic complex on the basis of innovation-digital cluster formation as an independent, we obtain the following sequence: megaeconomics – macroeconomics – mesoeconomics – microeconomics – minieconomics – nanoeconomics (Kolodinskyi, 2008, p. 19). The meso-level, in contrast to others, is less stable and is under the influence of adaptive transformation and strategic changes within the regional innovation market.

One of the main elements of the infrastructure that determines the development of a portfolio of innovation and digital strategic alternatives of the economic cluster at the meso level is the institutional component. This is due to the fact that market infrastructure acts as an institutionalized

transaction (agreement that is accompanied by mutual actions and deeds) (Tolstykh, 2009, p. 85).

CONCLUSION

Summing up our study, it should be noted that the network economy in the XXI century, like no other economy (innovative, informational, knowledgeable, blue, green, circular, row, digital), highlights the organic relationship of technological (virtual-real networks) and institutional specifics of a constantly updated way of life (a networked social environment).

It is the network economy that demonstrates new forms of qualitative accumulation and augmentation of new knowledge that occur through their network replication (division), and innovative growth is the result of the formation in the economy and society of a new, network model of coordination, networking of new quality, which is constantly adjusted by digital tools. As authors of the article, we can also state that it is obvious that the transition to a network economy is not enough to create the latest production infrastructure (digital platforms, business incubators, innovation hubs, industrial parks, technology platforms, coworking centers, technology parks, venture funds, etc.). Why? Because in the absence of the necessary density of social cooperation, in the case of a shortage of democratic institutions and a low level of public confidence, such an infrastructure will work idle.

The managerial consequences of our research are the formation of a new quality of cluster solutions, designed to create appropriate conditions and ensure the essential changes needed for innovative-digital development institutions, to direct the potential of all stakeholders in the development of national and international innovation clusters in the conditions of virtual reality, to create potential for economic development of the whole country. An example of such an initiative is the cluster service, the main purpose of which is to create conditions that will ensure the self-organized formation of clusters by the mechanism “top-down” in the future, and the role will be revealed through the organic unification of separate interests of government, science and business representatives on a fair, equal, parity basis due to the presence of their own interest, which does not contradict, but complements the interests of all stakeholders, forming synergy effects. The prototype of the cluster service at the current stage can be considered a project of educational and scientific diplomacy initiated by the National Center “Small Academy of Sciences of Ukraine”.

The synergistic effect of networking creates a new phenomenon of growing marginal utility and growing marginal productivity from innovative

glocalization and digital globalization. The greater the scale of innovation and digital activities is in the conditions of virtual reality, the greater the efficiency is of the use of additional resources. The effect of scale is especially pronounced within the network, which uses the standards produced and tested by it. Network structure helps to increase the digital competence of the members of all, without exception, economic agents of clusters. Standards in the network economy are becoming a major factor in competitiveness at all levels of aggregation.

Thus, the formation of a new quality of networking and cooperation is a new approach to solving the problem of competition in virtual reality and in the digital market for goods/services. This trend is a consequence of rapid digital development and the spread of high-tech products and integrated solutions in the modern economy, the processes of accelerated improvement of digital technologies, and high levels of risk in new markets.

Despite the scale of existing scientific achievements, it is still important in the future to conduct research aimed at understanding the ideology of the digital economy, in order to form a new virtual reality. There is a need to develop high-quality institutions that would accelerate digital development in terms of augmented reality, as well as to focus on the work of tools in terms of effective legislative and institutional capacity for digitalization of national economies. Research is needed to find answers to the following questions: How is virtual reality different from digital, augmented, augmented, augmented, augmented, and mixed realities? How is it possible to work in a digital ecosystem with an innovation ecosystem? How can digital entrepreneurship, start-up, and the state "in the smartphone", influence the development of innovations and derive economic benefits from it?

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Abstrakt

CEL: *Ukazanie efektu synergii, będącego rezultatem sieciowych interakcji instytucji rozwoju w nowej wirtualnej rzeczywistości gospodarczej oraz przedstawienie ogólnej charakterystyki ich relacji w kontekście funkcjonowania klastrów ery cyfryzacji gospodarki, której rezultatem są produkty/usługi cyfrowe i różne platformy.* ***METODYKA:*** *W oparciu o metody dialektyczne, systemowe i macierzowe oraz z wykorzystaniem podejścia instytucjonalno-sieciowego badane są charakterystyczne cechy oddziaływań sieciowych formacji klastrowych w warunkach wirtualnej rzeczywistości, które stają się dziś normą. Metodę porównawczą stosuje się w zakresie warunków tworzenia klastra innowacyjno-cyfrowego z punktu widzenia teorii instytucjonalnej.* ***WYNIKI:*** *Współpraca sieciowa w warunkach wirtualnej rzeczywistości wykazuje efekty synergiczne poprzez nowe formy akumulacji jakościowej i wzrost nowej wiedzy, który następuje poprzez ich sieciową replikację (podział), a wzrost innowacyjny jest wynikiem kształtowania się w gospodarce i społeczeństwie nowego, sieciowego modelu koordynacji połączeń, nowej jakości współpracy sieciowej, na bieżąco dostosowywanej przez narzędzia cyfrowe. Synergiczny efekt tworzenia sieci tworzy nowe zjawisko rosnącej użyteczności krańcowej i rosnącej produktywności krańcowej wynikającej z innowacyjnej glokalizacji i cyfrowej globalizacji. Im większa skala innowacji i działań cyfrowych w warunkach wirtualnej rzeczywistości, tym większa efektywność wykorzystania dodatkowych zasobów. Efekt skali jest szczególnie widoczny w sieci, która korzysta z produkowanych i testowanych przez nią standardów.* ***IMPLIKACJE DLA TEORII I PRAKTYKI:*** *Udowodniono, że podejście synergiczne stosowane w tworzeniu i rozwoju klastrów innowacyjno-cyfrowych rozpatrywane jest przez pryzmat relacji „relacja podmiotowo – podmiotowa organizacji aktywnych innowacyjnie i przedsiębiorstw cyfrowych". Dodatkowo w naszym przypadku efekt ten leży na płaszczyźnie restrukturyzacji „starych" instytucji rozwoju w „nowe", pod wpływem odpowiednich podstaw instytucjonalno-prawnych, systemowej i kompleksowej modernizacji i dywersyfikacji wszystkich sektorów produkcji, poprawy sytuacji innowacyjnej i inwestycyjnej, budowy efektywnej, innowacyjnej i cyfrowej infrastruktury wirtualno-rzeczywistej na poziomie europejskim, wdrożenie klastrowania gospodarki z wykorzystaniem możliwości współpracy sieciowej.* ***ORYGINALNOŚĆ I WARTOŚĆ:*** *Ujawnia się interakcja formacji klastrowych w oferowanych przez autorów warunkach wirtualnej rzeczywistości; podana jest wizja autorów, jej elementów strukturalnych, jak z rozszerzonej sieci cyfrowej i wirtualnej rzeczywistości społeczno-gospodarczej; badana jest taksonomia i kategoryzacja terminologii, za pomocą której można ukazać kształtowanie się współpracy sieciowej w warunkach wirtualnej rzeczywistości i jej dalszy rozwój. Na podstawie przeprowadzonej głębokiej analizy teoretyczno-metodologicznej oraz prezentacji retrospektywy zmian innowacyjnych i cyfrowych, pokazano stopniową transformację formacji klastrowych. Podstawą gospodarki sieciowej są instytucje sieciowe, podmioty, organizacje, ponadto środowisko, w którym każdy*

biznes, podmiot lub osoba, która, bez względu na to, gdzie znajduje się w systemie gospodarczym, była w stanie łatwo i przy minimalnych kosztach komunikować się z jakąkolwiek inną firmą lub osobą na temat współpracy, kwestii handlowych lub know-how, lub po prostu dla zabawy w warunki nowej wirtualnej rzeczywistości.
Słowa kluczowe: *rzeczywistość wirtualna, gospodarka sieciowa, współpraca sieciowa, tworzenie klastrów, rzeczywistość rozszerzona, efekty synergii, cyfryzacja gospodarki, struktury sieciowe klastrów, jakość połączeń sieciowych*

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Conflicts of interest

The authors declare no conflict of interest.

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Complexity, continuity, and strategic management of buyer–supplier relationships from a network perspective

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Abstract

PURPOSE: *Current research seeks to create an economic model that connects strategic management and network theory. However, most theoretical models do not provide empirical evidence of network relationships' real structure and attributes. The purpose of the paper is to explore the relation between enterprise characteristics and the characteristics of buyer–supplier relationships in supply chain networks. We are specifically interested in business relationships in networks with respect to the various enterprises' sizes and sectors of industry. The subject of our research was characteristics, such as network relationship complexity, continuity of relationships, and strategic management in networks. The paper summarizes the results of an empirical study on buyer-supplier networks and accentuates the importance of developing and fostering business collaboration for strategic management.* ***METHODOLOGY:*** *We conducted the questionnaire research in 2016–2019 on 360 enterprises from the Czech Republic. We selected the research sample based on the non-probability purposive sampling method. The members of the research team collected data from an online survey and personal visits to enterprises. The statistical analysis of hypotheses is based on the frequency of managers' answers. To evaluate results, a two-proportion Z-Test is used for comparing different categories of enterprises according to their enterprise size or prevailing sector of the industry.* ***FINDINGS:*** *The main results show that the differences between enterprises involved in the buyer–supplier structures lie mainly in their size. The survey did not identify*

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differences between industry sectors. The findings show that the complexity of networks in the Czech Republic is not high in terms of the number of suppliers or involvement in many supply networks. The continuity of relationships with partners in buyer–supplier networks is relatively long-term oriented. Long-term partnerships reflect the higher quality of relationships and support future integration. However, large enterprises prefer to build contracts for shorter or longer periods. An overall decentralization strategy characterizes the strategic management of buyer–supplier networks. This finding means dividing competencies such as planning, managing, sourcing, decision-making, transporting (delivering) among more enterprises. ***IMPLICATIONS FOR THEORY AND PRACTICE:*** *The paper provides an insight into understanding how the buyer–supplier network functions. The theory's implication builds on the connection of supply chain management and strategic management from the network perspective. Supply chain management is viewed as a part of strategic management, and the synthesis of both research areas opens an innovative view to business theory.* ***ORIGINALITY AND VALUE:*** *The paper's principal value is the connection between contemporary ideas of strategic management and supply chain management. The synthesis of supply chain management and network approach enhances strategic management theory.*

Keywords: *network, buyer–supplier relationships, strategic management, complexity, continuity, supply chain management*

INTRODUCTION

Our world's reality characterizes uncertainty, complexity, continuity, change, the informality of relationships, and interaction between networks. Strategic management's primary role in the new era is to connect everything into a massive web of networks of different levels of relationships. Resources and activities are shared, markets expand, and risk costs are reduced. Networks bring together businesses into a vast web of interdependent relationships. The network society's main characteristic is the networked connection between the micro and macro environment (Castells, 2010). Networks come in many forms and include supply networks such as transport, logistics, communication, and energy networks and abstract economic, financial, and social, and knowledge networks. Networks have complex structures that are often hidden, as our current understanding of these systems is uncertain.

Business relationships between enterprises are a strategic issue and play a key role in business strategy (Tikkanen & Halinen, 2003). The previous strategic management research mostly views the development and implementation of a strategy as an internal management challenge to cope with internal and external forces. However, it focuses less on the relationship between the network members' strategy and the network level's strategy beyond the focal enterprise's influence or control. Besides,

traditional approaches do not explain how and why organizations engage in relationships and how they are managed and coordinated. It is necessary to develop and create new concepts related to applying the network approach to strategic management. However, network theory still misses appropriate theoretical and empirical support (Krzakiewicz & Cyfert, 2013).

According to Moller and Halinen (1999), the management of buyer–supplier relationships is not a new research area but becomes a "hot topic" from a network perspective. Industry 4.0 technologies in global networks move traditional relations between buyer–supplier to a supply chain network of connections in which data are aggregated in disseminated platforms (Szozda, 2017). Digitization, robotics, and artificial intelligence (Vrchota & Pech, 2019) form the basis for a new economic system based on cyberspace and market changes on the network (Rifkin, 2000). It means horizontal integration across the value creation network, in-depth end-to-end engineering across the entire product life cycle, and vertical integration of management and manufacturing information systems (Wang, Wan, Li, & Zhang, 2016). New technology enables multiple parallel connections of customers, suppliers, and business partners (Simangunsong, 2015). Managing multiple chains is incredibly more complex, and the optimization requires knowledge of supply network characteristics. In the last two decades, the supply chain strategy and its role in supply chain management have been studied (Hasani & Khosrojerdi, 2016). However, the coordination of links in the final product's supply chain networks remains a problem due to enterprises' different characteristics. From this perspective, supply chain strategy is a part of a network approach to strategic management.

Literature sources state that the global economy is based on networks. However, most publications that are usually using aggregated data or theoretic models, provide empirical evidence of the complexity, continuity, or strategic management of these relationships indirectly only. Thus, our study uses empirical research and it tries to answer these research questions: Differ enterprises in length of cooperation in buyer–supplier networks according to the enterprises size or are important their sector of industry characteristics? Are enterprise size and sector of industry characteristics important for participation and complexity of supply chain networks? Is the managing role and type of management of the supply chain network determined by enterprise size and sector of industry characteristics? The contemporary characteristics such as network complexity, continuity, and strategic management were analyzed. Having a more comprehensive insight into a supply chain's aspects would yield useful information about how the buyer–supplier network works. The objective of the paper is to analyze relations between characteristics of

enterprises and buyer–supplier networks from a strategic management and network perspective point of view.

LITERATURE REVIEW

The literature review conceptualizes the main constructs and examines a research model. Further, the research questions and hypotheses are determined.

The conceptualization of constructs and a research model

The market can be understood as a network where nodes are business units – production and service enterprises and the relationships between them are links (Håkansson & Ford, 2002). The network approach is based on the assumption that economic activities are influenced by the social context (relational and structural) in which they are embedded. Relational embeddedness refers to a shared understanding of strongly tied network members' behaviors. Structural embeddedness is related to the information role of the network's position (Gulati, 1998). Current knowledge indicates more types of embeddedness of networks such as knowledge (Sudolska & Lis, 2014), technology (González-López, 2012), financial, political, and cultural (Klincewicz, 2012). The interconnectedness of business relationships emerged due to the existence of an aggregated structure, a form of network organization (Håkansson & Snehota, 1995). Thus, networks are multiple organizations that interact directly or indirectly, based on alliance agreements. Networks can exist between enterprises, but they do not replace enterprises. They complement the activities that companies coordinate internally. The network diversity expresses the strength of individual connections, network size, modularity, membership mix, network management methods, or tendency to form clusters. The networks vary in density, the existence of structural holes, structural equivalence, and the difference between core versus peripheral firms (Gulati, Nohria, & Zaheer, 2000).

According to Tikkanen and Halinen (2003), the classic strategic management theories fail to explain enterprises interconnected within the network. Therefore, there is a need to study strategy and management from a new network perspective. The contemporary world of networks is difficult to describe, analyze, and explain using the traditional competitive strategy paradigm (Jarillo, 1988). Despite various strategic and network approaches, the network perspective in strategic management is still relatively fragmented (Koch & Windsperger, 2017). The industrial network and strategic network

theory are mostly considered as the base for this new approach. The industrial network theory highlights the relation of a strategy to the network environment regarding business relations (Tikkanen & Aino, 2003). Strategic network theorists emphasize the role of network relations as a resource (competence or knowledge) of competitive advantage. The network research models related to management are classified by Światowiec-Szczepańska and Kawa (2018) into three dimensions: homogenous and heterogeneous models, flow and architecture models, and models based on the emergent or intentional origin of networks. These models are mainly based on symbolic, graphical (social network analysis theory), or mathematical (graph theory) approaches to network theory.

In the literature, networks are in general conceived as alliances and relationships between enterprises. Barczak (2015) distinguishes networks into complex networks, networks within the organization, and networks between organizations. The networks consist of closer business cooperation with suppliers within the supply chain, customers, or other enterprises. Ketchen and Giunipero (2004) show that the main contributions of strategic management to supply chain management are a resource-based (knowledge-based) view, an agency and institutional theory, and an emphasis on enterprise performance. On the other side, supply chain management offers new analysis levels (Harland, 1996) and new organization types to management (Croom, Romano, & Giannakis, 2000). Some supply chains fulfill organizations' main characteristics – participants, social structure, goals, and technology. Enterprise-centric and network-centric paradigms have some mutual technological, organizational, and managerial aspects described by Akyuz & Gursoy (2020). It means that supply chain management is an enterprise function supporting the strategy and is a crucial part of the strategy (Hult, Ketchen, & Arrfelt, 2007). Supply chain management brings strategy implementation and a holistic approach from the network perspective (Venus, 2014).

The network perspective leads to several important questions for managers, as follows. The level of complexity, symmetry/asymmetry, continuity/discontinuity, and formality/ informality is considered as structural characteristics of business relationships in networks, particularly in customer–supplier relationships (Håkansson & Snehota, 1995). Our paper focuses on some of these characteristics, namely, complexity (relational perspective), continuity (long-term perspective), and further, we expanded the research topic to include management (strategic view). The symmetry/asymmetry characteristic is considered a part of the strategic view of network management. We analyzed these characteristics according to enterprise size (A) and sector of industry (B). The proposed model of research is presented in Figure 1. The research model divides the researched

area according to the level of business relationships (length of relationships, number of suppliers) and the level of network characteristics (roles, types of management, and engagement in networks). This division indicates the relationship of research areas to the network and the buyer–supplier relationship as intended by Håkansson & Snehota (1995). Based on this research model, we proposed research hypotheses H1A, H1B (continuity of relationships), H2A, H2B, H3A, H3B (complexity of relationships), H4A, H4B (role in supply chain networks), and H5A, H5B (strategic management type), which are described below. Hypotheses H1A, H2A, H3A, H4A, and H5A relate to enterprise size and hypotheses H1B, H2B, H3B, H4B, H5B focus on the sector characteristics of enterprises.

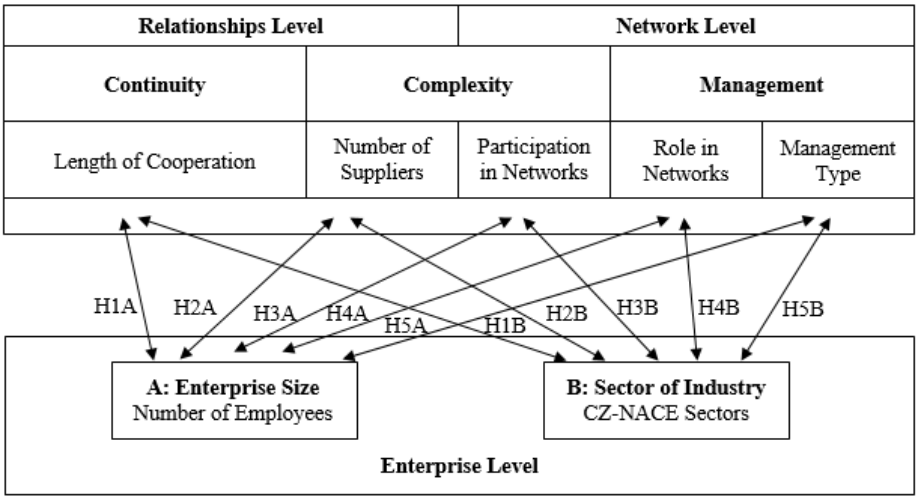

Figure 1. The model of the research

Source: Processed literature sources.

The characteristics of relationship continuity

The first research question focuses on the length of business cooperation in buyer–supplier networks and how long agreements and partnerships in networks last. This question relates to the quality of relations, as long-term collaboration is usually the result of a good partnership between enterprises.

Today, there are efforts to create fixed relations with long-time cooperation, based on partnership and mutual exchange of information, which accelerates material flow and creates value-added. The strategic management for cooperation in the network is focused on optimizing the entire value

chain. Relationships in networks are more complex and long lasting, and their current structure is the result of previous interactions between enterprises (Håkansson & Ford, 2002). Borgatti and Li (2009) describe the dimensions of relationships in duration, interaction, flow, association, frequency, or power. Long-term arrangements allow enterprises to gain or maintain a competitive advantage and they are considered strategic networks (Jarillo, 1988). Manufacturing enterprises usually choose their leading suppliers for a long period, during which formal or any other types of partnerships could arise. When selecting a new supplier, the enterprise always chooses from several candidates. As a rule, the price of materials, parts, and many other indicators such as quality, speed of delivery, reliability, and other criteria are evaluated (Pech & Vanecek, 2020). Therefore, enterprises develop relations with suppliers, and with the help of management, they seek to increase the benefits of such cooperation. Unfortunately, most enterprises resist the information exchange because of its possible misuse by competitors. Some of them even prefer informal long-term relationships based on repeated interaction under price-only contracts (Sun & Debo, 2014).

For this reason, these days, the real partnership comes into existence mostly in industrial production between the assembly plant and suppliers of components, who deliver and transport to the assembly plant the prevailing parts required for production and depend on the assembly plant as a focal enterprise. On the other side, it guarantees them long-time cooperation, passes them the necessary knowledge, and provides them with other advantages. We assume that enterprises in different industry sectors have arranged contracts with their partners for different time intervals. The length of these contracts also varies according to the size of the enterprises. Based on the prevailing opinion on the importance of long-term cooperation of companies in networks, we formulated the following hypotheses:

H1A: There is a relationship between the enterprises' size and the length of cooperation in buyer–supplier networks.

H1B: There is a relationship between the enterprises' sector of industry characteristics and the length of cooperation in buyer–supplier networks.

The characteristics of network complexity

The second research question comprises the essential buyer–supplier network characteristics related to the complexity of connections between enterprises. We asked managers how many relationships with suppliers and how many links to supply chain networks they maintained.

The concept of network complexity is not entirely new. Simon (1972) stated that buyer–supplier relationships formed a complex network consisting of many buyers and suppliers embedded in each other. According to Govindan, Fattahi, and Keyvanshokooh (2017), classic buyer–supplier and supply chain concepts provide a too simple view, so current authors favor the term supply chain network current market uncertainty. Christopher (2016) recommends replacing the term chain with the term web or network, because there are many suppliers and their suppliers, similarly as there are customers and their customers. This area's interest has led to a viable approach that the organization works with many – often hundreds – of different products, each of which has its supply chain. Supply chains are no longer a linear representation of independent entities. The term network, which includes many interconnected enterprises in a given transaction, is increasingly emphasized. According to Lambert and Cooper (2000, p. 1), "the supply chain is not a chain of businesses with one-to-one business-to-business relationships, but a network of multiple businesses and relationships." According to Bozarth, Warsing, Flynn, and Flynn (2009), supply chains are dynamic and complex systems with unstable and unpredictable behaviors (Roelich et al., 2015).

Many studies of network complexity in supply chains focus on innovation (Bellamy, Ghosh, & Hora, 2014), performance (Lu & Shang, 2017), environment (Adhikary, Sharma, Diatha, & Jayaram, 2020), disruptions (Bode & Wagner, 2015) and other topics. Networks are often analyzed by game theory, network and relationship structure models, models of network dynamics, strategic network models, monopoly, and oligopoly models. The complexity is often measured by entropy (Wen & Jiang, 2019) or similar complexity indicators (Modrak & Bednar, 2016).

Many studies explored different dimensions of complexity. The network's complexity is related to structural (i.e., the total number of elements) and relational (i.e., the total number of relationships) characteristics.

The total number of direct suppliers represents horizontal complexity (Bode & Wagner, 2015). The supply chain complexity of most organizations has grown incredibly. It is not uncommon for global brands to own tens of thousands or even hundreds of thousands of suppliers (Walmart, companies in the energy industry, etc.). The real-world situation is mostly unknown. Most enterprises only estimate the size of their supply base. Other dimensions include the number of the next (higher) tier suppliers or their geographical dispersion (Lu & Shang, 2017). Structural and operational complexity is distinguished by Cheng, Chen, and Chen (2014) to differentiate static and dynamic network variables.

A supply chain network is hierarchical and as proposed by Wei, Wang, and Chen (2015) could be represented in two ways: a supply chain system with multiple suppliers ("Λ" type) and a supply chain system with multiple retailers ("V" type). The type "Λ" is typical for the automotive industry. The structure is based on the forward chain used to purchase materials, assemble them in manufacturers' factories, and deliver the product to customers (Özceylan, Demirel, Çetinkaya, & Demirel, 2017). There are many suppliers participating in developing and producing a small number of products. To the contrary, in the agri-food industry a structure of type "V" means that a few suppliers (farms, farmers) supply harvested fruit, vegetables and other commodities for processing in food factories, which produce many different end products. Retailers in the food supply chain are selling thousands of different products, each of which has its own supply chain with a different structure (Zhong, Wang, & Xu, 2017). This brings higher complexity to the network structure.

Based on related works, we examined the first part of the complexity in buyer–supplier networks as the total number of (tier 1) enterprises' suppliers. We established two hypotheses about the complexity of buyer–supplier networks related to the number of suppliers for our research:

H2A: There is a relationship between the enterprises' size and the number of suppliers that enterprises have.

H2B: There is a relationship between the enterprises' sector of industry characteristics and the number of suppliers that enterprises have.

However, the network structure consists of nodes representing autonomous business units such as enterprises that collaborate in relationships. A bunch of relationships connects these enterprises to create products or services. The network's relational complexity means exchange relationships and the contract between enterprises (Hearnshaw & Wilson, 2013). The network building blocks vary according to the level of analysis at which the research is performed. Most authors referred to networks globally or as a result of mutual interaction between any of the two enterprises called "dyads" (Ashnai, Smirnova, Henneberg, & Naudé, 2019). Enterprises establish these dyadic arrangements of strategic alliances, joint ventures, supplier networks, or research consortia to cope with current environment changes (Tikkanen & Halinen, 2003). These relationships' substance is based on different layers: activity links, resource ties, and actor bonds (Håkansson & Snehota, 1995). Activity links include other technical, administrative, or commercial activities or flows between enterprises.

Resource ties mean a way how enterprises share and utilize their resources. Actor bonds are characterized as close (strategic) partnerships (or clusters) of enterprises' close collective relationships. The emerging network perspective of supplier relationship management and the relationship between distributors and customers is based on vertical and horizontal relationships. The interconnection types of network elements are, according to Borgatti and Li (2009), similarity (association), relations (joint ventures, alliance, agreement, shares), interactions (competitive or collaborative contracts), and flows (technology, cash, information, material). Although the view of business relations as dyads is prevalent, Håkansson and Ford (2002) pointed out that multiple network effects depend on the third party's relationship. The fundamental building block of a network is not the dyad but the triad (Choi & Kim, 2008), a fundamental network structure (Wasserman & Faust, 1995). Choi and Wu (2009) show how dyadic relationships are embedded in the triadic buyer–supplier–supplier relationship.

From the above, it is clear that networks have a very complex relational structure. The second part of the complexity in buyer–supplier networks can therefore be expressed directly via connections engagement in various supply chain networks. We suggest that these enterprise characteristics vary by industry characteristics and enterprise size. Given the above, we established two hypotheses about the complexity of buyer–supplier networks for our research:

H3A: There is a relationship between the enterprises' size and their participation in supply chain networks.

H3B: There is a relationship between the enterprises' sector of industry characteristics and their participation in supply chain networks.

The characteristics of strategic management of networks

The third research question relates to the strategic management of supply chain networks. We found out how an enterprise can control a network and the roles of enterprises in the network.

To make a complex network more manageable, it seems appropriate to distinguish between various enterprise management roles in the network. The network structure consists of organizers (key/focal enterprises), bridges (enterprises connecting isolated parts of the network), and other network members. They play different roles, powers, and competencies in networks (Gibbons, 2007). Lambert and Cooper (2000) stated that in a network there are two groups of enterprises: primary and supporting members. Another

distinction is the one between demand-related positions – relating to links to buyers – and supply-related positions – relating to links to suppliers. Wynstra (1994) emphasized the distinction between an enterprise's micro and macro position in relationships. A network's role depends on the interdependence between position dimensions, a firm's demand-related and supply-related positions, and the direct and indirect positions. The enterprise's role in the network is closely related to network strategies.

A supply chain, network leader has the power and competency to manage decisions in a centralized strategy. In supply chain networks, the assembly plant usually becomes a focal enterprise. The focal enterprises influence the supply chain network and information, material, and financial supply chain flows (Pražáková & Pech, 2019). Pibernik and Sucky (2006) differentiate the focal enterprise's power between monocentric or polycentric supply chains. Managed supply chain networks usually have their control tower, a key (focal, head) enterprise that monitors and manages relationships within networks according to plans (Christopher, 2016). These focal enterprises play a leading role, implementing strategies towards supply chain members (Jia, Gong, & Brown, 2018). In many vertical networks, the focal enterprise remains in the integrator role and coordinates the network as a hub (Achrol & Kotler, 1999). The focal enterprise systematically coordinates strategic, traditional business functions and tactics to improve the whole long-term performance (Mentzer, DeWitt, Keebler, Min, Nix, Smith, & Zacharia, 2001). Jarilo (1988) describes a focal enterprise's role in strategic networks as exclusive relationships with the other network members. According to Chen, Lin, and Yih (2007), a key player in a supply chain is the member who overlooks and leads others, creating an environment in which the partnership with suppliers can grow accordingly. Similarly, Handfield and Nichols (1999) emphasize focal enterprises' governance roles, especially in communication with customers and product or service design. The focal enterprises can control the movement of knowledge flows to distribute asymmetric knowledge sourcing and sharing in internal or external business networks (Scott-Kennel & Saittakari, 2020). Gulati, Nohria, and Zaheer (2000) proposed that structural holes in a customer–supplier network can be entrusted by power through control and, ultimately, profitability.

Because there are different ways of managing the network, we state that these network members' roles (key or dependent) will differ according to industry characteristics and enterprise size. In the questionnaire survey, we asked enterprise managers whether the enterprise is considered a focal or subsidiary member in the supply chain network. Based on these views, we formulated these hypotheses:

H4A: There is a relationship between the enterprises' size and their role in managing the supply chain network.

H4B: There is a relationship between the enterprises' sector of industry characteristics and their role in managing the supply chain network.

Heydari, Zaabi-Ahmadi, and Choi (2018) distinguish between centralized and decentralized strategies. The centralized management strategy is related to a focal enterprise role. The alternative decentralized strategy emphasizes a collaborative supply chain management (Danese, 2011). In response to the external environment, enterprises create effective supply chain networks where each member specializes in activities (parts, components, and services) with strong core competencies (Moller & Halinen, 1999). Enterprises in supply chain networks "cooperate in control, management, and improving the flow of materials and information from the supplier to the end consumer" (Christopher, 2016, p. 4). The essence of this cooperation is the sufficient resolution of conflicts between individual members of this network. Each unit tries to minimize its own cost locally, not the supply chain's total costs (Jung & Jeong, 2005). In this case, the network's core is a strategic network, a group of enterprises, or a strategic cluster in the supply chain. These enterprises usually create competence groups (Rudberg & Martin West, 2008). Decentralized strategies require a fully integrated supply chain. This strategy includes integration at the level of information sharing among partners (Shin, 2007). Fawcett (2002) stated that a fully integrated supply chain reality also exists. Still, it tends to be quite rare because only a few enterprises have closed the gaps among the various internal functions. From this fixed integration, today a switchover to virtual integration, enterprises perform their main competencies, and the other activities are relocated to sustainable outsourcing (De Felice, Petrillo, & Autorino, 2015). The virtual enterprise focuses on strategic planning knowledge and IT management to achieve agility (Clarke, 1998). A special type of managing a supply chain via outsourcing to service providers (external enterprises) is a concept called fourth-party logistics (Hingley, Lindgreen, Grant, & Kane, 2011).

All strategic choices at the network level need to be aligned with strategic interests, negotiation, and consensus building between partners. The structural logic of strategies is focused on their position (Burt, 2004), the configuration of alliances (Iurkov & Benito, 2018) or supply chains, or relations in the network (Parker & Cox, 2013). Czakon (2016) categorized them into structural, resource-based, and value-creation types. The resource-based view includes resources (Gulati, Nohria, & Zaheer, 2000) or competence-related networks. Value creation means cooperation and ecosystem strategies

focusing on the environment and sectors providing value to customers. The enterprises in alliances cooperate, but they can even compete in certain areas. This phenomenon is referred to as co-opetition, i.e., cooperation and competition at the same time (Nalebuff & Brandenburger, 1997). At present, it is no longer just the enterprises that compete, but the entire supply chain network (Gomes-Casseres, 1996).

Based on theory, we distinguish three types of management in supply chain networks: focal enterprise, multiple managing enterprise, and virtual organization management. We expect that these types of management will differ according to industry characteristics and enterprise size. Then, we formulated the last two hypotheses:

H5A: There is a relationship between the enterprises' size and their type of supply chain management.

H5B: There is a relationship between enterprises' sector of industry characteristics and their type of supply chain management.

METHODOLOGY

This paper explores relationship between enterprise characteristics and some characteristics of buyer–supplier networks from a strategic management and network perspective point of view. We are specifically interested in the aspects of primary networks' tendencies as they pertain according to different sectors of industry and enterprise size. The subject of our research was buyer–supplier relationships, which are part of the supply chain networks. Our objective is to answer research questions related to the importance of enterprise characteristics for network features such as complexity, continuity of relationships, and networks' strategic management.

The quantitative empirical research is based on the structured questionnaire survey administered by the research team from October 2016 till February 2018. We realized additional research in 2019 for a deeper analysis of supply chain, management types. We obtained primary data from a questionnaire survey of 360 enterprises engaged in supply chains. The research was conducted on enterprises doing business in the Czech Republic; however, 44% of them have ownership ties with other European countries. The research sample size was determined based on the number of 416,351 enterprises (population sample) in the Czech Republic (Czech Statistical Office, 2019) in the industry's observed sectors in 2018. We used the non-probability purposive sampling method for choosing enterprises. According to the sample size and population sample, the

estimated margin of error approximation at a 95% confidence level is about 5.17%. Therefore, the research data are representative concerning the entire population of enterprises.

The structured questionnaire contains questions related to some buyer–supplier network characteristics. The items in the questionnaire were pre-tested for validity by 15 managers using the Delphi method. The feedback helped to set the appropriate nominal scales in the questionnaire. The questions in the survey focus on four main areas: number of suppliers (categories 1-10, 11-50, 51-100, 101, and more), engagement in supply chain networks (categories: 1-5, 6-20, 21 and more), management of networks (key or dependent role in supply chain network), and duration of cooperation between enterprises (short-term collaboration, i.e., less than one year; long-term partnership, i.e., over one year; different contract periods). Additional questionnaire research in 2019 focused on the types of strategic management of networks (categories of supply chain management: one focal enterprise, multiple managing enterprises, special (virtual) organization). Respondents had the option of choosing one of the answers to the closed question. The frequency of respondents' responses to the given topics was thus determined.

The data collected from questionnaires consists of an online survey (questionnaire on webpages) or a personal visit to the enterprise (printed questionnaire), including telephone calls combined with an e-mail invitation to participate in the research. The research team involved representatives of academics and students of the University of South Bohemia in České Budějovice. The group of respondents consisted entirely of managers, mostly from the field of logistics and management. Trained members of the research team helped the managers and CEOs complete the questionnaire, and they also explained any items the respondents wished to clarify. In the online survey, a contact point and a link to a more detailed explanation of any ambiguities in the questionnaire, questions were available. The completed questionnaires were obtained with an overall response rate of 20% for online data collection and 85% for personal collecting of questionnaires. Of the 482 completed questionnaires, 11 were eliminated due to incomplete or missing responses. We excluded 111 questionnaires of enterprises without supply chain engagement. The data consist of a total of 360 answers from the questionnaire (Table 1).

We processed the data sample according to the size and sector of enterprises' industry characteristics (Table 1). The classification of enterprises by sector of industry (specialization) is based on the prevailing industry focus.

Table 1. Research sample

Group	Category of Enterprise	Characteristics of Research Sample		
		Main Research (2016-2018)	Additional Research (2019)	Total (n)
Sector of industry	Engineering and Electro-technical production	146	35	360
	Household supplies	61	5	
	Food production	54	8	
	Chemical, paper and non-metallic production	20	16	
	Agriculture	15	0	
Size	Small Enterprises	86	15	360
	Medium-sized Enterprises	109	20	
	Large Enterprises	101	29	

Source: Survey data.

This category defined groups based on the CZ-NACE classification (Czech Statistical Office, 2019) into Engineering and electro-technical production (groups 24-30), Production of products for domestic use (Groups 13-16, 31-32; household supply), Food production industry (Groups 10-12), Chemical paper and non-metallic production (groups 17-23), and Agriculture (groups 01-03). The classification of enterprise size is based on European Commission methodology (2003). We analyzed the groups of small enterprises (10-49 employees), medium-sized enterprises (50-249 employees), and large enterprises (over 250 employees). More than half of the enterprises related to the engineering (50.28%) industry in the data sample. About 18.33% of enterprises consist of enterprises of household goods production, and 17.22% of food production enterprises. The other fields (chemical, paper and non-metallic production, agriculture) cover about 14.17%. According to their size (number of employees), enterprises' distribution is roughly the same (around 28-36% for all categories).

The analysis is based on the data from questionnaires. The research is set out to test the five hypotheses (H1-H5) for each group of enterprises. The null hypothesis for the hypotheses is that there are no differences between groups of enterprises. It means that their proportion is not different in at least one case. The hypotheses were tested based on enterprise size and then by industry characteristics. To evaluate results, we carried out a statistical analysis using "individual tests of equal and given proportions without correlation to continuity," i.e., two-proportion Z-Test (Field, Miles, & Field, 2012). We compared the total number of enterprises and the

total number of observations according to the enterprise size or industry characteristics. The calculation is based on a weighted sum of squared deviations between the observed proportions in each group and the overall proportion. The test statistics are defined as follows:

$$z = \frac{p_A - p_B}{\sqrt{pq / n_A + pq / n_B}} \quad (1)$$

where,
p_A is the proportion observed in the group A with size n_A
p_B is the proportion observed in the group B with size n_B
p and q are the overall proportions

The analysis of the data was performed in the R 3.6 programming environment. The statistical significance level of differences was set at 0.05. Significant results (including the achieved level of significance – p-value) are presented in the text. In case of significant differences between proportions in the observed groups, a pairwise comparison test with the Holm method adjustment (Holm, 1979) is used.

RESULTS AND DISCUSSION

According to the working hypotheses, this analysis summarized three main areas: length of cooperation between enterprises, network complexity, and strategic management of networks. Based on the survey data, we investigated whether enterprises differ based on their size and sector of industry characteristics.

The characteristics of relationship continuity

Using the questionnaires data, we were able to investigate the duration of cooperation between enterprises. Long-term cooperation is essential for easier strategic planning and relationship management. In terms of industry classification, enterprises with short-term supplier relationships predominate. An interesting finding is that only in the food sector are contracts concluded for various periods. According to enterprise size, small enterprises mainly prefer short-term contracts. On the contrary, medium-sized and large enterprises enter into agreements for multiple periods (Table 2).

Table 2. Length of Cooperation between Enterprises in 2016-2018 (in %, n = 230)

Group	Category of Enterprise	Length of Cooperation between Enterprises		
		Short-term cooperation (< 1 year)	**Long-term cooperation (>1 year)**	**Different Contract Periods**
Sector of industry	Engineering and Electro-technical production	44.95	11.01	44.04
	Household supplies	43.48	13.04	43.48
	Food production	39.47	23.68	36.84
	Chemical, paper and non-metallic production	30.00	35.00	35.00
	Agriculture	58.82	11.76	29.41
Size	Small Enteprises	62.86	8.57	28.57
	Medium-sized Enterprises	41.86	13.95	44.19
	Large Enterprises	27.03	25.68	47.30

Source: Survey data processed.

The evaluation of hypotheses H1A and H1B is shown in Table 3. Hypothesis H1A states: "There is a relationship between the enterprises' size and the length of cooperation in buyer–supplier networks". The hypothesis H1A (by enterprise size) is accepted. It was found that enterprise size is predominant in the length of cooperation between enterprises for all categories (short-term p-value = 0.0000, long- term period p-value = 0.0161, different contract time p-value = 0.0488). Therefore, we state that an enterprise's size affects how long it has been working with other enterprises. The difference in duration of cooperation among enterprises of different sizes is significant. Hypothesis H1B states: "There is a relationship between the enterprises' sector of industry characteristics and the length of cooperation in buyer–supplier networks." The hypothesis H1B (by sector of industry) is rejected. There were no differences between sectors of industry in terms of the length of cooperation between enterprises. The industry sector is not the main factor that influences the duration of collaboration between enterprises.

Table 3. Length of Cooperation between Enterprises in 2016-2018 (n = 230)

Length of Cooperation	H1A: Size differences		H1B: The sector of industry differences	
	Z-score	p-value	Z-score	p-value
Short-term cooperation (less than 1 year)	18.9380	0.0000*	3.4520	0.4852
Long-term cooperation (over 1 year)	8.2592	0.0161*	9.3585	0.0527
Different contract periods	6.0398	0.0488*	3.2302	0.5201

Source: Survey data processed.

Overall, only the size of enterprises influenced the length of cooperation between enterprises. While small enterprises tend to use short-term contacts, large enterprises encourage long-term relationships. However, for large enterprises, our research has confirmed the use of contracts of different periods. This finding may indicate the selection and careful choice of partners for long-term relationships. The most successful manufacturers seem to have carefully linked their internal processes to external suppliers and customers in unique supply chains. In the new millennium, upstream and downstream integration with suppliers and customers has emerged as a vital manufacturing strategy element (Frohlich & Westbrook, 2001). This type of interconnection is only possible in the case of long-term cooperation between enterprises. A special kind of partnership between supplier–purchaser is described in the literature, connected with Japanese-style management as a vertical "keiretsu" (Yamada, 2019). A Japanese vertical partnership includes classic long-term contractual arrangements between enterprises and mutual assistance, willingness to make significant customized investments, intensive and regular sharing of information, and trust-building practices. From the strategic management perspective, enterprises should foster and develop their relationships with partners for a longer period.

The characteristics of network complexity

The first factor examined to determine the complexity of the network was the number of suppliers. It is interesting to note that the highest number of enterprises has 11-50 suppliers (Table 4), but it was more than one hundred in some cases. This quantity depends on the production's character, and it is not possible to recommend decreasing their number, not even in situations when two or more suppliers deliver the same items.

Table 4. Number of Suppliers for Enterprises in 2016-2018 (in %, n = 232)

Group	Category of Enterprise	Number of Suppliers for Enterprises			
		1-10	11-50	51-100	101 and more
Sector of industry	Engineering and Electro-technical production	18.35	44.04	11.93	25.69
	Household supplies	27.66	40.43	21.28	10.64
	Food production	25.64	48.72	12.82	12.82
	Chemical, paper and non-metallic production	10.00	55.00	10.00	25.00
	Agriculture	41.18	41.18	11.76	5.88
Size	Small Enteprises	45.71	47.14	4.29	2.86
	Medium-sized Enterprises	18.60	54.65	16.28	10.47
	Large Enterprises	5.26	31.58	19.74	43.42

Source: Survey data processed.

The most significant number of suppliers was found in large and medium-sized enterprises. A larger number of suppliers bring advantages in their possible competition, possibilities of differentiation, and distribution of risks. Potential problems occur later when the supplier does not fulfill his contracted duties. With increasing tension and supply chain interdependence, a failure in any link can lead to a production shutdown (Berger, Gerstenfeld, & Zeng, 2004). However, fewer suppliers mean easier control, management, and integration into the supply chain network. It may be essential for some companies to determine the optimal number of suppliers to eliminate the risk of failure. Unique models allow simulating decision-making processing to consider the optimal level and the number of suppliers according to the probability of avoiding risks (Ruiz-Torres & Mahmoodi, 2007).

The evaluation of hypothesis H2A and H2B continues in Table 5. The second part of the complexity hypotheses H2A states: "There is a relationship between the enterprises' size and the number of suppliers that enterprises' have." The hypothesis H2A (by enterprise size) is accepted. The working hypothesis was proved for the size classification in all the researched categories (1-10 p-value = 0.0000*, 11-50 p-value = 0.0117*, 51-100 p-value = 0.0181*, 101 and more p-value = 0.0000*). Thus, it can be stated that the size of an enterprise affects how many suppliers an enterprise has. The hypothesis H2B states: "There is a relationship between the enterprises' sector of industry characteristics and the number of suppliers that enterprises' have." The hypothesis H2B (by sector of industry) is rejected. There were no statistically significant differences in the number of suppliers among enterprises.

Table 5. Number of Suppliers for Enterprises 2016-2018 (n = 232)

Number of suppliers	H2A: Size differences		H2B: The sector of industry differences	
	Z-score	p-value	Z-score	p-value
1-10 suppliers	35.4260	0.0000*	7.2269	0.1244
11-50 suppliers	8.9010	0.0117*	1.5629	0.8154
51-100 suppliers	8.0263	0.0181*	2.8648	0.5807
101 and more suppliers	45.4380	0.0000*	8.6514	0.0704

Source: Survey data processed.

Secondly, we examined results concerning the number of supply chain networks in which enterprises are involved. An overall summary of the results is given in Table 6. Most enterprises are involved in multiple networks. In line with the findings, we report that the first two categories (1-5 and 6-20) prevail. The type with 1-5 supply chain, network engagement predominates for household goods enterprises. Enterprises in the food and engineering industry are mostly involved in 6-20 supply chain networks. Interestingly, agriculture enterprises are mainly engaged in fewer (category 1-5) supply chain networks.

We did the subsequent analysis to find out whether the size of the enterprises showed significant differences. Small and medium-sized enterprises are involved only in a small number of supply chain networks (1-5). Large enterprises are substantially involved in 21 or more networks. These results are in agreement with our expectations. This finding can be explained by the regional factors, where small businesses are targeting a smaller region, and large enterprises operate more internationally in multiple supply chain networks. We think that this discrepancy is because these large enterprises plan their activities efficiently in chains, especially in delivering a specific amount of materials and deadlines.

Table 6. Number of Supply Chains in which were Enterprises engaged in 2016-2018 (in %, n = 178)

Group	Category of Enterprise	Number of Supply Chain Networks		
		1-5	6-20	21 and more
Sector of industry	Engineering and Electro-technical production	33.33	40.86	25.81
	Household supplies	61.54	25.64	12.82
	Food production	33.33	43.33	23.33
	Agriculture	68.75	18.75	12.50
Size	Small Enteprises	60.34	34.48	5.17
	Medium-sized Enterprises	46.97	39.39	13.64
	Large Enterprises	18.52	33.33	48.15

Source: Survey data processed.

The results of the evaluation of hypothesis H3A and H3B are presented in Table 7. Hypothesis H3A states: "There is a relationship between the enterprises' size and their participation in supply chain networks." The hypothesis H3A (by enterprise size) is accepted. In terms of size, the differences among enterprises are statistically significant at the significance level of 5% for all categories (for 1-5 supply chain networks p-value = 0.0000, for 21 and more supply chain networks p-value = 0.00000) except category 6-20 supply chain networks. It is interesting to note that the size of the enterprise affects its involvement in supply chain networks. Hypothesis H3B states: "There is a relationship between the enterprises' sector of industry characteristics and their participation in supply chain networks." The hypothesis H3B (by sector of industry) is rejected. The only significant difference was confirmed in category 1-5 supply chain networks (p-value = 0.0023*). In other cases, the differences are not approved. Therefore, we conclude that the sector of the industry is not relevant to the involvement in supply chain networks.

Table 7. Number of Supply Chain Networks in which were Enterprises engaged in 2016-2018 (n = 178)

Number of supply chain networks engagements	H3A: Size differences		H3B: The sector of industry differences	
	Z-score	p-value	Z-score	p-value
Engagement in 1-5 supply chain networks	20.7780	0.0000*	14.5050	0.0023*
Engagement in 6-20 supply chain networks	0.5577	0.7578	5.5394	0.1363
Engagement in 21 and more supply chain networks	34.4750	0.0000*	3.6064	0.3072

Source: Survey data processed.

The network's overall complexity is shown in Figure 2, where the two factors' frequencies are expressed concerning each other. The coordinates of the points are based on a random representation of both factors' values in given intervals. Although it is not possible to express the relationship's dependence by an exact correlation coefficient, a certain tendency can be traced from Figure 2 (if we omit outliers).

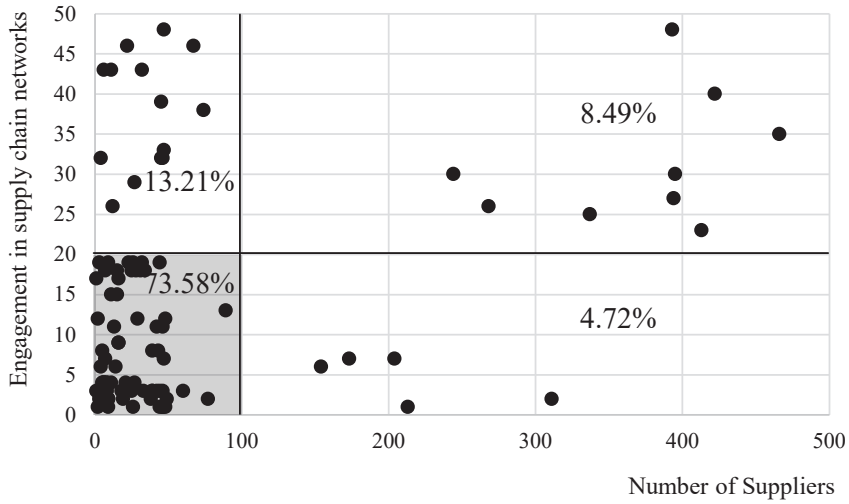

Figure 2. Number of Suppliers concerning Engagement in Supply Chain Networks (n = 230)

Source: Survey data, processed.

Enterprises with a larger number of suppliers and a higher involvement in supply networks are rare. Most enterprises have less than 100 suppliers and are involved in less than 20 supply chain networks (73.58%). This situation is described as a power-law distribution in scale-free networks (Guo, 2006). Thus, there may be so-called authorities with many suppliers or hubs that connect key links in the supply chain network.

To summarize the results of hypothesis H2 and H3, we found that the industry sector is not relevant to the involvement in supply chain networks and the number of suppliers. The more substantial variable that affects the number of engagements and suppliers is the size of the enterprise. From a network complexity perspective, it is relevant that large enterprises are usually involved in multiple supply chain networks. In contrast, small and medium-sized enterprises tend to be engaged in fewer supply chain networks. We found that these enterprises instead tend to maintain relationships with a smaller number of suppliers as well. Many suppliers have mostly large and medium-sized enterprises. A high number of suppliers indicate a rather vast net than traditional supply chains. Communication and management pass only between two neighboring links up and downstream the chain, but not to more distant links from the focal enterprise. When enterprises are involved in hundreds of supply chain networks, this leads to an innate complexity that makes the whole supply chain invisible to management (Yli-Huumo et al., 2016). A comparison with the number of supplier frequencies in Smolová's (2008) research shows similar tendencies. Although, today, there is a prevailing view of networks' high complexity, the global trend in supplier–customer relationships is probably to reduce the number of suppliers. This finding brings a particular risk of late deliveries, especially when deliveries are from other continents. In such cases, only a supplier of essential components would represent a considerable risk for the enterprise. From the strategic management perspective, supply chain management is primarily focusing on a key group of suppliers and developing relationships with them.

The characteristics of strategic management of networks

The strategic management of networks area was divided into two parts: the role in the supply chain network (key or dependent) and the type of supply chain management (management by focal enterprise, multiple managing enterprises, or virtual enterprise).

First, we explored the role of enterprises in supply chain networks. According to Figure 3, enterprises, in the majority of cases, are unlikely to play a key role in supply chain networks. However, many enterprises from the agriculture industry are only in a dependent position. This situation is

usually not mentioned in the literature. It is suspected that this may be due to the strategy of differentiation. Another strategy should be formulated for goods in supply chains. The enterprise plays a focal enterprise and another role when it is only in a dependent position.

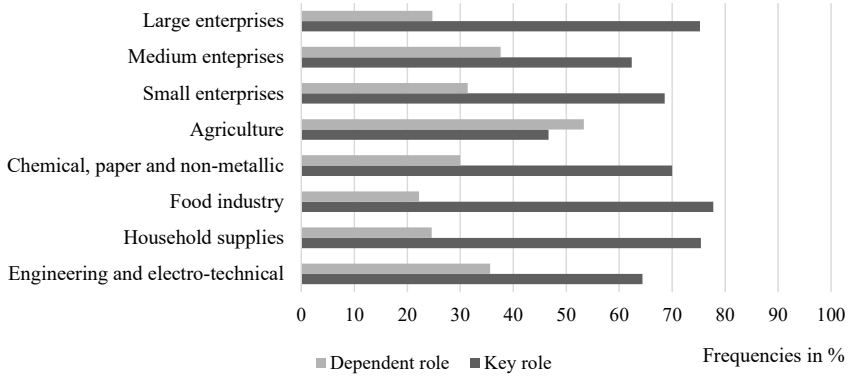

Figure 3. Enterprise' Role in Supply Chain Network

Source: Survey data, processed (n = 296).

The evaluation of hypotheses H4A and H4B is shown in Table 8, based on the comparison of key and dependent roles of the enterprises in supply chain. Hypothesis H4A states: "There is a relationship between the enterprises' size and their role in managing the supply chain network." The hypothesis H4A (by enterprise size) is rejected. The significant differences in supply chain, network roles were not confirmed according to the enterprise size. The hypothesis H4B states: "There is a relationship between the enterprises' sector of industry characteristics and their role in managing the supply chain network." The hypothesis H4B (by sector of industry) is rejected. The significant differences in supply chain, network roles were not confirmed according to the sector of industry.

The focal enterprise in a key position should manage the whole supply chain network or at least to drive its closest neighbors. That means to set the necessary volumes of materials, their delivery terms, and acceptable prices. As focal enterprises are pushing to decrease costs, they help to search for reserves and remove unnecessary activities. Large enterprises play a key role more often.

Table 8. Supply Chain Management Role in 2016-2018 (n = 296)

Supply chain management	H4A: Size differences		H4B: The sector of industry differences	
	Z-score	p-value	Z-score	p-value
Key vs. Dependent Role in Supply Chain	4.025	0.1337	7.9954	0.0918

Source: Survey data processed.

Small and medium-sized enterprises are rarely in key positions since they experience issues regarding the alignment of the supply chain strategies and a low level of influence (Calderon, Roark, Urrutia, Paravie, & Rohvein, 2017). At the contemporary time, enterprises are aware of their position and role in the supply chain network.

Furthermore, we applied a deeper analysis of supply chain, management types based on the additional research in 2019. This research sample contained only 64 enterprises. An outstanding question related to supply chain network management discusses supply chain managers' work in more detail. We asked managers whether only one or more enterprises manage the supply chain. Managing through multiple enterprises (key links) is possible for longer supply chains. For example, one focal enterprise manages businesses' activities in the European country and activities in Asia. In this example, the necessary parts are supplied and transported to different factories in different countries. The questionnaires' results appeared totally in line with our expectations that the supply chain is driven by several key links, more often in longer supply chains (Table 9). Enterprises in the food industry, the household sector, and large and medium-sized enterprises play a key role in the network. However, more enterprises are involved in the management of the whole network.

Table 9. Supply Chain Management in 2019 (in %, n = 64)

Group	Category of Enterprise	Supply Chain Management		
		One Focal Enterprise	Multiple managing enterprises	Special (virtual) organization
Sector of industry	Engineering and Electro-technical production	28.57	57.14	14.29
	Household supplies	20.00	80.00	0.00
	Food production	50.00	37.50	12.50
	Chemical, paper and non-metallic production	37.50	62.50	0.00
Size	Small Enteprises	13.33	73.33	13.33
	Medium-sized Enterprises	40.00	45.00	15.00
	Large Enterprises	37.93	58.62	3.45

Source: Survey data processed.

The analyzed types of management are focal enterprise (centralization strategy), multiple managing enterprise (decentralization strategy), and special (virtual) organization (part of decentralization strategy). The evaluation of hypotheses H5A and H5B is shown in Table 10. Hypothesis H5A states: "There is a relationship between the enterprises' size and their type of supply chain management." The hypothesis H5A (by enterprise size) is rejected. The significant differences in supply chain, management type were not confirmed according to the enterprise size. The hypothesis H5B states: "There is a relationship between the enterprises' sector of industry characteristics s and their type of supply chain management." The hypothesis H5B (by sector of industry) rejected. The significant differences in supply chain, management type were not confirmed according to the sector of industry.

Table 10. Supply Chain Management in 2019

Supply chain management	H5A: Size differences		H5B: The sector of industry differences	
	Z-score	p-value	Z-score	p-value
One key (focal) enterprise	3.3950	0.1831	1.8893	0.5957
Multiple managing enterprises	2.8355	0.2423	2.5131	0.4729
Special (virtual) organization	2.2204	0.3295	3.2578	0.3536

Source: Survey data processed.

The results show no differences between enterprises according to their size and sector of industry in supply chain, management types of strategy. In the past, long intercontinental supply chains had the advantage of

supplying inexpensive components for assembly factories. This advantage has gradually disappeared as wages have increased in developing countries and the manufacturing of parts has been transferred back to the mother country. This process is known as the 'globalization to localization' path, the use of local resources. The return to local resources will be possible mainly by applying mass 3D printing and additive manufacturing technologies in parts production. It will not increase employment because fully automated production is expected.

Overall, the different supply chain, management roles or types are not related to industry characteristics' enterprise size or sector. From the strategic management perspective, decentralized kinds of strategies in supply chain networks are used the most. This is an exciting finding, and it could be anticipated that a decentralized strategy is usually related to the cooperation of enterprises on supply chain management. Regardless of the industry's size or sector, it is possible to state there are more uncomfortably managed enterprises in the supply chain with divided competencies. Some enterprises in the network have more confidence and power to control others. However, some authors emphasize the importance of the customer as a crucial element in managing future, supply chain networks. This fundamental change from a production-driven chain to a demand-driven chain is being pushed by market forces and enabled by new technologies (Christopher & Ryals, 2014). It strengthens all physical processes and information flows, when and where they are needed, across manufacturing supply chain networks, in multiple industries (Wan, Tang, Li, Wang, Liu, Abbas, & Vasilakos, 2017).

CONCLUSION

In view of global challenges, the role of strategic management is emphasized in leading complex networks of long-term relationships between enterprises. This paper offers several contributions to supply chain management and attempts to respond to calls for studies that are connecting strategic management concepts with the network perspective. The paper particularly emphasizes the role of complexity, continuity, and strategic management of relationships in contemporary buyer–supplier and supply chain networks.

In conclusion, we have shown some contemporary characteristics of enterprises engaged in buyer–supplier networks. The results of four years of research emphasize that most enterprises are involved in multiple networks. These enterprises prefer to maintain relationships with a small number of suppliers. We found that the complexity of networks in the Czech Republic is not high unless the network is a part of a global supply chain. Overall, the

main differences between the enterprises involved in the supply chain were in their size. Enterprise size affects the number of supply chain networks in which they are involved, the number of suppliers, and the duration of the relationship with their partners. Hypotheses H1A, H2A and H3A were confirmed and enterprise size is a relevant factor in supply chains. In buyer–supplier relations, there is a higher tendency to maintain long-term relationships with a smaller number of partners, with the goal being the possibility of integration of modern technologies. From the results, we have drawn that the industry sector has no impact on the enterprises involved in supply chain networks.

The strategic management of networks is a current challenge in network research. We analyzed enterprises engaged in supply chain networks to explore their roles in networks and preferred types of management. Results show that hypotheses H4A and H4B cannot be confirmed. Thus enterprise size or industry characteristics are not important for position in key or dependent roles in supply chain networks. We further focused on the types of supply chain management of enterprises. It can be argued that enterprises should apply two different strategies (centralization, decentralization) depending on the products (or parts of products) they are finalizing. Hypotheses H5A and H5B were not confirmed. From the results, we have drawn that the prevailing strategy is decentralization. Enterprises distribute competencies among several members of the network, regardless of the size of the enterprise or industry. This result finds applications in strategic management and opens new questions from the network approach perspective.

There are some limitations associated with the research. In this research, we examined the complexity of buyer–supplier network relationships based on data (the number of suppliers and their involvement in supply chains). From the network perspective, it is more appropriate to use all business contacts, i.e., without the direction of ties (in the case of supply chains – all suppliers and customers). The research procedure used was selected because of its aim in the direction of material flow. The complexity is also measured in some studies using other indicators, such as entropy. We are aware of this shortcoming and plan to remove this limitation in further research. Although we use a single small country, the Czech Republic, as an object to answer our research questions, the research sample contains about 44% of enterprises with ownership ties to other European countries. The research sample consists of an equal representation of enterprises of all sizes (number of employees). However, we admit that the results of enterprises from the analyzed sectors of an industry may not allow the generalization of the findings to all (mostly global) networks. In addition, the research sample for the evaluation of hypotheses H5A and H5B is smaller in size and differs

from the data sample for other hypotheses. We made this additional research and analysis for greater depth of strategic aspects of supply chain networks. Nevertheless, we think that the research results provide exciting conclusions concerning the strategic management of networks.

Several theoretical implications emerge from the research study results. Our study helps advance the theoretical development of strategic management in supply chain network management and accentuates the importance of developing and fostering business collaboration. According to Håkansson & Snehota (1995) any change in a business relationship has three types of effects: at enterprise level, at the level of interplay among enterprises, and a more indirect reaction in the overall network. We focused on enterprise characteristics that may influence other levels. Our model shows mainly dependences of enterprise size at the business relationship level for business cooperation continuity and partially for network complexity. At the network level were enterprise characteristics viable only for participation in networks. Thus, the strategic management of networks is independent to some characteristics of enterprises. This conclusion supports the idea of an indirect effect at the network level (Håkansson & Snehota, 1995). We believe that the synthesis of supply chain management and network approach opens a new angle on strategic management theory. For management researchers, the results suggest that supply chain management is an integral part of strategic management.

Finally, results of the research have been embodied in some practical implications. Determining the focal enterprises of the network and defining their characteristics will help in redesigning the network, especially in crisis situations. These situations can include, of course, the lengthy crisis over Covid-19 and its consequences, which will certainly not end, especially in some sectors, in a few months' time (and will not return to its original status for several years). If the existing key member of the network needs to be replaced by another company due to its poor financial health or the impossibility of its functioning by government restrictions, knowledge of possible successors is crucial for the survival of the network. It can be expected that the networks will behave according to the following two scenarios: 1. specialization – i.e. a reduction in the number of suppliers and with it a reduction in the number of networks in which companies operate. To survive and be more robust thanks to stronger ties and flows (and they will kind of hope that their industry will not take it away next time): 2. the extension of the scope – as a safeguard against the restriction of one part of the production spectrum, to expand the production program and thus participate in other networks and cooperation with other suppliers. Moreover, perhaps mastering them will be the key to overcoming the difficult situation facing not only the Czech Republic.

Future research directions are related to the conditions, factors, and variables that affect the division of roles and power networks. A potential area for further research is applying and using new technologies (such as blockchain) that virtualize relationships and connections into a digital form. Although these tendencies may not yet be apparent from the research findings, it is appropriate to focus on them. A very interesting future research area could be a case study focusing on the supply chains in the agri-food and automotive industry, which would uncover differences between the "Λ" and "V" type of networks structures in more details.

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Abstrakt

CEL: *Obecne badania mają na celu stworzenie modelu ekonomicznego, który łączy zarządzanie strategiczne i teorię sieci. Jednakże większość modeli teoretycznych nie dostarcza empirycznych dowodów rzeczywistej struktury i atrybutów relacji sieciowych. Celem artykułu jest zbadanie zależności między cechami przedsiębiorstwa a charakterystyką relacji nabywca-dostawca w sieciach łańcuchów dostaw. Jesteśmy szczególnie zainteresowani relacjami biznesowymi w sieciach z uwzględnieniem różnych wielkości przedsiębiorstw i sektorów przemysłu. W artykule podsumowano wyniki badań empirycznych nad sieciami kupiec-dostawca oraz podkreślono znaczenie rozwijania i wspierania współpracy biznesowej dla zarządzania strategicznego. Artykuł podsumowuje wyniki badań empirycznych dotyczących sieci nabywców i dostawców oraz podkreśla znaczenie rozwoju i wspierania współpracy biznesowej w zarządzaniu strategicznym.* ***METODYKA:*** *Badanie ankietowe przeprowadziliśmy w latach 2016-2018 na 360 przedsiębiorstwach z Czech. Próbę badawczą dobrano w oparciu o metodę celowego pobierania próby. Członkowie zespołu badawczego zebrali dane z ankiety internetowej i osobistych wizyt w przedsiębiorstwach. Analiza statystyczna hipotez opiera się na częstotliwości odpowiedzi menedżerów. Aby ocenić wyniki, stosuje się test Z w dwóch proporcjach do porównywania różnych kategorii przedsiębiorstw zgodnie z ich wielkością lub dominującym sektorem przemysłu.* ***WYNIKI:*** *Główne wyniki pokazują, że różnice między przedsiębiorstwami zaangażowanymi w struktury nabywca-dostawcy wynikają głównie z ich wielkości. Badanie nie wykazało różnic między sektorami przemysłu. Wyniki pokazują, że złożoność sieci w Republice Czeskiej nie jest duża pod względem liczby dostawców lub zaangażowania w wiele sieci dostaw. Ciągłość relacji z partnerami w sieciach nabywców i dostawców ma charakter stosunkowo długofalowy. Długoterminowe partnerstwa odzwierciedlają wyższą jakość relacji i wspierają przyszłą integrację. Jednak duże przedsiębiorstwa wolą budować kontrakty na krótsze lub dłuższe okresy. Ogólna strategia decentralizacji charakteryzuje zarządzanie strategiczne sieciami nabywców i dostawców. Odkrycie to oznacza podział kompetencji, takich jak planowanie, zarządzanie, pozyskiwanie, podejmowanie decyzji, transport (dostarczanie) między przedsiębiorstwami.* ***IMPLIKACJE DLA TEORII I PRAKTYKI:*** *Artykuł zapewnia wgląd w zrozumienie, jak działa sieć nabyw-*

ca-dostawca. Opiera się na połączeniu zarządzania łańcuchem dostaw i zarządzania strategicznego z perspektywy sieci. Zarządzanie łańcuchem dostaw postrzegane jest jako część zarządzania strategicznego, a synteza obu obszarów badawczych otwiera innowacyjne spojrzenie na teorię biznesu. ***ORYGINALNOŚĆ I WARTOŚĆ:*** *Zasadniczą wartością pracy jest powiązanie współczesnych idei zarządzania strategicznego i zarządzania łańcuchem dostaw. Synteza zarządzania łańcuchem dostaw i podejście sieciowe wzmacnia teorię zarządzania strategicznego.*
Słowa kluczowe: *sieć, relacje kupiec-dostawca, zarządzanie strategiczne, złożoność, ciągłość, zarządzanie łańcuchem dostaw*

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Conflicts of interest

The authors declare no conflict of interest.

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Interfirm network structure and firm resources: Towards a unifying concept

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Abstract

PURPOSE: *The objective of this paper is to propose a concept of network resource distribution that systematically unifies the resource-based and network-based perspectives on interfirm networks and enables integrated analysis of how firm resources and network structure interact to affect firm performance.* ***METHODOLOGY:*** *This conceptual paper first reviews the extant literature on interfirm networks and then develops the unifying concept of network resource distribution.* ***FINDINGS:*** *The literature review indicates that strategy scholars have long sought to integrate the resource-based view and the social network explanations of firm performance but, thus far, only a partial integration has been achieved. In particular, studies on the resource-level heterogeneity of interfirm networks have largely been limited to the analysis of firm dyads. How firm resources and network structure beyond the immediate network partners interact to affect firm performance has not yet been adequately addressed. The proposed unified concept of network resource distribution systematizes prior research and illuminates how network structure and firm resources interact to affect firm performance beyond the immediate network partners.* ***IMPLICATIONS FOR THEORY AND PRACTICE:*** *For theory, this paper highlights gaps in the extant literature on interfirm networks and proposes a unifying concept that can be utilized to address these gaps and to develop further theory in the area. For practice, this paper encourages managers not to limit their analyses of strategic alliances to immediate partnerships; it is also crucial to consider the partners and their resources, and reflect on how they are related to one another outside of the immediate partnership portfolio.* ***ORIGINALITY AND VALUE:*** *Network resource distribution is a novel concept that ties together and systematizes various strands*

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of research on interfirm networks, thus providing a foundation for future research in the area. The concept is also amenable to detailed operationalization, facilitating subsequent quantitative testing of theoretical arguments combining firm resources and the structure of a network.
Keywords: *resource-based view, strategic networks, interorganizational relations, alliances, firm performance*

INTRODUCTION

Strategy scholars have long attributed differences in firm performance to the internal characteristics of a firm, typically conceptualized as resources (Barney, 1991; Wernerfelt, 1984) or capabilities (Teece, Pisano, & Shuen, 1997). Simultaneously, strategic network scholars have posited that superior firm performance is related to a firm's external network of interfirm ties (Dyer & Singh, 1998; Gulati, 1998; Baum, Calabrese, & Silverman, 2000; Gulati, Nohria, & Zaheer, 2000). While both perspectives have been successful in explaining many aspects of firm performance, research on strategic management has also sought to integrate these two streams of research for a more nuanced and comprehensive understanding. Integrative studies have indicated, for example, that the capabilities of network partners influence the focal firm performance (Baum et al., 2000), that the network structure may enable firms to better leverage their internal capabilities for improved performance (Zaheer & Bell, 2005), and that the configuration of alliance portfolios can affect the focal firm performance (Jiang, Tao, & Santoro, 2010; Lavie, 2007; Lee, Kirkpatrick-Husk, & Madhavan, 2017; Subramanian & Soh, 2017; Wassmer, 2010). Although this integrated approach has provided a more holistic view of the sources of competitive advantage, there are still significant gaps in the understanding of how firm resources and interfirm networks interact to affect organizational performance (Burt & Soda, 2021).

In particular, most of the integrative studies accounting for the resource-level heterogeneity of interfirm networks are limited to the analysis of firm dyads (Gulati, Lavie, & Madhavan, 2011; Phelps, 2010; Phelps, Heidl, & Wadhwa, 2012; Zaheer & Bell, 2005). Studies spanning beyond the focal firm's immediate partners tend to aggregate network partner resources and thus ignore the potential influence of the actual location of resources within the network. The understanding of how the interfirm network structure interacts with the resources within the network is thus limited, particularly regarding the whole network level of analysis. In fact, recent empirical studies investigating interfirm and knowledge networks (e.g., Wang, Rodan, Fruin, & Xu, 2014; Guan & Liu, 2016) indicate that indirect ties matter and that the network position of a partner is often unrelated to what the partner has

to offer in terms of resources. These studies thus suggest that aggregating network partner resources result in an incomplete understanding of interfirm networks, potentially biasing results. Consequently, there is a need to better reconcile the resource-based and network-based perspectives beyond the dyadic level of analysis. Although the practical challenge of collecting data on relationships among a large population of network actors is likely to have contributed to the scarcity of integrative research (Monaghan, Lavelle, & Gunnigle, 2017; Schilling, 2009), it is also possible that this scarcity is due to the lack of appropriate conceptual tools for adequately accounting for both perspectives beyond the immediate partners.

The objective of this paper is to propose a concept of *network resource distribution* that systematically unifies the resource-based and network-based perspectives on interfirm networks and enables integrated analysis of how firm resources and network structure interact to affect firm performance. By introducing this novel concept, this paper contributes to research on interfirm networks in two ways. First, the concept ties together various strands of research on interfirm networks, thus facilitating the integration of the resource-based view and the social network theory, called for in prior research (Phelps et al., 2012), and provides a systematic foundation for future research in the area. Second, similar to the work of Carpenter, Li, and Jiang (2012), this concept supports a systematic method of operationalizing the complex combination of network structure and resources, further facilitating subsequent quantitative testing of theoretical arguments combining firm resources and interfirm network structure.

The paper is organized as follows. First, a brief review of the literature using the resourced-based view to study interfirm networks is presented, followed by a similar review of studies utilizing the social network theory and studies that combine the two theoretical perspectives. Building upon the review, the unifying concept of *network resource distribution* is introduced and elaborated. Then, a formal definition of the concept is provided to facilitate its use in strategy research. Next, five previous papers combining the resource-based view and network theory are discussed, and their relation to the concept is elaborated. Discussion on the significance and potential uses of the concept concludes the paper.

LITERATURE OVERVIEW

The resource-based view and interfirm networks

The resource-based view posits that competitive advantage and, consequently, firm performance variance can be explained by analyzing the internal resources of firms (Barney, 1991; Peteraf, 1993; Wernerfelt, 1984). Resources are typically defined in a very broad manner, encompassing physical, knowledge, and cultural aspects of a firm. The resource-based view argues that firm performance differences are attributable to unique and valuable resources (Barney, 1991), competences (Prahalad & Hamel, 1990) or capabilities (Teece et al., 1997) around which firms devise value-creating strategies that allow them to accrue above-average profits (Lavie, 2006; Peteraf, 1993).

The resource-based view has also been applied to the analysis of interfirm networks. From the resource-based perspective, the main rationale for firms to engage in interfirm relationships is to gain access to valuable complementary resources (Das & Teng, 2000; Eisenhardt & Schoonhoven, 1996; Lado, Boyd, & Hanlon 1997; Madhok & Tallman 1998), including knowledge accessed through interfirm learning (e.g., Lin, Wu, Chang, Wang, & Lee, 2012; Subramanian, Bo, & Kah-Hin, 2018). Partners' complementary resources enable firms to pursue opportunities that would otherwise either be unavailable due to lack of resources or unfeasible due to the expenses of developing and integrating resources internally. Interfirm alliances help the focal firm access complementary resources while maintaining a focus on the development and exploitation of its core competencies (Wassmer, Li, & Madhok, 2017). Access to complementary resources may also constitute a necessary condition for appropriating returns from the firm's own resources (Teece, 1986; Carnabuci & Operti, 2013).

In addition, as argued by Dyer and Singh (1998), the resource combinations created from the resources of two firms may be so unique in themselves that the interfirm relationship itself may constitute a source of competitive advantage (Galunic & Rodan, 1998; Mesquita, Anand, & Brush, 2008; Wang & Zajac, 2007). Lavie (2006) developed this notion further by proposing an integrated theoretical model of competitive advantages arising from interfirm collaboration. In Lavie's model, competitive advantage from interfirm collaboration derives from three types of rents: internal rents, resulting from the use of the focal firm's internal resources; appropriated relational rents, derived from the use of shared resources; and spillover rents, generated by the partner's resources. Together, these prior studies indicate that resource sharing in interfirm alliances can yield significant competitive advantages and that network partners and their resources can

affect the performance of the focal firm both directly through relational rents and indirectly through spillover rents.

Furthermore, the relationships of the focal firm and the resources residing in the interfirm network may also be considered to constitute network resources (Gulati, 1999, 2007; Gulati, Lavie & Madhavan, 2011; Huggins 2010) or social capital (Dyer & Hatch, 2006; Inkpen & Tsang, 2005; Koka & Prescott, 2002; Tsai & Ghoshal, 1998; Walker, Kogut, & Shan 1997), both of which might be valuable to the focal firm.

In short, the resource-based view suggests that competitive advantage in interfirm networks and interfirm relationships stems from (1) access to valuable complementary resources that allow the focal firm to concentrate on its core activities and to appropriate returns from its own resources; (2) unique and hard-to-imitate resource combinations created through collaboration between two or more firms; and (3) the interfirm network itself as a valuable resource for the focal firm, as suggested by the social capital concept.

While these resource-based explanations of the impact of interfirm networks have advanced understanding on how external resources affect the performance of the focal firm, prior studies have largely been limited to firm dyads; less is known about how the resources of the entire interfirm network influence the focal firm performance (Gulati et al., 2011; Phelps, 2010; Phelps et al., 2012; Powell, Koput, & Smith-Doerr, 1996; Shan, Walker, & Kogut, 1994; Zaheer & Bell, 2005). For example, research on alliance portfolios has extended attention from a purely dyadic level of analysis to consideration of all immediate partners of the focal firm (Cui & O'Connor, 2012; Hagedoorn, Lokshin, & Zobel, 2018; Jiang et al., 2010; Lavie, 2007; Lee et al., 2017; Subramanian & Soh, 2017; Wassmer, 2010; Wuyts & Dutta, 2014). Yet, ignoring the impact of alliance network partner characteristics beyond the immediate partners may result in a limited and potentially skewed view of how these more distant partners and their resources affect the performance of the focal firm. The focal firm may thus become too preoccupied with its immediate partners to consider how they should be positioned vis-à-vis other firms in the network. For example, the focus on immediate partners may distract attention from valuable complementary knowledge resources possessed by more distant firms in the interfirm network (Hansen, 2002). Intermediaries may be required to access and translate the required knowledge so it can be absorbed by the focal firm (Howells, 2006; Shohet & Prevezer, 1996). These intermediaries may become congested if multiple firms try to access partner resources through them (Aggarwal, 2020). In conclusion, the resource-based view of interfirm networks lacks a coherent theoretical explanation of when the resources of indirectly related network partners matter for the focal firm performance.

The social network theory and interfirm networks

The social network theory posits that firms are always embedded in social networks built on various relationships among firms, ranging from informal relationships among management to formal licensing and joint venture agreements (Zaheer, Gözübüyük, & Milanov, 2010). Network embeddedness both enables and restricts the strategic actions of the focal firm (Gargiulo & Benassi, 2000; Polidoro, Ahuja, & Mitchell, 2011; Uzzi, 1997). Unlike the resource-based view, which emphasizes the rational choice of partners based on resource complementarity and similarity, the influence of network embeddedness is more holistic; it depends on the overall interaction with other firms and considers the network both as an antecedent to the focal firm performance and a consequence of firm partnering decisions (Borgatti & Halgin, 2011). The social network theory suggests that superior firm performance is due to the position of the focal firm within the interfirm network (Burt, 2000; Inkpen & Tsang, 2005; Stuart, 1998; Zaheer & Bell, 2005) and overall network structure (Gilsing, Nooteboom, Vanhaverbeke, Duysters, & van den Oord, 2008; Schilling & Phelps, 2007; Soh, 2010).

Prior literature suggests that networks enhance the competitive advantage of a firm through three mechanisms. First, social networks function as conduits of knowledge and can relay valuable information efficiently and in a timely fashion. As argued by Burt (2004), firms that occupy a central position in a network are likely to have a superior position and positional advantage in terms of negotiating power, access to information, and brokering. Second, an interfirm network may have structural holes (Burt, 1992), defined as the lack of direct ties between specific firms in the network. Structural holes present opportunities for explorative learning (Uzzi, 1996) brokerage (Burt & Soda, 2021; Kwon, Rondi, Levin, De Massis, & Brass, 2020), and the creation of novel resource combinations (Nahapiet & Ghoshal, 1998; Tsai & Ghoshal, 1998). These mechanisms enhance the focal firm performance (Zaheer & Bell, 2005b). Third, networks are argued to be superior to other forms of governance when firms are adapting to new conditions in the competitive environment (Dittrich & Duysters, 2007; Kraatz, 1998). Given efficient transmission of knowledge about changes in the environment, and high flexibility resulting due to lack of rigid governance structures, interfirm networks can facilitate a swift strategic response to environmental changes, again improving firm performance.

While the existing social network theory literature suggests that interfirm ties and embeddedness in interfirm networks affect firm performance, most prior studies have only considered the impact of network structure; only a limited number of studies have explored the interplay between network

structure and the actual resources present in the network (cf. Phelps et al., 2012). Most studies have implicitly assumed that network structure in itself explains firm performance sufficiently well. Yet, as discussed in relation to the resource-based view, firm resources, network partner resources, and how they are related to one another, do influence firm performance (Gulati et al., 2011). Hence, differences in firm performance are thus likely to depend not only on the structure of the interfirm network they are embedded in but also on how resources are distributed within the network. Recent empirical studies that investigate interfirm networks by decomposing firms into resource-level knowledge components support this view (Wang et al., 2014; Guan & Liu, 2016). These studies indicate that indirect ties matter and that the network position does not necessarily imply what resources the partner has, suggesting that resource-level disaggregation of firms on the whole network level is required to understand fully how embeddedness affects the focal firm performance.

Integration of the resource-based view and the social network theory

The resource-based view and the social network theory explanations of interfirm networks are interrelated. Accessing the resources of a partner requires an interfirm relationship, which consequently embeds the focal firm in a social network. Conversely, being embedded in a social network can be considered a resource in itself. However, research combining the two perspectives is still limited (Burt & Soda, 2021), and how exactly the two theoretical perspectives interact to influence the focal firm performance and how this interaction should be conceptualized remains unclear.

To understand further how exactly the resource-based view and the social network theory have been combined in prior research, a literature review was conducted. Articles were searched in citation databases, such as Web of Science and Google Scholar, by using relevant keywords such as “resource-based,” “networks,” “embeddedness,” “social capital,” “organizational,” “firm,” “interfirm,” “ties,” “collaboration,” and “alliances.” Initially, articles were included or excluded based on their title. For each tentatively included article, the abstract and, ultimately, the full text were inspected to check if the article fitted two sampling criteria. First, only articles that explicitly (i.e., in hypotheses) combined both perspectives were included. Second, only papers addressing firm-level effects were included. Articles meeting these criteria were then categorized with respect to two dimensions: the level of network structure and the scope of resources addressed in the article.

First, the categorization of the level of network structure used three possible levels of analysis: the dyadic level, the ego network level, and the

whole network level. The dyadic level, or ego network with distance 1, includes only the direct ties and the related immediate partners of the focal firm (the "ego"). Typical measures related to the dyadic level of networks are the number of ties and the strength of ties. The ego network level refers to ego networks with unlimited distance and differs from the dyadic level by fully accounting for all possible network partners, including those only indirectly related to the focal firm. Since the number of articles studying entire ego networks was very small, no typical measures of network structure used on this level could be inferred. However, based on the social network theory, potential measures for ego network level analysis include path length (the number of ties needed to reach from the focal firm to another) and the number of indirect ties (the number of firms accessible through immediate partners). The whole network level includes all firms and all possible ties within an interfirm network. Two types of measures of whole network structure were identified (c.f., Carpenter et al., 2012). The first type of measure considers the overall structure of the network (thus independent of the focal firm) and includes measures such as network density, the number of structural holes, and cohesion. The second type of measure characterizes the focal firm's position within the whole network and includes measures such as betweenness and centrality.

Second, the articles were categorized into three distinct types of resource scope depending on which firms' resources were included in the theoretical models. The first type of articles included only the focal firm's resources in the interaction between resources and network structure. The second type included the resources of both the focal firm and its network partners. The final type of articles included only the resources of network partners.

These categorizations resulted in a 3-by-3 matrix of studies, summarized in Table 1. Next, each cell of the matrix and the limitations of extant studies in terms of understanding the interaction between resources and network structure are discussed.

Table 1. Studies integrating the resource-based view and the social network theory

Network structure level	Resources		
	Focal firm	**Both**	**Partners**
Dyadic Measures: Tie existence Tie strength Number of ties	How do the resources of the focal firm affect the impact of immediate ties? Examples: Anand and Khanna (2000) Eisenhardt and Schoonhoven (1996) Lee et al. (2001) Powell et al. (1996) Uzzi and Lancaster (2003) Walker et al. (1997)	How do the resources of the focal firm and immediate partners interact with the immediate ties? Examples: Das et al. (1998) Inkpen (2000) Inkpen and Tsang (2005) Gulati (1999) Reagans and McEvily (2003) Lin et al. (2009) Vasudeva et al. (2013) Subramanian and Soh (2017)	How do the resources possessed by immediate partners affect the focal firm performance? Examples: Gulati and Higgins (2003) Koka and Prescott (2002) McEvily and Marcus (2005)
Ego Measures: Path length Indirect ties	How do focal firm resources interact with local network structure beyond the dyadic level?	How do focal firm resources and resources of more distant partners affect the focal firm performance? Example: Gulati (1995a)	How do the resources of partners beyond the immediate ones affect the focal firm performance?
Whole Measures: Centrality Connectedness Structural holes	How do focal firm resources affect the impact of overall network structure and position? Examples: Tsai and Ghoshal (1998) Tsai (2001) Guan and Liu (2016)	How do focal firm resources and network resources interact with the network structure? Examples: Arya and Lin (2007) Zaheer and Bell (2005)	How do the resources within the network interact with the network structure? Examples: Bae and Gargiulo (2004) Owen-Smith and Powell (2004) Whittington et al. (2009) Rulke and Galaskiewicz (2000)

Dyadic level studies

One of the most common types of integrative studies focuses on the interaction between the focal firm's resources and its dyadic ego network structure. Typical focal firm resources considered include absorptive capacity

(Dyer & Singh, 1998; Tsai, 2001) and alliance capability (Kale, Dyer, & Singh, 2002; Rothaermel & Deeds, 2006). These studies seek to explain how the focal firm's capabilities and resources help the firm leverage the information and opportunities emerging in its dyadic network. An obvious shortcoming of these studies is that they ignore the resources of network partners, making it uncertain whether the partners actually possess resources valuable to the focal firm. These studies thus depend solely on the social network explanation of interfirm networks—the internal resources are merely factors that moderate the relationship between the dyadic network structure and the focal firm performance.

By contrast, dyadic level studies that incorporate the resources of the focal firm's immediate partners avoid this issue. By focusing on the fit between the focal firm's and its partners' resources, these studies explain the focal firm's performance through either resource complementarities (Kale, Singh, & Perlmutter, 2000; Rothaermel & Boeker, 2008) or similarities (Grant & Baden-Fuller, 2004; Mowery, Oxley, & Silverman, 1996). The first type of fit is based on the creation of unique complementary combinations of resources (Dyer & Singh, 1998; Galunic & Rodan, 1998; Wang & Zajac, 2007; Wiklund & Shepherd, 2008), while the second type of fit is based on the absorptive capacity arguments of having sufficient similarity for knowledge absorption (Cohen & Levinthal, 1990; Lane & Lubatkin, 1998). Typical resources considered in these studies include knowledge domains (Grant & Baden-Fuller, 2004), technologies (Wang & Zajac, 2007), organizational structures (Lane & Lubatkin, 1998), and organizational culture (Gulati, 1995b; Inkpen & Tsang, 2005). The focal firm's and partners' resources are not always treated symmetrically (Gulati, 1999; Inkpen, 2000; Stuart, 2000); the focal firm's resources are usually treated similarly to the first case of studies, while the network partners' resources are now assessed explicitly, or refer to partners' attitudes towards the focal firm (Simonin, 2004). Although these studies provide a more thorough explanation of interaction between firm resources and network structure than those based only on the focal firm's resources, they are still limited to the dyadic level network of the focal firm and disregard the potential effects of indirectly related firms and the whole network structure on firm performance.

Dyadic level studies that address the interaction between resources of the focal firm's immediate partners and the dyadic network structure are less common than the first two types discussed above. These studies typically analyze how the focal firm can leverage its dyadic network ties to benefit from the resources of its immediate partners. Partner resources considered include technological knowledge (Koka & Prescott, 2002; Phelps, 2010), organizational prestige (Gulati & Higgins, 2003), and organizational factors

(McEvily & Marcus, 2005). Although these studies improve on the first kind of study by considering which valuable resources the focal firm can access within its ego network they are still limited in three ways. First, the analysis still only considers the dyadic relationships with immediate partners. As discussed above, indirectly connected firms can also influence how the resources of these immediate partners impact the focal firm's performance. Second, with the exceptions of Koka and Prescott (2002) and Phelps (2010), partners are conceptualized as a homogeneous group that can be analyzed through simple resource aggregation. Yet, as suggested by Gulati and Higgins (2003), McEvily and Marcus (2005), and Phelps (2010), partners are likely to be dissimilar. Subsequently, the diversity of partners, and how they are managed, has an impact on the focal firm performance (Jiang et al., 2010). Third, the exclusion of the focal firm's resources raises the question of how well they are actually complemented by the resources of network partners.

Ego network level studies

There were extremely few examples of research on the ego network level that combined the analysis of firm resources and network structure. One rare example is Gulati's study of alliance formation in a social structure of interconnected firms (Gulati, 1995a). This study also considers the match between the focal firm's resources and network partners' resources in terms of strategic independence, referring to the usefulness of the partners' resources to the focal firm. It can thus be concluded that the understanding of the impact of resources embedded in interfirm networks, when accessed through indirect ties in an ego network setting, is severely limited.

Whole network level studies

Multiple studies analyzing the interaction between resources in interfirm networks and the whole network structure were found. These studies are in many ways similar to the studies discussing the interaction between resources and dyadic network structure. The whole network level studies are focused on how the focal firm's resources can be used to leverage the potential benefits of the whole network structure (Tsai, 2001; Tsai & Ghoshal, 1998). However, rather than taking advantage of direct dyadic ties, here the focal firm benefits from the overall network structure or its position within the network. Resources of the focal firm considered in the research include absorptive capacity (Tsai, 2001) and trustworthiness (Tsai & Ghoshal, 1998). Furthermore, Guan and Liu (2016) investigated both interfirm networks and resource-level knowledge networks, claiming that innovations are doubly

embedded in these networks. Although Guan and Liu did not directly address the interaction between the interfirm network structure and resources in their analyses, they nevertheless provided evidence for the integrative perspective that indirect ties of interfirm networks do matter and that the network position of a partner does not necessarily imply what resources the partner possesses. Taken together, however, these studies are limited in the same sense as the dyadic level network studies – most studies disregard partners' resources and do not consider whether they are actually beneficial to the focal firm. For example, while the network structure may enhance access to knowledge or other specific resources, these resources may in fact be worthless to the focal firm.

Only a handful of studies discussing the interaction between the whole network structure and the resources of both the focal firm and its network partners were found. Zaheer and Bell's (2005b) study of interactions between firm capabilities and network position considered how the fit between the focal firm's capabilities and the aggregated capabilities of its network partners interacts with overall network structure. Arya and Lin (2007) studied the interaction between organizational characteristics, partner attributes, and network structure in a not-for-profit context. These studies are more enlightening than the previous type of studies. By considering how the focal firm should be positioned in relation to the resources of its partners, these studies provide a more detailed view of how exactly the network structure benefits the focal firm, given the resources of the network partners. However, these studies present an additional challenge: if the partners' resources are aggregated at the whole network level, information on the exact location of these resources is lost, precluding analysis of how individual partners' resource endowments affect the focal firm performance.

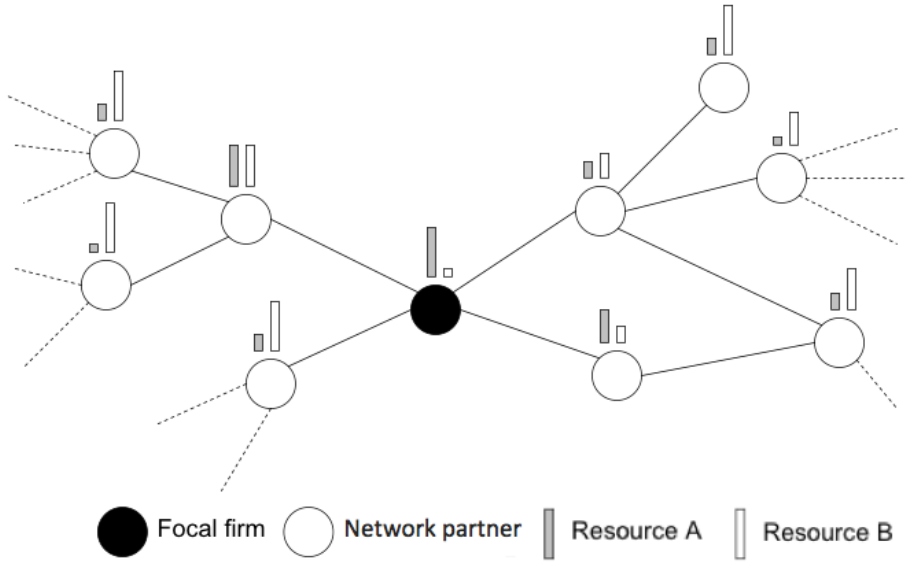
The whole network level studies discussing the interaction between the global network structure and the resources of network partners explore how the whole network structure should be matched with aggregated partner resources. Specific partner resources considered include organizational prestige (Kraatz, 1998), controlled resources (Bae & Gargiulo, 2004), and organization type (Owen-Smith & Powell, 2004). However, these studies forgo the analysis of the precise ego network structure required to leverage these resources. More specifically, these studies do not analyze where exactly the resources are located within the network and instead assume that the focal firm can access them somewhere in the network. In addition, similar to the dyadic network level, excluding a focal firm's resources from the analysis introduces the problem of not knowing whether there is in fact a fit between the resources of the focal firm and those of its partners.

THE UNIFYING CONCEPT OF NETWORK RESOURCE DISTRIBUTION

The brief review of literature that integrates the resource-based view and the social network theory indicates that while much is known about how resources and network structures interact to affect the focal firm performance on the dyadic level, the understanding of how resources and network structures interact to affect the focal firm performance on the ego and whole network levels is limited. In particular, it is poorly understood how the detailed resource structure of an interfirm network beyond the dyadic level is related to firm performance. It is contended that the understanding of the impact of interfirm networks on firm performance can be improved by introducing a concept that transcends existing conceptualizations of the interaction between resources and network structure and that provides a coherent new framework for integrating existing research. To this end, this paper proposes the unifying concept of *network resource distribution* that facilitates a detailed analysis of how firm resources and interfirm network structure interact to affect the focal firm performance.

Network resource distribution is defined as *a spatial pattern of resources within an interfirm network in which a specific location is related to specific levels of those resources.* The concept thus explicitly combines network structure and firm resources and crucially incorporates information on *what* resources firms possess with the information on *where* these resources are located within the interfirm network. *Network resource distributions* are agnostic with respect to the type of ties between firms, and can be based on any type of relationship, including formal alliance agreements or informal collaboration. Similar to the resource-based view, firms are conceptualized as bundles of resources. The network of firms can thus be construed as a network of resources localized at the interfirm network nodes that represent firms. Each resource has a particular level at each node (i.e., firm) of the interfirm network, resulting in a particular pattern of resources distributed throughout the network. To simplify the discussion, it is assumed that the network consists of a single connected group of firms instead of multiple disconnected groups of firms.

An example of an interfirm network with two resources—resource A and resource B—is shown in Figure 1. The levels of the two resources vary throughout the network. There are thus two types of knowledge regarding this interfirm network: (1) the level of resources located at each node of the network and (2) the ties (i.e., relationships) between the nodes. The network of interfirm ties combined with the resources of the firms constitute a *network resource distribution*—a unique pattern of resource levels and how they are related to each other.



In the above figure, the focal firm and each network partner are network nodes. Solid lines depict connections between the network nodes. Dashed lines depict connections to network nodes not visible in the figure. The pillars above a node indicate the types and levels of resources localized at that network node. The resource type is indicated by the pillar color, and the resource level (i.e., how much of that resource resides at the given node) is indicated by the pillar height.

Figure 1. An example of varying resource levels in an interfirm network

The *network resource distribution* is a generic abstract concept. Because interfirm networks are typically characterized by a complex structure, marked by a large number and variety of interfirm ties and by nodes composed of a large number of heterogeneous firms, each having a certain set of resources and a certain level of each resource, the related specific *network resource distributions* remain somewhat elusive. Hence, to operationalize the concept in order to test hypotheses regarding the interplay between firm resources and network structure, one needs to decide which precise structural and resource aspects of the network one wants to analyze (cf. Carpenter et al., 2012). Specifically, first, to reduce the complexity related to the network structure, one needs to choose what type of network structural metric would be relevant to the research question at hand. Next, to reduce the complexity related to the resources, one must define what specific resource metric would best serve the objective of the study.

A *network resource distribution* can accommodate multiple types of relationships between firms simultaneously. Above, only the spatial pattern of

ties between firms was used to determine the *network resource distribution*. However, the concept can also incorporate tie strength in terms of, for example, trust and the frequency of interaction between firms, which have been shown to have an impact on interfirm networks and, subsequently, on firm performance (Gulati, 1995b; Krishnan, Martin, & Noorderhaven, 2006).

Moreover, a *network resource distribution* can also accommodate any number of resources or even a continuum of resource types. The specific operationalization of the concept can be based on one or more resources, depending on the research question at hand. In some cases, several distinct operationalizations of the concept could be used simultaneously, one for each resource of interest in order to examine their interactions, for example.

Formal definition of a network resource distribution

To illustrate how a *network resource distribution* can be operationalized and applied in empirical research, it may be formally defined as follows. First, an interfirm network can be represented as an N x N matrix that indicates the existence of ties between firms. In the simplest case, this may be represented as either 0—no tie exists between the two firms—or 1—some kind of tie exists between the two firms. This approach can be generalized in the sense that this structure can also incorporate tie strength, indicated by the magnitude of the linkage in the matrix, as well as tie directionality—ties do not need to be reciprocal. This *network structure matrix* can be used to describe a very broad range of network relationships.

Each resource within the interfirm network can be represented by an N-dimensional vector r = r(i), where the value of one component indicates the level of the resource possessed by a particular firm i within the network. Like the network structure matrix, these resource vectors can accommodate a wide variety of resource distributions, ranging from monopolized resources—value 1 for one firm and 0 for all others—to different types of knowledge with no sharp differences in the level of knowledge between firms. All observed resource levels within the network, in turn, can be represented by an N x M *resource matrix*, where M is the number of resource vectors (i.e., distinct resources).

As indicated above, various network metrics calculated from the network structure matrix are used to facilitate a closer analysis of the network structure. Choosing a focal firm—or "ego firm"—for analysis, these metrics can be expressed as m = m(i, j), where i and j denote firms within the network. There are two main types of network metrics: (1) structural metrics and (2) distance metrics.

Structural metrics, such as betweenness centrality and number of structural holes, describe the overall structure of the network. Some structural metrics, such as the number of structural holes, are calculated for the whole network, and do not depend on the focal firm. In this case the value of a structural metric is the same for all firms in the network. Other structural metrics, such as betweenness centrality, depend on the chosen focal firm. Structural measures can be calculated either for the whole network or for the immediate ego network.

Distance metrics describe how distant two firms are from each other within the interfirm network. The value of a distance metric, such as path length, thus depends on the choice of two firms; it is a function of both the focal firm and the chosen alter in the network. For example, the path length metric indicates how many ties are needed to connect the focal firm to the chosen alter.

Depending on which network structure metric is used the resultant metric is (1) constant for all firms, (2) dependent on the chosen focal firm, or (3) dependent on both the chosen focal firm and another firm. The resultant *network resource distribution* can thus have zero, one, or two dimensions, respectively. The zero-dimensional *network resource distribution* relates the resources available in the whole network to the whole network structure by using a network structure metric that is independent of the focal firm. Because the network metric in this case reduces to a constant, the resulting *network resource distribution* is zero-dimensional with respect to the network structure. However, there is still a two-dimensional resource matrix with M resource endowment vectors, each with N components corresponding to the firms within the network. The complexity of the resource matrix can be reduced, for example, by calculating the aggregate level of one resource—by summing over all eligible nodes for one resource—or the variance of resources—by calculating the variance of resources over multiple resources and all nodes. In either case, the result is a single measure that describes the resources within the network. This figure can then be multiplied by the network structure metric, yielding a zero-dimensional *network resource distribution*.

The one-dimensional *network resource distribution* relates the resources within the network to the network structure and it can be applied on both ego and whole network levels. In both cases, the network structural metric depends on the chosen focal firm and is thus one-dimensional. As in the previous zero-dimensional case, there is still a need to reduce the complexity of the resource matrix by aggregating one resource or calculating the variety of resources, for example. Multiplying the resource metric and the network structure metric, results in a one-dimensional *network resource distribution* that depends on the choice of the focal firm.

The two-dimensional *network resource distribution* relates the resources available within the whole network to the distance between the focal firm and the network partners. In this case the network metric depends not only on the focal firm but also on the particular alter and is thus two-dimensional. Combining the network structure matrix with the resource matrix yields a two-dimensional *network resource distribution* for each observed resource. Formally, there is a function d(i, j) for each pair of firms that describes the level of resources at firm j as measured from firm i. The focal firm can also be included in the formulation as the value for d(i, i). Obviously, this is the most general and complex description of the interaction between firm resources and the network structure. This formulation can be applied to the whole network or to a subset of the network. For example, a researcher may limit the analysis to only the closest network partners (i.e., the dyadic level). Effectively, this means setting a threshold for the used metric. As an example, a two-dimensional *network resource distribution* can be used to describe the degree of access the firms in the network have to certain types of knowledge held by other firms in the network. In this case, the network structure metric could be based on inverse values of path lengths (Hansen, 2002), which could then be interacted with the levels of knowledge held by the firms to correct for the loss of value that might occur when the knowledge has to be indirectly accessed to form the two-dimensional *network resource distribution*. To use the distribution in quantitative analysis, one could calculate the sum of distance-corrected knowledge level values for each firm and correlate them with the firm performance measures, for example.

A summary of the above formulations of specific *network resource distributions* is given in Table 2. To summarize, to operationalize the concept of *network resource distribution*, the interfirm network structure and firm resources are first modeled as a network structure matrix and a resource matrix, respectively. Then, in most cases, the complexity related to both matrixes is reduced by choosing specific metrics for them. Finally, the network structure metric is interacted with the resource metric to arrive at a specific *network resource distribution*. The resulting *network resource distributions* describe how a particular resource or resources are distributed throughout the entire network as seen from the perspective of the focal firm. This distribution can then be incorporated in an analysis of outcomes of interest, such as the focal firm performance.

Table 2. Network resource distribution types

Network resource distribution type	Network level	Examples of network metrics	Examples of resource measures
Zero-dimensional d = m * r	Whole network	Number of structural holes Cohesion	Aggregation of one resource Variety over multiple resources
One-dimensional d(i) = m(i) * r(i)	Ego networks Whole network	Betweenness Degree Closeness Clustering coefficient Access to bridging ties	Aggregation of one resource Variety over multiple resources
Two-dimensional d(i, j) = m(i, j) * r(j)	Whole network Ego networks	Path length Cluster membership	One type of resource, no aggregation

The above functions of d, m, and r stand for *network resource distribution*, *network structure matrix*, and *resource matrix*, respectively. The parameters i and j depict firms in the network.

Relating network resource distribution to existing integrative research

To illustrate how the generic *network resource distribution* concept is related to prior research integrating network structure and resources, five selected studies that have combined the resource-based view and the social network theory, shown in Table 3, are analyzed and discussed in detail. This demonstrates how the concept can be applied in practice.

Baum et al. (2000)

The seminal study by Baum et al. (2000) analyzed the impact of alliance network composition on start-up performance in the context of biotechnology firms. Their study related alliance network size and efficiency, defined in terms of diversity of partner types, with the innovative capabilities and relative competitive scopes of potential partners.

Table 3. Relating the concept of network resource distribution to select studies

Study	Network level	Distribution type	Network metrics	Resource metrics
Baum et al. (2000)	Ego network	One-dimensional	Network efficiency Network size	Relative market scope of partners Partner innovativeness
Bae and Gargiulo (2004)	Ego network, with ties between partners	One-dimensional	Network density	Aggregate market power of partners Share of critical partners
Koka and Prescott (2008)	Whole network	One-dimensional	Eigenvector centrality Structural holes Number of ties	Ego strategy
Zaheer and Bell (2005) Whole network One-dimensional Structural holes				Ego innovativeness Average over partner innovativeness
Phelps (2010)	Ego network, with ties between partners	One-dimensional	Network density	Technological diversity

Expressed in terms of the *network resource distribution* concept, the study by Baum et al. (2000) is an example of a one-dimensional *network resource distribution* in which the network metric is calculated for the ego network of each firm. Baum et al. (2000) also differentiate ties with different partners, thus studying the impact of multiple networks—resulting in a separate *network resource distribution* for a given resource for each network. The metrics they use for the ego networks are network size—in essence, the number of ties to each different type of partner—and network efficiency, expressed in terms of a Hirschman-Herfindahl index over the different types of partners.

The resources of network partners were measured in terms of the relative scopes of competitive activity between the focal firm and its potential rivals in the biotechnology industry, as well as the innovative capabilities of network partners. These two measures represent two ways of aggregating partner resources: innovative capabilities are summed for all network partners, while the relative scope of competitive activity relates the firm's own scope to the summed scope of its potential rivals. This latter measure provides an example of a situation in which the relative resources of network firms have an impact on the focal firm performance.

Bae and Gargiulo (2004)

The study by Bae and Gargiulo (2004) examined how alliance network structure and resources controlled by partners affect the focal firm performance. In contrast to Baum et al. (2000), they also considered explicit ties between partners and used the metric of network density to measure network structure around the focal firms, thus expanding the network metric beyond the dyadic ties between the focal firm and its immediate network partners. However, the metric used was still one-dimensional—i.e., it is dependent only on the focal firm.

In terms of partner resources, Bae and Gargiulo (2004) measured the market shares and quasi-monopoly status of immediate network partners. An index was formed for the former by summing over the market shares of partners, while for the latter the market share of partners with quasi-monopoly status was used as a measure. Both of these measures are again one-dimensional for each focal firm, and accordingly, the resultant *network resource distribution* is also one-dimensional. However, the study of Bae and Gargiulo demonstrates that a *network resource distribution* does not need to be limited to the immediate partners and that distributions can account for the whole network structure beyond immediate dyadic ties.

Koka and Prescott (2008)

The study of Koka and Prescott (2008) is an example of research on alliance networks that incorporates measures of the focal firm's position within interfirm networks. The authors used network centrality and degree metrics to measure the strength of the focal firm positioning and a structural hole metric to characterize the network structure. In terms of the *network resource distribution* concept, they thus used one-dimensional metrics that were measured over the whole network. Moreover, their study also used a weighing scheme, in which the intensity of collaboration in each alliance was measured and used in the calculation of network metrics. This provides an example of how tie strength can be included as part of a *network resource distribution*.

Unlike the other two previous studies discussed above, the study by Koka and Prescott (2008) only incorporates ego resources—strategy type—in the interaction between firm resources and network structure. Apparently, this type of measure does not need to be aggregated, and the measure depends only on the focal firm. This study thus exemplifies that the concept of *network resource distribution* can accommodate research that does not explicitly include partner resources.

Zaheer and Bell (2005)

The study by Zaheer and Bell (2005) related the occurrence of structural holes in interfirm networks with focal firm and partner innovativeness. Using data from the Canadian mutual fund industry, they were able to construct the structure of the entire network instead of just the immediate partners of focal firms. Using these data, they measured structural holes between the focal firm and all possible network partners, including indirectly connected partners. In terms of the *network resource distribution* concept, they constructed a one-dimensional metric—structural holes—that depended on the chosen focal firm.

This structural measure was then complemented with two measures of firm resources: focal firm innovativeness and partner innovativeness. Partner innovativeness was measured as a weighted average of the innovativeness of all partners, using the reciprocals of partner network redundancy as weights. This partner innovativeness measure thus captured, to some degree, how the innovativeness of partners was distributed in the network as measured from the focal firm. However, despite this weighting, the partner innovativeness measure was still an aggregate measure of partner resources. No detailed information on how innovative partners were specifically positioned with respect to the focal firm was used. Thus, the resulting *network resource distribution* was still only one-dimensional. Nevertheless, this study highlights the main idea behind the concept of *network resource distribution*: when analyzing firm performance in interfirm networks, the analysis should not be limited only to the resources of immediate partners; rather, the whole network should also be accounted for.

Phelps (2010)

The study by Phelps (2010) investigated how network density and partner knowledge diversity interact to affect the focal firm explorative innovation. Network structure was again measured in terms of network density over potential ties between the focal firm's immediate network partners, and thus, the measure extended beyond the simple dyadic level of analysis.

By contrast, Phelps (2010) measured partner knowledge diversity based on a categorization of the firms' patents and their uniqueness among the partners, calculated over the whole network. This measure thus accesses the resources of all partners in the network, including those that are only indirectly linked to the focal firm. However, the resulting measure is only one-dimensional and depends only on the chosen focal firm. Combined with the network density measure, the resulting *network resource distribution* is again

one-dimensional and thus depends only on the chosen focal firm. Interestingly, Phelps also considers a curvilinear relationship between network knowledge diversity and the focal firm performance. This is an example of how different types of *network resource distribution* measures can be related to the focal firm performance.

Summary

The selected five empirical studies highlight how existing research has considered the interaction between firm resources and interfirm network structure. However, closer analysis revealed that only a few of the potential types of interaction have thus far been examined empirically. For example, none of the studies considered the possibility of studying the individual resources of specific network partners. The studies also use a relatively unvaried set of network structure metrics and resource measures. In this sense, the generic *network resource distribution* concept helps to reveal which conceptually possible combinations have not yet been considered, and where contributions are still needed to improve the understanding of the interplay between the resource-based view and the social network theory. Importantly, the analysis of the selected studies also demonstrated that the existing analytical models can be conceptually deduced from the concept of *network resource distribution,* highlighting its generic nature and applicability across different research goals.

Network resource distributions and the focal firm performance

As demonstrated above, the concept of *network resource distribution* can successfully be used to model and analyze a wide variety of combinations of interactions between firm resources and network structure. In the following, it is argued that *network resource distributions* matter for the focal firm performance.

First, extant research combining the resource-based view and the social network theory has indicated that in a dyadic setting, the interaction between firm resources and network structure does affect the focal firm performance (Baum et al., 2000; Kale et al., 2000; Reagans & McEvily, 2003; Rothaermel & Boeker, 2008). Moreover, the overall structure of interfirm networks and resources distributed throughout those networks affect the performance of firms embedded in those networks (Bae & Gargiulo, 2004; Whittington, Owen-Smith, & Powell, 2009; Zaheer & Bell, 2005). These studies, although limited to the dyadic level, suggest that a combination of the two perspectives is needed to explain fully the focal firm performance.

Second, chaining this dyadic logic implies that relational benefits are likely to ripple throughout the network. The interaction between two firms benefits the focal firm not only through access to complementary resources but also by relational advantages created by unique combinations of resources as well as by potential spillover effects from the resources of the network partner. Thus, as suggested by Lavie (2006), the resources of interconnected firms affect the performance of both firms in a dyadic relationship. While, for many resources, the boundaries of firms formed by buy-or-sell decisions are clear, this is not the case for all types of resources. For example, many knowledge resources require intermediaries, if a firm is to benefit from the knowledge of other firms (Carlile, 2004; Hargadon & Sutton, 1997). Hence, there is a need to consider the impact of more distant network alters and their resources on the performance of the focal firm. Based on Lavie's model of competitive advantage for dyadic relationships, the resources available to the immediate partners of the focal firm depend at least partly on the resources of more distant firms in the network. The same logic can be applied to the network partners beyond the immediate ones, and so on. Thus, based on this recursive logic, it can be argued that the resources accessible to the focal firm depend to some degree on the resources possessed by all firms in the interfirm network. Now, as argued by the resource-based view of interfirm alliances, having access to required complementary resources has an impact on the performance of the focal firm by, for example, allowing it to concentrate on its own core competences and mitigating the need to invest in complementary resources. Such ambidexterity through alliances has recently been studied on the alliance portfolio level and proposed to have a positive impact on the focal firm performance (Wassmer & Madhok, 2017). The static view of interfirm network relationships thus suggests that to understand fully the performance of the focal firm, it is necessary to consider how resources are distributed throughout the entire network. This view is also corroborated by Gulati et al. (2011), who argue that network structure, relational properties of ties, and firm attributes (i.e., resources) should all be analyzed for complete treatment. A similar indirect effect on the value-creation potential of the "operating" resources was recently explored by Wibbens (2019) in the context of the focal firm's higher-order resources. In this view, the whole network could be seen as a higher-order resource—or a dynamic capability—that does not directly affect the performance of the focal firm but does affect it indirectly by affecting the value-creation potential of the focal firm's "operating" resources. In this same vein, to account more fully for the value-creation potential of the whole network as a higher-order resource, all of its members and their relationships with one another need to be accounted for. Another recent study suggests that the competitive tensions

and cooperative arrangements between partners affect their value-creation prospects for the focal firm (Asgari, Tandon, Singh, & Mitchell, 2018), further implying that additional attention needs to be paid to the partner network structure to benefit from available resources.

Third, based on the theory of relational benefits, empirical evidence from other levels of analysis also suggests that the interaction between resources and network structure needs to be analyzed beyond the dyadic level of relationships. On the organizational unit level, Hansen's (2002) study of knowledge transfer between organizational units and its impact on project completion suggests that the path length between two organizational units that need to exchange knowledge has an impact on project completion time. It is thus not sufficient to know that the required knowledge is available in a network but also know where this knowledge is located and how many ties must be crossed to access this knowledge. Interpreted in the context of interfirm networks, Hansen's results suggest, as argued in this paper, that the location of network partners possessing valuable complementary resources matters for the focal firm's performance. More recently, the study by Chiambaretto, Masse, and Mirc (2019) on the impact of knowledge brokers in managing the tensions of internal coopetition suggests that trusted knowledge brokers have a pivotal role in facilitating knowledge flows between organizational units. In the context of interfirm networks, this finding suggests that direct partners with appropriate levels of resources—trust and knowledge, for example—facilitate and mediate resource flows originating from indirect partners. This finding points to the importance of considering the resources of all firms along longer network paths. On a managerial level, Rodan and Galunic (2004) studied how knowledge heterogeneity in managers' social networks affected their performance and innovativeness. They found that managerial performance is affected not only by the knowledge of their social contacts but also by how the knowledge of these persons is related to each other. This finding indicates that to analyze the focal firm's performance within interfirm networks, it is not enough to consider the resources of the network partners; one must also consider how the resources of these partners are related to each other.

Fourth, limited direct empirical evidence also exists in support of the presented theoretical arguments relating *network resource distributions* to firm performance. The study by Gulati (1995a) analyzed the formation of alliances based on prior network structure and strategic interdependence (i.e., resource characteristics). The findings of the study suggest that indirect ties matter for alliance formation, hinting that firms consider these indirect ties beneficial for their performance.

In summary, both existing empirical evidence and theoretical arguments suggest that *network resource distributions* have an impact on firm

performance. However, given that the focus of this paper is on developing the unifying *network resource distribution* concept, testing of the related theoretical argument is left for future research.

DISCUSSION

By proposing a unifying concept that accounts for the network structure and firm resources, this paper makes two contributions to research on interfirm networks. First, the *network resource distribution* concept systemizes the existing research on interfirm networks that has sought to combine the resource-based view and the social network theory. The concept generalizes the currently used conceptualizations of the perspectives and provides an integrated, coherent framework for future research on interfirm networks. The unifying concept highlights similarities and differences in existing research and helps authors in the area relate their work to the work of other researchers, as existing approaches can be derived deductively from the concept (c.f., Carpenter et al., 2012). Furthermore, the *network resource distribution* concept helps to identify gaps in the existing knowledge about the combined impact of interfirm networks and firm resources, highlighting potential avenues for future research. As research on the strategic impact of interfirm networks is still in a relatively early phase, the concept helps researchers direct their efforts to areas that are likely to enhance the understanding of the interaction between resources and network structures. Relatedly, as a step towards closing a specific and significant gap in the literature, the *network resource distribution* concept highlights the importance of studying the interaction between resources and network structure beyond the dyadic level. As already suggested in the existing literature (e.g., Gulati et al., 2011), the resources of indirectly related firms can also influence the focal firm performance. The concept accentuates this point by emphasizing the importance of observing the actual resources within the network beyond the immediate partners (cf. Tasselli, Kilduff, & Menges, 2015).

Second, similar to the work of Carpenter et al. (2012), the *network resource distribution* concept complements prior studies and paves the way for new studies that propose complex theoretical concepts combining network position and firm resources by aiding the operationalization and, thereby, the testing of the concepts. For example, the unifying concept complements the theoretical framework of Gulati et al. (2011), aiding high-precision operationalization and testing of the proposed reach, richness, and receptivity concepts—the three mechanisms that are proposed to drive the firm-level performance outcomes of networks.

Avenues for future research

The *network resource distribution* concept opens new and significant opportunities for researchers to contribute to research on interfirm networks and firm performance. The proposed concept constitutes a small step forward; many further theoretical issues need to be investigated in the future. First, how does the network configuration at the network node level—the resource mix and the resource characteristics—affect the optimal shape of *network resource distributions*? Second, how do configuration choices at the relational level affect the optimal shapes of the distributions? Recent research indicates that relational factors, such as competitive tensions and cooperative arrangements among partners (Asgari et al., 2018) as well as trust (Chiambaretto et al., 2019), affect the value of partners for the focal firm. Third, how do external environmental conditions influence the optimal shapes of the distributions? Prior research indicates, for example, that the prevailing regime of intellectual property protection affects the flow of resources between firms (Dushnitky & Shaver, 2009). Fourth, it would be interesting to study how the optimal shapes of *network resource distributions* depend on the configuration choices made on the whole network level and how optimal distributions evolve over time. Recent studies on alliance portfolios indicate that portfolio configuration choices play an important role in determining how much value the focal firm can derive from its network of partners over time (Andrevski, Brass, & Ferrier, 2016: Martinez, Zouaghi, & Garcia, 2017). Specifically, recent research indicates that the focal firm can achieve ambidexterity through alliances with an appropriate diversity of partners (Wassmer & Madhok, 2017), that partner diversity also affects relational characteristics such as trust (Lee et al., 2017), and that resource-utilization levels are significant drivers of network evolution at the alliance portfolio level (Chiambaretto & Wassmer, 2019). Network level configuration studies could seek to extend these findings from the alliance portfolio to the network level. The proposed *network resource distribution* concept could be used to test the validity of these portfolio level findings on the network level. Fifth, recent research has investigated firm exploratory and exploitative innovation output on the individual inventor level (e.g., Grigoriou & Rothaermel, 2017; Tasselli et al., 2015; Yan & Guan, 2018), suggesting that unpacking firm level aggregate measures into more fine-grained employee level resource networks would reveal strategically significant but otherwise invisible configurations. Interestingly, the *network resource distribution* concept could also be applied on the employee level to further extend these efforts. Finally, it has been argued that the social network theory needs to be extended into a multilevel theory—accounting for individuals and their

collectives. In this vein, Paruchuri, Goossen, and Phelps (2019) have recently suggested conceptual foundations for multilevel social networks. Future research could build upon the study of Parachuri et al. (2019) and seek to investigate how *network resource distributions* on various levels of analysis interact with one another.

Managerial implications

Viewing an interfirm network through the *network resource distribution* lens highlights that managers should not limit their analyses of strategic alliances to immediate partnerships; it is also essential to consider the partners, their resources, and how they are related to one another outside of the immediate partnership sphere. Thus, managers are encouraged to shift their focus from dyadic strategic alliances towards sequential partnering, a strategy in which firms accrue value outside of immediate partnerships. To this end, the commonly practiced ego network analysis should be applied not only to the focal firm but also to every network partner to reveal the true value-added of the partners. Network synergies (Hernandez & Shaver, 2019) can constitute a significant portion of the value-added of a partner.

CONCLUSION

Although prior research has sought to integrate the resource-based view and the social network theory perspectives on interfirm networks and their impact on firm performance, this research has been limited to the types of interactions considered between firm resources and network structure. To provide a coherent and unifying grounding for further research in the area, a unifying concept of *network resource distribution*—defined as the spatial pattern of resources within an interfirm network, in which a specific location is related to specific levels of those resources—is introduced. This concept combines—in detail—the concepts of network structure and firm resources and, thereby, facilitates further empirical inquiry by aiding the operationalization of related complex constructs that have, thus far, received only theoretical treatment. Based on theoretical arguments and existing empirical evidence, it is argued that *network resource distributions* can be linked to firm performance.

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Abstrakt

CEL: *Celem tego artykułu jest zaproponowanie koncepcji dystrybucji zasobów sieciowych, która systematycznie ujednolica zasobową i sieciową perspektywę sieci międzyorganizacyjnych oraz umożliwia zintegrowaną analizę interakcji zasobów firmy i struktury sieci w celu wpływania na wydajność firmy.* ***METODYKA:*** *Zawiera przegląd istniejącej literatury na temat sieci międzyorganizacyjnych, a następnie rozwija ujednoliconą koncepcję dystrybucji zasobów sieciowych.* ***WYNIKI****: Przegląd literatury wskazuje, że badacze strategii od dawna starali się zintegrować pogląd oparty na zasobach i wynikach firmy w sieciach społecznych, ale jak dotąd osiągnięto tylko częściową integrację. W szczególności badania nad heterogenicznością na poziomie zasobów sieci międzyorganizacyjnych ograniczyły się w dużej mierze do analizy diad firm. W jaki sposób zasoby firmy i struktura sieci poza bezpośrednimi partnerami sieci współdziałają, aby wpływać na wyniki firmy, nie zostało jeszcze odpowiednio wyjaśnione. Zaproponowana ujednolicona koncepcja dystrybucji zasobów sieciowych systematyzuje wcześniejsze badania i wyjaśnia, w jaki sposób struktura sieci i zasoby firmy oddziałują, wpływając na wydajność firmy poza bezpośrednimi partnerami sieci.* ***IMPLIKACJE DLA TEORII I PRAKTYKI:*** *Niniejszy artykuł zwraca uwagę na luki w istniejącej literaturze na temat sieci międzyorganizacyjnych i proponuje ujednoliconą koncepcję, którą można wykorzystać, aby zająć się lukami badawczymi i rozwijać dalszą teorię w tej dziedzinie. W praktyce niniejszy artykuł zachęca menedżerów, aby nie ograniczali swoich analiz strategicznych sojuszy do bezpośrednich partnerstw; ważne jest również, aby wziąć pod uwagę partnerów i ich zasoby oraz zastanowić się, w jaki sposób są ze sobą powiązani poza bezpośrednim portfolio partnerstwa.* ***ORYGINALNOŚĆ I WARTOŚĆ:*** *Dystrybucja zasobów sieciowych to nowatorska koncepcja, która łączy i systematyzuje różne wątki badań nad sieciami międzyorganizacyjnymi, stanowiąc w ten sposób podstawę dla przyszłych badań w tej dziedzinie. Koncepcja jest również podatna na szczegółową operacjonalizację, ułatwiając późniejsze ilościowe testowanie argumentów teoretycznych łączących zasoby firmy i strukturę sieci.*

Słowa kluczowe: *podejście zasobowe, sieci strategiczne, relacje międzyorganizacyjne, sojusze, wydajność firmy*

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Conflicts of interest

The authors declare no conflict of interest.

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