

The Network Structures of Industrial Enterprises. A Modern Trend of Economic Development

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Abstract

The development of the digital economy is impossible without the transformation of the internal organization of the economic space, which is associated with the transition to a network model. Network structures of industrial enterprises can become an effective embodiment of such networks. The basis of the network model of development are high-tech industrial enterprises, a significant part of which are mechanical engineering enterprises, where the results of scientific research are materialized in goods, technologies, services, and, in turn, form the order, the need for further research. Our study presents an analysis of the conditions of networkization of the economy, its benefits for enterprises. Conclusions and results of quantitative analysis are also presented. Limitations and suggestions for further research are discussed.

Keywords

Network; structures; industrial enterprises; characteristics; networkization.

Introduction

In the conditions of globalization and increasing uncertainty, there is a need for transformation of the organizational and economic structure of the domestic economy. The transformation can be achieved through network interaction which is the basis of such a process as networking which becomes an integral feature of the modern economic system connected with the development of knowledge, high technologies, and breakthrough innovations. In the conditions of development of integration processes, the effectiveness of interaction of enterprises observed within network structures (Rakhova & Zakirova, 2018), which are a more effective form of organization and management of business processes in the economy, increases. The world practice proves that the vertically built system of interactions between economic entities limits the opportunities to implement innovations and high

technologies in the activities of enterprises and becomes, among other things, the reason for the slowdown of their economic growth and competitive development.

According to W. Powell networking is based on mutually beneficial models of communication and parity exchange, relying on different types of mutual trust (Powell, 1991). It is the trust between the network participants that underlies the decision to join the network structure, a meaningful choice of strategy, partners for interaction, determination of the risks of loss of independence, allowing increasing the quality of interaction, stimulating the exchange of knowledge, technologies. Necessary conditions of formation of confidential relations in network structures are the intensity of interaction; the business reputation of participants; expected benefits from cooperation within a network; the presence of norms and rules of interaction. In the course of the research, it is established that the emergence of network structure in industries causes a significant increase in profits (Romanenko, 2010); an increase in the market value of high-tech companies (Stuart, Hoang, & Hybels, 1999) and promotes the accelerated penetration of knowledge (Powell, 1992).

World practice shows that the benefit of cooperation and integration is achieved, first, in the production of complex high-tech products, as well as unique and exclusive goods, because the choice of partners is limited, and the cost of its behavior to extract their benefits through cooperation is high. Second, the production of goods for a dynamic market is difficult to predict, with uncertain demand and uncertain price changes.

In the process of networking, network structures are created, which are considered as a new model of organizing business interactions (Podolny & Page, 1998) and harmonization of interests (Smorodinskaya, 2012), representing special ways of integrating economic subjects based on dynamic horizontal links. In scientific circles, the network is also considered as an institution that defines the rules, norms of interaction, and integration of economic subjects (Tyutyushev, Gasanov, & Vasechko, 2011).

As the literature review shows, sufficient attention is paid to networking issues.

Previous research has shown that networking through networks is an innovative response to solving social problems (Keast, Mandell, Brown, & Woolcock, 2004). At the same time, there is no effective way to determine if networks are a more effective means of developing policy and delivering goods and services (Mandell & Keast, 2008). Brian W. Head believes that networking is more effective in an environment where agreed agreements between stakeholders are seen as necessary and appropriate, and technical solutions are not feasible (Head, 2008). At the same time, it is argued that assessing the mechanisms for managing network structures is a difficult task. However, there are network characteristics that affect the functioning of the networks and their efficiency (Willem & Lucidarme, 2014).

Methodology

This article is structured as follows:

The introduction provides an overview of the theoretical and empirical literature on the formation and functioning of network structures; methodology, which shows the main characteristics of the study.

The main section, where the main results of the study are given: This section contains statistics on the distribution of network structures; theoretical substantiation of the peculiarities of the functioning of network structures; and their assessment of the characteristics of network structures on the example of the network structure of industrial enterprises in the Vladimir region.

The discussion section summarizes the research results and draws the main conclusions.

The purpose of this study is to study the characteristics that network structures have and highlight those that can be used to assess the degree of development of the network structure and the success of enterprise interaction. To assess the development of the network structure, a set of indicators is used, the calculation model of which is presented in Table 1.

Table 1. Characteristics of structural properties of the network structure of high-tech industrial enterprises

<i>Indicator name</i>	<i>Economic Interpretation</i>
Formation density	Reflects the ratio of actual interactions within the to the network structure number of all possible interactions
Duration of business contacts	Reflects the ratio of the average contract time to the time of existence of education
Stability of connections	Reflects the number of long-term connections to the total number of actual connections
The tightness of business ties	Share of the number of transactions made with the same partner to the total number of transactions
The level of communicativeness of education	Characterizes the relative number of education elements associated with enterprises that are not education elements.
Asymmetric relationships that take into account differences in the market power of partners.	Characterizes the ratio of the number of interactions between large participants to the actual number of interactions within the network structure
Mutual Interest Indicator	Characterizes the share of double bonds in the total number of bonds of formation.
The appeal of education	Characterizes the ability not only to retain previous members but also to attract new members

The study used data from Russian industrial enterprises. These enterprises are located in the Vladimir region. The data were obtained in the course of interviews with top managers of companies and their deputies. The interview was conducted over two weeks in February 2021.

Results

Currently, network structures are widespread. Thus, according to M.A. Kantemirova's estimates, the number of network structures in the Russian economy increased by 1.3 times from 2005 to 2012 (Kantemirova, 2015) and this process continues. There is also an increase in the share of innovation-active manufacturing enterprises participating in cooperative interactions. The most common interaction of manufacturing enterprises with suppliers of raw materials and other types of resources is reflected in Figure 1. The most frequent forms of their interaction are long-term partnerships (Vlasova, Kuznetsova, & Rud, 2017). As seen in Figure 2, 38.5% of high-tech enterprises in the manufacturing industry choose the network model of cooperation.

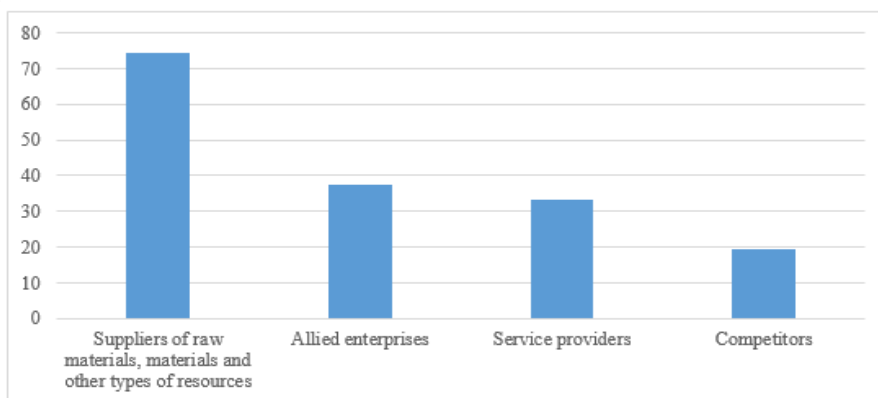


Figure 1. Share of enterprises interacting with the partner, as a percentage of surveyed enterprises
(Vlasova, Kuznetsova, & Rud, 2017)

It is difficult to overestimate the influence of network structures, within which network interactions are carried out, on economic development as they open prospects and new possibilities: time of realization of economic operations is reduced; there is a possibility of contact without intermediaries; mobility and flexibility in the realization of economic activity are increased; return from results of the executed work increases (Kelly, 1999); the importance of intellectual and technological component increases; the focus is shifted from reception of a full set of the results of economic activity. Assessment of the results of the influence of interactions between enterprises on the criteria of their activities showed an increase in such indicators like revenue, production of new/improved products, profitability of production, energy intensity, environmental friendliness in different types of interactions of enterprises (Eliseeva, 2019). Labor productivity and material intensity increased to a greater extent when enterprises cooperated with partners in the production chain than with enterprises of similar or close profile.

The key motive of the formation and development of network structures is the reception of effect from joint activity of the enterprises-participants of a network. Thus benefits of the concrete enterprise increase, if it carries out activity in a network, that

is observed effect of synergy which is a key component of any network structure and the reason for its formation. It is a proven fact that the presence of network cooperation contributes to the growth of competitiveness of network participants (Filimonova, Starikova, & Clark, 2018; Pavlenko & Lovkova, 2018; Stukalo, 2016).

Network structures are formed where there are constant interactions, stable relations, and interdependent strategies of the participants, and are "multicenter ... associations using a common system of communications, built on the commonality of goals and values, constantly exchanging various kinds of resources". By interacting, companies voluntarily enter into resource dependence on each other, as the pooling of resources controlled by different companies in the implementation of a common project allows them to receive common benefits (Powell, 1991).

The ways of creating such structures are varied and include transformation, merger, accession, cooperation, division, spin-off, etc. (Kostareva & Sterlyagova, 2014).

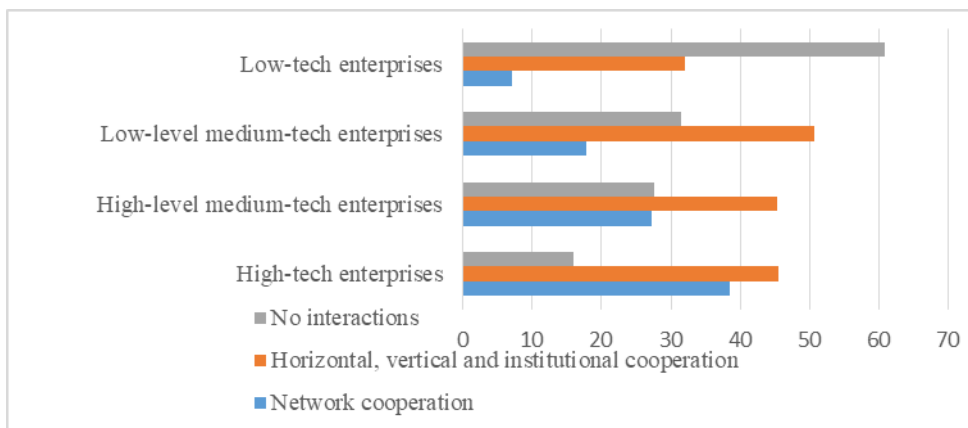


Figure 2. Share of enterprises using different models of interaction, by type of activity, as a percentage of surveyed enterprises
(Vlasova, Kuznetsova, & Rud, 2016)

The formation and development of network structures are due to (Novikova, 2013; Smorodinskaya, 2015):

- The emergence and widespread use of outsourcing and offshoring as business strategies;
- The formation of global value chains everywhere;
- customization of production, in which the consumer who uses the final product is directly involved in its creation through direct interaction with the manufacturer, thereby realizing the reserves of cost savings based on the effect of diversity rather than economies of scale;
- a change in the nature of competition, when enterprises compete not for the volume of activity, as such, but for speed in the creation of innovation;
- technological development and the emergence of a new generation of advanced industry (the fourth industrial revolution - Industry 4.0), capable of producing complex individualized goods at a lower cost than the mass and serial type of production;
- integration of the information and financial space;

- abandonment of the use of hierarchical structures with a closed-loop, vertical subordination, and traditional model of management in favor of structures built on the principle of "coordination of links without hierarchy";
- creation and development of high-tech productions, the payback of which is achieved not only through access to regional and national markets, but, to a greater extent, through access to global markets;
- the increasing complexity of inter-industry, inter-regional, inter-country economic relations, and business environment.

Thus, network structures are the result of an objective and natural process of the development of economic systems.

The peculiarity of network structures is, firstly, the duration and length of the links between the elements of these structures, which, according to D. Bratsun, "*are regulated without the participation of a higher authority*", and the basic principle of management is coordination, and the basic principle of management is coordination, secondly, the openness of network interactions, which eventually leads to the rapid depreciation of information, which is a factor of production of high-tech products, thirdly, the resource interdependence of enterprises participating in the network, which is caused by the implementation of the stated objectives and is formed through access to additional resources.

It is resource interdependence that is the key incentive for the creation of contacts between economic entities, which, in turn, is the basis for sustainable partnerships. However, the degree of resource interdependence varies from participant to participant and is determined, on the one hand, by the importance of the resource at the participant's disposal, and, on the other hand, by the possibility of its replacement, which has an impact on the development of behavior strategies of network participants. An imprint on the implementation of strategies and an obstacle to the achievement of the goals is the unwillingness or inability of business entities to properly assess their resource potential (awareness of resource dependence, overestimation of their resource potential). Asymmetry of roles of managing subjects in a network is determined by their inequality in resources, in the fourth, a high level of information and communication interactions, in the fifth, secondary character of market mechanisms in interrelations, in the sixth, a variety of participants and their goals. The network structure includes diverse and different-scale participants, which implement the goals and maintain their independence. Thus any of the participants cannot predict the result received at network interaction and result of the transformation of its priorities and the purposes in the course of interaction.

Uncertainty of interaction is multiplied by unpredictability and variability of the behavior of network participants. Factors hindering effective interaction at the present stage include opportunistic behavior, in which participants invest little effort and resources in collective projects, favoring the transfer of responsibility and decisions to others, short-term partnership before the goal is achieved, postponing the decision to cooperate until the benefits and drawbacks of joint action become apparent.

Strategica. Shaping the Future of Business and Economy

Thus, the network structure is the structure formed as a result of interaction and integration of the enterprises transforming all kinds of resources into finished products. Proceeding from its system elements of network structure are the industrial enterprises, especially their hi-tech part, various forms of ownership, represented in various organizational-legal forms.

The identification of the network structure begins with the fixation of interactions between enterprises. Such a scheme is presented in Figure 3 among the enterprises of mechanical engineering in the Vladimir region.

The characteristic of the density of connections allows to quantitatively estimate a degree of development of network structure (Table 2), and success of interaction of the enterprise is estimated through an indicator of mutual interest.

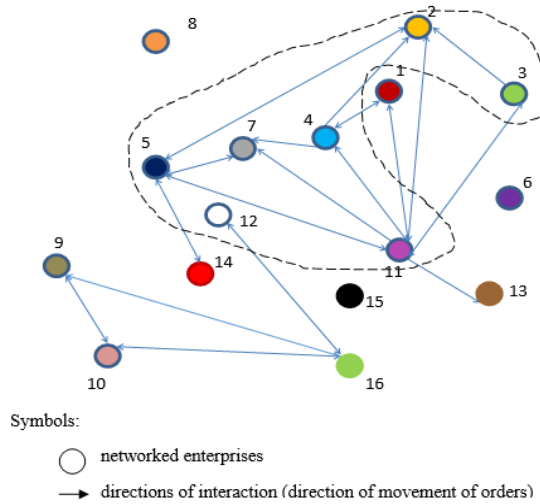


Figure 3. Interaction of industrial enterprises of the Vladimir region

Table 2. Cooperation level

Participating companies	1	2	3	4	5	6	7	8
Maximum possible number of links	26							
Actual number of links	6	2	7	0	4	2	3	6
Cooperation density indicator	23,08	7,69	26,92	0	15,38	7,69	11,54	23,08
Participating companies	9	10	11	12	13	14	15	16
Maximum possible number of links	26							
Actual number of links	0	10	1	4	4	0	1	5
Cooperation density indicator	0	38,46	3,85	15,38	15,38	0	3,85	19,23
Total level of cooperation					22,92			

The outline in Figure 3 highlights the identifiable network structure. Let us provide quantitative assessments of the characteristics of the structural properties of the network structure of industrial enterprises (Table 3).

Table 3. Indicators of network structures of industrial enterprises

<i>Indicator name</i>	<i>level</i>
Formation density	11,54
Duration of business contacts	0,33
Stability of connections	61,91
The tightness of business ties	78,12
The level of communicativeness of education	57,14
Asymmetric relationships that take into account differences in the market power of partners.	28,57
Mutual Interest Indicator	47,62
The appeal of education	42,85

Thus, we obtained the characteristics of the network structure of industrial enterprises in the Vladimir region. It is possible to conclude that the stability and high potential of this structure.

Conclusion

Our study used a scoring system to gain a clearer and simpler understanding of network structures and how they function. The results obtained in this study are in good agreement with other studies conducted in this area. In our study, it is proposed to use a larger number of indicators to characterize the operation of network structures.

In the course of the study, it was found that the indicator of the density of connections allows one to quantify the degree of development of the network structure, and the indicator of mutual interest characterizes the success of the enterprise's interaction. This finding complements the findings of a study by Annick Willem & Steffie Lucidarme, which showed that network flexibility and trust play a central role in building effective networks (Willem & Lucidarme, 2014). We also proposed a system of indicators for assessing the development of the network structure. The proposed indicators have a high predictive potential for the development of network structures. In this article, we move the discussion forward based on the assertion that industrial networks contribute to the economic development of both the enterprises themselves and the territory.

Our research has limitations that future research will need to take into account. The scope of the study should be broadened and tested across more enterprises and multiple networks. Also, as part of network structures, it is necessary to take into account not only enterprises but also educational and scientific institutions, financial and other organizations.

The results presented in this study can be of benefit to enterprises that are part of network structures in planning the performance of modern industrial enterprises, building their business models, territorial authorities - when creating conditions for the formation of network structures, government authorities when forming industrial policy.

Further direction of research requires the development of methods for assessing the level of maturity of industrial enterprises to participate in network structures.

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