

AN ASSESSMENT OF THE NETWORK CONSISTENCY OF THE ENTREPRENEURIAL STRUCTURE IN THE CONDITIONS OF THE DIGITALIZATION OF THE ECONOMY

Olena KHADZHYNOVA

*SHEI Pryazovskyi State Technical University
Universytetska str. 7, Mariupol 87555, Ukraine,
Email: azsudcom@gmail.com
ORCID: 0000-0002-7750-9791*

Pavlo BURAK

*Mykolas Romeris University,
Ateities str. 20, 08303, Vilnius
Email: pavel.v.burak@gmail.com
ORCID: 0000-0001-5689-4355*

Oleksandr KALININ

*SHEI Pryazovskyi State Technical University
Universytetska str. 7, Mariupol 87555, Ukraine,
Email: kalininandkalinin@gmail.com
ORCID ID: 0000-0001-5238-0525*

Abstract. This article is dedicated to the study of network viability, the abilities of the entrepreneurial structure, and an analysis of interfirm interactions in the context of the digitalization of the economy. The key goal is to develop a network solvency model as a methodological basis for the most complete assessment of the capabilities of the entrepreneurial structure for effective interaction in an entrepreneurial network in the context of the digitalization of the economy. The theoretical basis of the model was the work of representatives of institutional economic theory, the resource approach, economic sociology, etc.

The object of the study was the set of intercompany relations in the business network in the context of the digitalization of economic activity.

The subject of the study is the economic relations between business structures regarding the formation and development of inter-firm relations in a network association.

The logical and system methods of analysis were used alongside the methods of statistical analysis and expert assessments.

The specifics of the problem of determining the factors that affect the ability of economic entities to build effective long-term intercompany interactions in the context of the development of the digital economy determined the structure of the study.

It was necessary to analyze approaches to assessing intercompany interactions in a business network in order to identify a number of features and systematize the factors that affect the effectiveness of such interactions. The research algorithm included the following stages: the study of scientific research reflected in the periodical press on the trends in the development of the digital economy; the identification of factors affecting inter-company interactions in the business network in the digital economy; the formation of the authors' vision of the network viability of economic entities in the digital economy; and the identification and evaluation of the parameters of the network viability of economic entities in the digital economy.

The developed model of network consistency is based on the analysis of the space of factors from the standpoint of the relationships between three structural elements that have an indicative, connecting and affirming effect on the development of inter-company interactions in the context of digitalization of economic activity. The pointing element is formed by the resource characteristics of the participants in intercompany interactions, the connecting element is aimed at the competent management of emerging relationships, and the resulting element reflects the synergistic effects that appear as a result of strengthening the interactions of economic entities in the business network.

Keywords: entrepreneurial networks, entrepreneurial structures, economic entities, intercompany relations, network solvency, digital economy.

Introduction

A variety of organizational and legal forms of business in the modern economy contribute to the formation of a huge number of industrial, commercial, information and entrepreneurial structures. In the process of the production and economic activity of entrepreneurial structures, groups of partner enterprises are formed – entrepreneurial networks, the participants of which have a certain dependence and interconnection. The network interaction of business entities is based on: the need to reduce costs and increase competitiveness; reducing risks and threats to the external environment; obtaining the possibility of mutually beneficial use of joint resources, technology, and information; and the opportunity to create organizational and financial stability for further business development.

The developing digital economy is characterized by: the expansion and strengthening of the relationship between the state, science, education and business, implying the presence of purposefulness and systematicity in activities; planning; information transparency; contact of subjects; mobility; trust; and social activity. This implies that economic entities have: common goals; clear structures; and a high level of organization, motivation, humanization, effectiveness and coordination of actions, which is the basis for the development of entrepreneurial networks. Thus, the active processes of the digital transformation of all basic sectors of the economy contribute to the development of business networks and dictate new trends in the process of interaction between business structures. Despite the great interest of modern researchers in the topic of network business structures, the issues of managing network structures in the context of digital transformations, determining the network potential of an entrepreneurial structure, and relationship management in business networks remain understudied. The purpose of this work is the study of the networking ability of entrepreneurial structures, as well as the analysis of inter-firm interactions in the entrepreneurial network in the context of the digitalization of the economy.

Research results

The phenomenon of entrepreneurial networks is not new to the economy. Since the late 1980s, entrepreneurial networks have been actively developing, fueled by rapid advances in technology and increased market competition. The development of globalization processes has marked the transition to new business models based on strategic partnerships between business sub-subjects and the creation of value. Modern high-tech companies generate products, vicarious resources and the competencies of hundreds of partners scattered around the world. Efficient cooperation adopts the development of information technologies that allow the online mode to obtain accurate information, coordinating the efforts of all participants in the process of value creation. Enterprises are becoming the most important organizational and administrative structures in the current business climate. As a result of the effective interplay of the participants in the network, the competitive advantage for the final purchaser is the lower price, which builds the capacity of all network subjects.

The features of modern economic processes, due to the development of the digital economy, involve the formation of:

- the global ecosystem of the digital economy and the global digital space;
- a qualitatively new structure of economic assets that meet the economic priorities of the digital economy;
- approaches to the organization of manufacturing industries, the trade sector, and the service sector, taking into account the achievements of the digital economy that are effective in the context of the formation and development of the global digital space;

- principles of effective management and the improvement of the management of existing economic resources;
- conditions for the active participation of the business community and the population in the formation of the digital economy space by creating attractive organizational and regulatory conditions and a space of trust in the digital environment;
- systems for ensuring the security and sovereignty of the national space of the digital economy.

These trends have led to the formation of new forms of organizing intersubjective interactions based on the advantages of flexible structures, contracts and other types of agreements, combining external components into various types of network forms of organization and adapting to rapidly changing market realities.

The study of various definitions of network, network organization, etc., shows that within the entrepreneurial network, most researchers understand the presence of a permanent, stable circle of autonomous independent firms (usually quite highly specialized) that perform various tasks necessary either for the functioning of the parent company in the market or the implementation of some unifying idea that they cannot implement separately. A network organization combines advanced technologies, traditions, resources, goals, experience and production capabilities of agents of an entrepreneurial network.

An entrepreneurial network is a set of legal entities and individuals (entrepreneurs, enterprises and organizations) which, on the basis of social mechanisms, establish contacts, agree on forms and conditions of interaction to implement their ideas, intentions and goals, achieve competitive advantage, and reduce transaction costs and economic benefits in terms of risk and uncertainty of the external environment.

The network is an association of business structures regulated by market laws. The network elements, which are independent business entities, are aimed at cooperation with each other, the exchange of information, and the provision of products and services on favorable terms for other network participants in order to maintain their own place in the value chain.

Today, entrepreneurial networks, along with syndicates, concerns, holdings, consortiums, business associations, franchisees, cartels, pools, virtual companies, trusts, strategic alliances, unions, complexes, industrial hubs, financial and industrial groups, contract groups, multinational companies, etc., are one of the more complex forms of metacorporation – an association of a certain number of business entities that does not have the status of a legal entity. Voluntary participation implies the development of creativity in the activities of the network elements. Network elements are constantly adapting to market requirements, take into account the development trends of science, engineering and technology, and are flexible in relation to environmental factors. This contributes to the constant renewal and development of network organizations.

It is in network organizations that the synergistic effect is clearly manifested. The ability to improve the final results of enterprises' activities through joint work and the attraction of new partners due to the reliability, sustainability, flexibility and adaptability of the structure is ensured. The use of network structures can provide small businesses with the opportunity to compete in the market with large organizations due to their flexibility and efficiency.

Today, a new trend has emerged in the global community – the creation and development of entrepreneurial networks. This is a new approach of firms to solving various problems with the rapid development of the global economy, markets, technologies, and the emergence of new high-tech products, while improving integrated solutions in the modern economy, with a high level of risk on the market.

Companies create entrepreneurial networks in the form of strategic partnerships with suppliers, consumers, governments and other organizations, various institutions, research centers, laboratories, and even with competing firms in order to increase the efficiency of the enterprise,

reach a new level of quality of products, services, development and introduce innovations to the global market which is impossible to achieve in the conditions of direct competition. Based on the foregoing, we can conclude that relationships between companies provide the formation of an entrepreneurial network in which the success of each unit depends on the success of the entire network as a whole.

Thus, business networks are based on social mechanisms and links between entrepreneurs and organizations in different sectors of society that are determined by the intentions and interests of decision-makers, as well as the potential of their enterprises and organizations (capital, knowledge, technology and other resources). Firms have variable forms of interaction due to changes in their internal environment, which involve reformatting relationships and agreements, reconfiguring the network structure, the transition from mono- to poly-centric entities and back, and establishing mechanisms of hierarchical control and partnership.

The development of network forms of intercompany interactions in the digital economy requires, in order to assess the effectiveness of organizations, taking into account not only their individual characteristics, the specificity of the resources used and the ability to manage them, but also the long-term relationships that arise within the framework of the joint use of these resources to ensure the formation of new technologies, processes and knowledge.

Within the framework of the merging approach, mutual trade between companies is not seen as a bilateral repetition of trade, but as a system which has a mutually autonomous group of agents. The purpose of directing studies in these groups is to establish, develop and successfully promote a different kind of exchange between the parties, many of whom are not seeking a purely market-facing transaction. In this way, the results of the activity of an affiliated organization are determined by the distribution of resources and mutual relations with other affiliated organizations.

The decision to create a network is not always simple and obvious. Despite their successful development, inter-firm partnerships, in fact, remain controversial. They simultaneously manifest the features of both the firm and the market. On the one hand, entrepreneurial networks behave like a single firm, and partners jointly coordinate strategic actions and collective decisions. On the other hand, the competitive mechanism of the market continues to operate within the network. The success of the result depends on many factors: the choice of the level of association, the compatibility of strategic interests, the maturity of the industry, and even the commonality of cultural characteristics.

Most of the work on network topics in economics focuses on the problems of network structures in general as a new form of organization. At the same time, the issues of the optimal choice of partners to improve the efficiency of intercompany interactions within the framework of the network structure and the development of the digital economy remain understudied.

One of the key characteristics of economic entities in modern conditions is the presence of network solvency, which will provide entities with the ability to combine in their activities two processes of interaction with other market entities: competition and cooperation. Under the network solvency of an entrepreneurial structure, one should understand the totality of means and opportunities for cooperation of economic agents in order to increase the efficiency of network organizations. The network solvency of an entrepreneurial structure is also defined as a set of means and opportunities to improve the effectiveness of its network activities.

However, this approach does not take into account the features of the developing digital economy, such as:

- a change in the economic structure, expressed in a change in traditional markets and social relations, associated with the penetration of digital technologies into them;
- a change in the economic management model;
- the transition of the function of the leading mechanism for the development of the economy to institutions based on digital models and processes;

- the expansion of control and the development of value chains for additional business models based on platforms;
- new opportunities in the economy of accommodation.

Therefore, this approach needs to be adjusted taking into account the importance of the participation of economic entities in the processes of formation of the global ecosystem of the digital economy and the global digital space. This is because the digital economy is an economy based on digital computer technology and information and communication technologies, but, unlike informatization, digital transformation is not limited to the introduction of information technology. Instead, it radically transforms areas and business processes based on the Internet and new digital technologies (Pishchulina, 2020, p. 12).

The digital economy is impossible without the use of electronic technologies, electronic infrastructure and services, and technologies for analyzing large volumes of data and forecasting in order to optimize production, distribution, exchange, and consumption and increase the level of socioeconomic development. The rapid development of digitalization is becoming a reality not without new opportunities, but with serious threats and problems. In the context of digitalization, economic actors have unequal access to digital technologies and new opportunities, which leads to the emergence of digital divides. Therefore, it is important for economic entities to form and develop network capabilities and potential, i.e., a set of means and opportunities that ensure the satisfaction of the interests of both one's own business and the business network as a whole in the context of the development of the digital economy through a system of intercompany interactions.

The formation and development of network viability contributes to the creation of conditions for the active formation of the digital economy by maintaining a digital space of trust, which will allow networks:

- to create conditions under which justice and respect for obligations arising from formal and informal agreements will be observed;
- to prevent economic conflicts between different economic entities;
- to initiate the processes of creating sustainable and effective interactions to maintain and strengthen the economic security of the subjects;
- to promote social progress and the improvement of living conditions;
- to develop cooperation in the field of digital space and, in particular, in the field of the digital economy.

In general, network viability allows assessing the opportunities available to an economic entity and identifying those opportunities that it lacks for expanding intercompany interactions.

For the formation of network viability, an economic entity must take into account the relevant requirements of the external environment. First of all, an economic entity needs to realize the value of long-term, respectful relationships with other representatives of the business community and the client as the main consumer of the created goods and services, as well as to respect the role of state institutions in the formation of effective inter-company interactions.

In the context of the development of the digital economy, the success of any economic entity is largely determined by its ability to create effective inter-firm interactions. Of particular relevance is the issue of developing networking ability and viability, the main ideas of which are that long-term intercompany interactions are one of the key resources that bring both economic and non-economic effects in the long term.

Network viability combines the following levels of connections and relationships at the same time:

- basis, i.e., a set of properties and parameters accumulated by an economic entity to realize the ability for effective functioning and further development;
- the current situation, i.e., a characteristic of the use of available abilities under the current economic conditions.

Here it is also necessary to consider the fact of the presence of unrealized opportunities that reduce the effectiveness of inter-firm interactions in the business network.

Network viability is an opportunity for future development, i.e., the presence of prospects for the acquisition of new forces and abilities. This once again proves the important role of network potential as the ability of an organization to build effective inter-company interactions in the context of the development of the digital economy ecosystem.

Thus, economic entities can achieve sustainable development by choosing the optimal model of network viability as a factor that ensures the satisfaction of the interests of both business and society in the context of the development of the digital economy through a system of intercompany interactions.

Therefore, thanks to the assessment and timely formation of effective networking ability, participants in interfirm interactions have the opportunity to form a base of strategies that allow them to satisfy their own goals and all market requirements.

However, it should be noted that the key factors influencing the formation of network viability are the features of modern economic processes due to the development of the digital economy, described above. Thus, when forming effective intercompany interactions, economic entities should take into account the main directions of digital transformation: ensuring universally accessible connection to high-performance broadband Internet networks; digital platforms; infrastructure for information storage; big data processing technologies; and the formation of the digital space.

The network viability formed at the same time will be able to ensure the effectiveness of inter-company interactions by: attracting stakeholders to interact in solving a wide range of issues related to the development of the digital ecosystem of the business network; globalization of resources to create the possibility of managing risks arising from the complexity of the tasks of the functioning of the business network; coordination of actions between interested counterparties of the business network; and the formation of the possibility of rapid generation of knowledge.

It should be noted that the specific type of network consistency is determined by the forms and methods of implementing inter-firm interactions in the business network. At the same time, the following should be taken into account: due to differences in the levels of availability and use of opportunities, economic entities differ in scope, goals and ways to achieve these goals. Consequently, these aspects should somehow be traced in the strategies of economic entities seeking to realize their networking ability.

To date, the system of intercompany interactions is not developed, which is due to the lack of information about the needs and requirements of each economic entity, as well as the insufficient development of forms and methods for conducting a dialogue between participants in intercompany interactions. In particular: there is no well-developed system for analyzing the needs of participants in intercompany interactions; the actions of participants in intercompany interactions are still characterized by isolation and inconsistency; and economic entities are guided to a greater extent by their internal needs.

Any economic entity that is a member of the business network, as an open and complex system, is constantly exposed to internal and external influences, resulting in both qualitative and quantitative changes. This is reflected in the dynamics of a large number of evaluation indicators, each of which can only give a points-based characterization of one or another aspect of activity. Therefore, in relation to the assessment of network solvency, it is legitimate to apply the method of identifying the most significant indicators for all participants in intercompany interactions, followed by their integration.

Since an entrepreneurial structure is an open organization consisting of interrelated business processes, its network consistency can be represented as an integral system, divided into blocks that describe various aspects of activity that affect the final efficiency of intercompany

interactions in an entrepreneurial network. It follows from this that economic entities should not so much dictate their terms to other market participants as interact with them in determining the needs of economic development in the context of digitalization.

Thus, it is important to determine ways to improve the system of intercompany interactions in order to achieve the goals of developing the digital economy. An analysis of approaches to evaluating the effectiveness of intercompany interactions showed the presence of a number of common features and factors that affect the effectiveness of such interactions. These are: resources and infrastructure (Williamson, 1996); management of network relations; and network structure (Asaul et al., 2004; Echols & Tsai, 2005). It follows that the main criteria that determine the effectiveness of intercompany interactions are specific resources, as well as the management of their distribution and use in intercompany interactions. Thus, it was advisable to include these parameters in the first place in the indicators assessing the level of network viability, and then bring out the most significant parameters according to the participants of intercompany interactions. Each of the components of network viability in this case, although it should have a certain set of indicators is, in fact, not strictly distinguished – they are interconnected and influence each other in different ways.

To assess the network viability of an entrepreneurial structure, it is proposed to consider the model of network viability through the interconnection of elements that have an indicative, connecting and affirming effect on the effectiveness of network organizations.

The pointing element is the presence of basic conditions, without which economic entities do not form sufficiently significant motives for creating long-term sustainable inter-company interactions in the business network. This element reflects the presence of certain resource characteristics that allow economic entities to interest other counterparties in interactions. In the conditions dictated by the developing digital economy, first of all, the multiplicity and complementarity of information and communication resources are required, since computerization is a central and indispensable condition for the development of information interactions. It is the presence of a modern technical base that allows economic entities to accelerate the processes of accumulation, processing and transmission of information, and the analysis of big data.

In addition to the presence of the resource component, the effectiveness of managing the distribution of these resources in the process of inter-company interactions in the business network plays an important role. This determines the structure of the connecting element of the network potential model. To strengthen inter-company interactions, an economic entity needs certain funds to realize its own opportunities and those received from other participants in the entrepreneurial network. This implies the existence of a system of adaptive, coordinating and protective mechanisms focused on the trends of the digital economy. Effective coordination of intercompany interactions is ensured, first of all, by the ability of an economic entity to maintain electronic communication and data exchange with other participants of interactions. In the presence of such abilities, the possibility of implementing effective electronic transactions in real time is realized, thereby significantly accelerating the processes of intercompany interactions.

Since one of the problems of intercompany interactions is the problem of a lack of trust between the participants in the relationship, it becomes necessary to have a high level of information openness to ensure the guarantee of the conscientious performance of contracts. The adaptive parameter of management is determined by the readiness of economic entities to develop technological flexibility in response to the changing requirements of the factors of the digital economy. This implies the availability of special software to achieve the efficiency of decision-making by officials based on algorithms that have been tested and recognized as optimal.

The resulting element reflects the synergistic effect resulting from intercompany interactions, which ensures the dominance of the effect of joint interactions over the sum of the effects of

autonomous activities. The higher the synergistic effect, the more stable the intercompany interactions (Table 1).

Table 1. The elements for assessing the network viability of economic entities participating in an entrepreneurial network in the digital economy

No.	Element of network consistency	Network solvency indicators
1	Pointing	Provision of employees with personal computers Availability of technical means for mobile access to the Internet (smartphones, tablet computers, modems) Availability of servers, local area networks Availability of corporate email/social network Use of cloud services
2	Binding	Share of departments using electronic data interchange in their activities Possibility of placing/receiving orders for the sale of goods/services using global information networks Possibility of using electronic payments Providing information using global information networks Participation in interactive communities Share of departments using in their activities special software for: scientific research, design, management of automated production and/or individual processes, CRM-, ERP-, SCM-systems, solving organizational, managerial and economic problems, managing purchases and sales of goods/services Using business integration platforms
3	Resulting	Share of revenue received from the sale of goods/services using global information networks Ability of joint platforms and technologies to ensure end-to-end automation and integration of production and management processes into a single information system Development of cooperation in the form of outsourcing, etc. Implementation of personalization of goods through the use of additive technologies Presence of joint or cross ownership, causing connections and personal contacts Increase in the number of ongoing interactions over a period of time Increase in the number of new interactions over a period of time

For the specified estimated indicators of the network solvency of economic entities participating in the entrepreneurial network, it is possible to apply the following criteria: either the target value or the availability criterion (Yes/No [1; 0]).

Thus, the objective function of this assessment, taking into account the significance of each of the indicators, is formed according to the formula:

$$\left[1 - \sum k \frac{(1 - \Delta I)}{1} \right]$$

where k is the share of the i -th assessed indicator;

ΔI is the change in the value of the i -th indicator (either the deviation of actual indicators from the targets is used, or the “yes/no” criterion, where “yes” is equal to 1 as a target value and “no” is equal to 0).

If the obtained value of network solvency is equal to 0, then the economic entity is absolutely incapable of creating and strengthening sustainable inter-firm interactions in the business network. If the maximum value of the objective function is equal to 1, this means that all elements of network solvency that are important for the development of intercompany interactions are present in the economic entity (or have reached the target values).

To make a decision about the sufficiency of the level of network solvency, the mathematical method of dividing the segment in half can be used as a decision rule. Then, according to the

obtained value of the objective function, it is possible to single out the categories of network consistency presented in Table 2.

Table 2. Criteria for assessing the level of network viability of economic entities participating in an entrepreneurial network

Indicator value	Network solvency level	Characteristic
≥ 0.75	High level of network solvency	The economic entity effectively uses its capabilities to implement effective interfirm interactions in the business network in the digital economy
$0.5 \leq X \leq 0.75$	Average level of network solvency	The economic entity has unrealized opportunities that reduce the effectiveness of interfirm interactions in the business network in the digital economy
≤ 0.5	Low level of network solvency	The economic entity is not capable of creating effective intercompany interactions in the business network in the digital economy

The advantages of this technique are:

- the possibility of applying the assessment for any economic entity, regardless of its size, form of ownership or territorial location;
- the possibility of obtaining an assessment of the network solvency not only of individual economic entities, but also of business networks as a whole;
- the possibility of comparing the network solvency of entrepreneurial structures;
- the possibility of isolating weak points in network viability for further strengthening and improvement.

Conclusions

This study showed that the development of network forms of intercompany interactions in the digital economy requires taking into account the main priorities in their creation: solving the problems arising before participants on the basis of their full interaction; increasing the efficiency of activities of economic entities included in the network; and obtaining a synergistic effect.

The main problems hindering the creation of effective inter-firm interactions are the lack of information about the economic, investment and production capabilities of economic entities and the degree of their participation in cooperation, the lack of a mechanism for internal incentives for the participation of enterprises in the processes of inter-firm interactions, as well as the underdevelopment of the market for applied services (information, advisory, engineering, design, etc.) for enterprises.

Thus, in order to create and strengthen inter-company interactions in the business network in the context of the digitalization of economic activity, subjects need to develop network viability through a system of information and communication resources that allow economic entities to accelerate the processes of accumulation, processing and transmission of information, to analyze big data, and to solve the problem of isolation and inconsistency. The proposed model of network consistency allows tools to be developed for analyzing the effectiveness of intercompany interactions, and enables the management of the development of entrepreneurial networks in the context of the digitalization of economic activity.

Acknowledgements

Sources of funding for research presented in a scientific article or scientific article itself: This research is/was funded by the European Social Fund under the No. 09.3.3-LMT-K-712-23-0211 measure "Transformation of the economic security system of enterprises in the process of digitalization."

References

1. Asaul, A. N., Skumatov, E. G., & Lokteeva, G. E. (2004). *Methodological aspects of the formation and development of entrepreneurial networks* (A.N. Asaul, ed.). St. Petersburg: "Humanistika."
2. Echols, A., & Tsai, W. (2005). Niche and performance: The moderating role of network embeddedness. *Strategic Management Journal*, 26, 219–238.
3. Pishchulina, O. (2020). *Digital economy: Trends, risks and social determinants*. Kyiv: Rozumkov Center.
4. Williamson, O. E. (1996). *Economic institutions of capitalism: Firms, markets, "relational" contracting* (Trans. from English, V. S. Katkalo, ed.). St. Petersburg: Lenizdat.