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INNOVATIVE SUPPLY CHAIN COORDINATION POSSIBILITIES

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Abstract

The aim of the study is to understand the challenges of supply chain coordination today, i.e. the factors that negatively affect the functioning of supply chain actors. To this end, the researcher will conduct a literature review to define the conceptual framework and possible tools of supply chain coordination and identify the most common coordination problems in business through an online questionnaire survey. The results are used to synthesise the information to create a model that visually presents the factors that inhibit coordination and the associated solutions to reduce or eliminate the negative impact of these factors on the supply chain actors.

Keywords: *supply chain management, supply chain coordination, partnerships, contracts, social impact*

1. Introduction

Supply chains have evolved into extensive networks in recent times. The term “chain” is primarily used for the sake of simplicity; in reality, every supply chain constitutes a network. In order to adapt flexibly to the rapidly changing customer demands, each member of the chain must respond effectively so that the consumer, positioned at the end of the chain, can be satisfied to the greatest extent possible in terms of timing, quantity, and quality.

For these reasons, the coordination of supply chains has become one of the most critical tasks of supply chain management. From the perspective of coordination, one of the most fundamental requirements is the smooth and complete flow of information. In managing the flow of information, the foundational principle of logistics, the 7R (right) approach, must be taken into account. This framework ensures that members of the supply chain have access to up-to-date information, enabling them to respond swiftly to changes and, in short, to cooperate more efficiently. Such cooperation is essential for maximizing both individual and overall supply chain profits.

Both international and Hungarian researchers have examined the issue of coordination. Studies have shown that a wide range of options are available to facilitate coordination. According to a behavioral science perspective, coordination through various soft factors can also lead to positive outcomes (Singh & Benyoucef, 2013), although the literature tends to favor hard factors, particularly different types of contractual arrangements (Lourenco, 2001; Singh & Benyoucef, 2013; Sluis & DeGiovanni, 2016).

2. Literature review

Given the relevance of the topic, it is pertinent to examine the conceptual framework of supply chain coordination and the various coordination mechanisms available.

2.1. The issue of coordination as a challange of supply chain management

Given the relevance of the topic, it is pertinent to examine the conceptual framework of supply chain coordination and the various coordination mechanisms available. Coordination stands as a pivotal domain within supply chain management. With the proliferation of supply chains and networks, the alignment of their processes has become crucial for maintaining and enhancing competitive advantage. Consequently, the 21st century has witnessed a significant research focus on methods and tools to harmonize the members of supply chains. This area is termed supply chain coordination. In this context, coordination refers to collaboration, a work process based on information sharing that involves the conscious and purposeful joint planning of all chain members' processes (Gupta & Weerwat, 2006; Kaipia, 2009). A fundamental requirement for effective coordination is the seamless and complete flow of information. This ensures that chain members are equipped with up-to-date information, enabling swift responses to changes and fostering more effective collaboration. Such cooperation is essential for optimizing the operations of individual members and the entire chain, with positive impacts on profit margins. Both international and Hungarian researchers have delved into the intricacies of coordination. Studies have identified a plethora of avenues to facilitate coordination. From a behavioral science perspective, coordination through various soft factors can yield positive outcomes. These factors encompass organizational attitudes, characteristics, and traits that fundamentally influence trust levels, information-sharing willingness, and the pursuit of joint activities. These elements significantly impact the extent of collaboration parties are willing to engage in, thereby influencing coordination. Conversely, the literature also highlights hard factors that define the financial framework of cooperation. These factors address the financial aspects of collaboration, seeking answers to questions such as how to optimize settlement prices between partners, determine cost-sharing ratios, and allocate various risks among parties. Coordination can be achieved with the support of information technology or, if companies wish to collaborate for a specified period, through the establishment of cooperation rules via project applications. Notably, contracts have gained high priority in recent research (Sluis & DeGiovanni, 2016).

Contracts, whether short-term or long-term, can assist organizations in operating in a coordinated manner. They provide a framework for cooperation, precisely defining cost-sharing ratios, profit allocations, risks, and responsibilities. Researchers consider contract types as potentially effective coordination solutions (Coltman et al., 2009). Researchers consider various types of contracts as potential solutions for effective supply chain coordination (Sluis & DeGiovanni, 2016). The literature presents a wide range of contractual models. These contracts are primarily illustrated through analytical examples, and in some cases, researchers employ case studies to model their coordinating potential. Based on a comprehensive literature review, the following contract types have been identified as the most frequently cited in academic sources: take-or-pay contracts, wholesale price contracts, quantity discount contracts, buyback contracts, and revenue-sharing contracts (Faludi, 2025).

2.2. Contracts in the supply chains

A previous study succeeded in identifying the most frequently occurring contract types, which are presented in this chapter (Faludi, 2025).

With regard to wholesale price contracts, both cooperation-oriented and non-cooperation-oriented configurations are possible. This means that such contracts can be applied in both centralized and decentralized supply chain structures. The distinction between these configurations lies in the differences in profit-maximization factors. In a centralized system, where members strive for maximum cooperation, participants aim to identify a common profit-maximizing strategy and, through

collaboration and consensus, establish the rules and parameters of cooperation. In contrast, in a decentralized system, where each member operates based on its own individual interests, the contract has only limited coordinating power. It primarily supports ad hoc relationships, which do not contribute to vertical integration. However, if economic actors align their efforts and define shared objectives, a centralized arrangement can be achieved, one that enables the functioning of a vertically integrated, cooperative supply chain or network. In such cases, wholesale price contracts can operate with significantly greater efficiency and are more capable of supporting collaborative relationships at a higher level (Giannoccaro, 2018).

The least cooperative contract type is the take-or-pay contract. This is a special form of agreement in which the seller's position is so strong that it can create a monopoly in the market. Such a contract is applicable when buyers in the market have limited alternatives to satisfy their demands, or when no other sellers exist. If buyers accept these terms, the contract can come into effect and operate efficiently among partners requiring minimal cooperation (Johnston et al., 2008; Polo & Scarpa, 2013; Keutz & Kopp, 2025).

The quantity discount contract is a popular sales promotion mechanism. Its core principle is that the more a supply chain member, acting as a buyer, purchases, the more favorable the procurement price they receive. Thus, an inverse relationship exists between the purchased quantity and the transfer prices applied between members. Mutual benefits do not necessarily emerge immediately under this contract; moreover, unilateral determination of discount levels and transfer prices may not facilitate higher levels of cooperation. Nonetheless, it undeniably demands a greater degree of collaboration than the previously described wholesale pricing contract (Ponte et al., 2020; Huang et al., 2021).

The buy-back contract is particularly suitable for organizations with a high risk tolerance and a strong collaborative attitude. This contract introduces a new risk factor, the buy-back price, wherein the seller guarantees to repurchase unsold goods from the buyer. Determining this buy-back price can pose challenges; establishing a price that is advantageous to both parties necessitates a significant cooperative relationship. The buy-back price must be set through a joint decision-making process that accounts for all risks. At this stage, the application of integrated enterprise resource planning (ERP) systems becomes indispensable. Thanks to advancements in the IT sector and Industry 4.0 solutions, these systems are increasingly accessible in virtual environments, substantially facilitating collaborative operations among organizations (Sluis & DeGiovanni, 2016; Mastos et al., 2021; Khan et al., 2022; Li et al., 2022).

The revenue-sharing contract offers the highest level of cooperative support. This is unsurprising, as in this arrangement, the revenue generated by the supply chain member closest to the market, typically the retailer, is shared among all members of the supply chain. The primary challenge lies in determining and establishing a fair revenue-sharing ratio. It is essential to consider the bargaining positions, negotiation power, roles, and dominance of the members within the chain to agree upon an equitable sharing proportion. Without such balance, the contract will fail to exert a positive effect; rather, extreme disparities may disrupt the equilibrium within the chain and prioritize individual interests. The aim of this contract is to achieve the highest level of vertical integration. A critical influence in setting transfer prices among members is the fact that the revenue generated from sales to the final consumer benefits not only the retailer but all chain members. Consequently, transfer prices can be maintained at lower levels, as a portion of the revenue compensates the members. This represents one of the contract's greatest strengths. However, maximal cooperation is required, as prices and revenue-sharing ratios are not determined unilaterally but through negotiations within a joint decision-making mechanism (Huang et al., 2021; Li et al., 2022; Yao et al., 2022).

2.3. Negotiation scenarios

The essence of the cooperative negotiation scenario lies in the fact that the negotiating parties form a coalition with the objective of maximizing the total profit of the entire supply chain. This is characteristic of collaborative, i.e., centralized supply chains. Each member cooperates to ensure that the chain as a whole is successful, efficient, and effective. In this case, members jointly make decisions concerning the chain by employing group decision-making techniques and striving for consensus. In contrast, the non-cooperative negotiation scenario entails that negotiating parties independently optimize their operations while taking into account the variables subject to agreement for a given planning period. Here, the members prioritize their individual preferences and aim to secure their own operational performance. However, they do so within a short-term cooperative interval, considering the basis of cooperation in every decision, with no party aiming to violate this foundation (Dudek & Stadtler, 2005; Hjaila et al., 2015).

One potential solution in the field of supply chain coordination is the iterative decision-making process. Collective decision-making within supply chain coordination is a dynamic and iterative process facilitated by a moderator. The moderator assists experts and decision-makers in aligning their opinions and reaching the desired level of consensus. Several publications report on negotiation algorithms and processes. Building on the premise that an ongoing business relationship impacts the profitability of both parties, multiple studies present negotiation-based algorithms that help the buyer gradually improve the quality of their relationship with suppliers (Hjaila et al., 2016; Proch et al., 2017).

Research concurs that the higher the level of negotiation techniques employed by supply chain decision-makers, the more successful the respective company and partnership will operate, thereby enhancing the overall performance of the entire supply chain (Moss, 2025).

2.4. Social impacts on supply chain coordination

Fundamentally, sustainability as a consumer expectation has also emerged within the objective framework of supply chain coordination. Today's conscious consumers increasingly consider the extent to which the products they purchase or the services they utilize are environmentally friendly, as well as the environmental impact associated with their production processes. Consequently, the sustainable operation of supply chains and the implementation of measures to reduce environmental burdens represent a fundamental societal impact (Raza, 2018; Yu et al., 2023).

Moreover, consumer purchasing decisions can be significantly influenced by online retail services, alongside factors such as rapid delivery and gift packaging. However, it is even more important that online retail services can be customized for different consumer segments (Pre et al., 2022; Kalia et al., 2023).

In other words, the parts of the supply chains closest to consumers, namely, retail outlets and last-mile delivery services, have substantially transformed the operations of this segment of supply chains. The accelerated pace of modern life demands correspondingly expedited services, to which consumer behavior has also adapted. For last-mile delivery systems, which pose considerable challenges to urban logistics and impose significant burdens on city infrastructure and transportation, time has become the most critical logistical principle; that is, delivering the package to the final consumer as quickly as possible. This situation presents a dual challenge: first, segmenting consumer groups becomes more complex because parcel delivery services are capable of transporting virtually any product, effectively integrating multiple supply chains. Second, it facilitates the functioning of various systems due to the collaboration occurring right before the final consumer; largely enabled by online platforms, different

consumer groups can be seamlessly connected, allowing consumer demands to be detected almost automatically (Shen et al., 2017).

Therefore, the social impacts influencing supply chains have largely enabled the drive toward digitalization and the acceleration of digital processes. As consumers' online presence expands, companies have also needed to position themselves as close to their customers as possible in the digital environment. This necessity applies not only to last-mile delivery services but also within the supply chain itself, where members that virtually integrate their processes can operate with significantly reduced response times and a more precise understanding of demand.

2.5. Smart tools

The advent of Industry 4.0 and Industry 5.0 has led to the emergence of Supply Chain Management 4.0 and Logistics 4.0 tools. Both fields fundamentally focus on supporting supply chain management and logistics processes through various modern information technology solutions (Nagy, 2017). These domains primarily emphasize digitalization and automation. Therefore, the key tools aim to integrate companies within the online, virtual environment. Various cloud-based platforms and integrated ERP systems provide significant assistance to companies by enabling faster responsiveness to dynamically changing consumer demands. Automation also serves this purpose, as the automation of standardized processes facilitates quicker customer service (Bányai, 2024; Mukanov et al., 2024; Tamás, 2025). In this study, the term "smart devices" will be used to collectively refer to these IT tools that facilitate information flow, cooperation, and collaboration.

3. Research design

To explore the coordination challenges within supply chains and networks, the researcher conducted a brief questionnaire-based study. The aim of this research was to identify the most prevalent contemporary issues that, to varying degrees, hinder the coordinated operation among supply chain members. The following chapter presents the details, methodology, and results of the empirical study.

3.1. Methodology

The online survey was conducted using the EvaSys system. The choice of an online questionnaire was motivated by the ability to reach a relatively large number of companies and collect numerous evaluable responses within a short timeframe. The database was compiled based on publicly available corporate information found online. Utilizing the Crefoport and Opten databases, the researcher primarily selected companies engaged in international trade, presuming that these firms are likely members of larger supply chains. To ensure that the questionnaire was completed by individuals in managerial positions, the researcher made efforts to target respondents accordingly. Specifically, the questionnaire was distributed to publicly available email addresses of company representatives who held at least middle management positions and whose professional roles were deemed relevant to the topic.

The questionnaire was divided into two sections. The first section aimed to gather information about the companies themselves. Questions regarding company size (net revenue, number of employees) enabled categorization of the organizations. Additionally, this section included questions to ascertain the companies' fields of activity and industry classification. The second section sought to identify the coordination problems that form the foundation of the study. This section included both multiple-choice and open-ended questions. In the open-ended questions, respondents were invited to describe the factors that most significantly impact successful collaboration with their immediate partners. These responses

could later be utilized to establish a prioritization hierarchy, as multiple respondents often cited the same issues or, where relationships existed between obstructive factors, the underlying causes responsible for their emergence could be identified. Consequently, a comprehensive picture of the most critical coordination barriers encountered today may be developed.

3.2. Research sample

The questionnaire was distributed via email with strict adherence to GDPR principles, targeting publicly available corporate email addresses obtained from company databases. The survey was conducted in a manner ensuring that participating companies could neither see each other's contact information nor responses. The introductory text of the questionnaire informed respondents that their answers would remain confidential and would be used exclusively for the purposes of this study.

The online survey was sent to 450 companies, resulting in 102 valid responses, corresponding to a response rate of 22.67%. The data collection took place in February 2025. One week after the initial distribution, a reminder email was sent to increase participation. The survey remained open for an additional two weeks and was closed thereafter, meaning that the data collection period spanned from February 3 to February 24. A total of 102 valid responses were received. Based on the responses, the majority of participants were small and medium-sized enterprises (SMEs), with a significant representation also from large multinational corporations. No industry-based sampling was applied in the selection of participating companies, as the current research does not focus on sectoral differences. However, based on publicly available information, the majority of the surveyed companies operate in the manufacturing sector. All participating companies operate internationally and maintain foreign partners.

3.3. Results

The aggregated responses revealed which factors cause the greatest difficulties in collaboration with partners. When these factors are contextualized, it becomes apparent that certain inhibitory elements exhibit causal relationships, suggesting that they should be addressed collectively in order to identify the root causes of the coordination barriers.

The most frequently cited deficiency was inadequate information flow. This issue merits further elaboration, as multiple underlying causes emerged from the responses. Recurring mentions included outdated information systems or the absence of a fully implemented ERP system. In the era of Industry 5.0, it may seem almost inconceivable that companies have not yet digitalized their operations, yet the survey responses confirm that this remains a relevant challenge. Although an increasing number of organizations are digitalizing their processes to avoid significant competitive disadvantages, instances still occur where partners fail to integrate their systems with one another. Beyond this technical factor, the organizational cooperation attitude must also be considered. Some companies may lack sufficient trust, resulting in a low willingness to share information, which similarly contributes to inadequate information flow.

Inadequate information flow subsequently leads to uncoordinated operations, manifesting in order quantity deviations, suboptimal ordering and production lot sizes, inefficient inventory replenishment mechanisms, and imbalanced delivery frequencies.

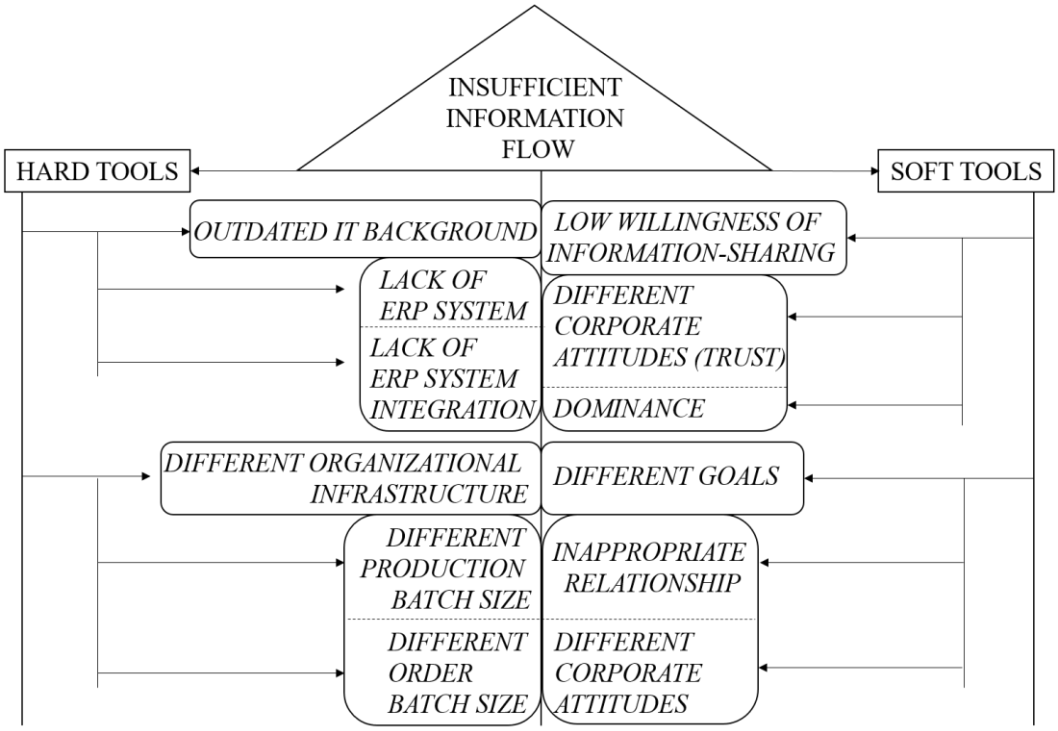

Figure 1. *Causal links between the defined barriers to cooperation* (source: own construction)

In *Figure 1*, the researcher systematically compiled the inhibiting factors identified during the study. These factors were categorized into two major groups: the first group encompasses those that hinder the physical realization of cooperation, referred to as the "hard" factors. The second group considers behavioral science aspects, including factors that reflect the attitudes of corporate decision-makers toward collaboration, cooperation, and coordination, these are termed the "soft" factors.

Within the hard factors category, the inadequate IT system is prominent. Many companies continue to struggle with establishing appropriate IT infrastructure. This challenge is particularly pronounced among smaller enterprises, where the implementation of such systems and the licensing costs of suitable software represent significant capital investments. Additionally, the operational costs associated with these systems can considerably increase corporate expenses. Inadequate IT infrastructure often results in the use of suboptimal ERP systems, which may also encounter adaptation or integration issues. Another major subset of hard factors relates to corporate infrastructure. Coordination problems may arise when the manufacturing system is not designed to meet the partner's requirements, such as when production batch sizes differ from the partner's needs or when ordering occurs in incompatible batch sizes or periods, reflecting poor scheduling practices.

Regarding corporate attitudes, it is important to note that not all companies seek to establish short- or long-term partnerships with every partner, and this is a valid approach. When forming partnerships, companies must evaluate how much a potential partner can contribute to corporate value and the extent to which the partner supports the company's value-creating processes. Consequently, it is evident that not all partnerships necessitate long-term engagement or high levels of integration. However, the exchange of information necessary for operational effectiveness and satisfying final consumer demands

should be the foundation of every relationship. Therefore, within the soft factors group, low willingness to share information appears as a significant issue, even in situations where the nature of the partnership and the value-creation processes would demand it. This reluctance typically stems from fundamental trust issues and efforts by companies to preserve their market positions. The presence of dominance disrupts the balance of power between companies, potentially leading to unfavorable partnerships characterized by information withholding and poor collaboration between dominant and subordinate parties. Another critical issue is the presence of divergent organizational goals. Differences in corporate attitudes contribute to insufficient information flow, as the lack of unified cooperation objectives prevents the alignment of individual goals with the defined collective aim. To address goal alignment, appropriate relationship management tools can assist companies in establishing partner relationships that best fit the attitudes involved and are mutually beneficial.

4. Final discussion

Supply chain coordination, as a widely studied field, is challenging due to the combined effect of numerous influencing factors that determine whether coordination in each individual case is adequate or inadequate. When attempting to achieve optimal or near-optimal coordination performance, decision-makers face a multi-factorial, dynamic decision-making problem. Due to this complexity, in practice, decision-makers typically focus on improving only one or a few influencing factors during any single intervention.

Based on the literature review and the findings of the questionnaire survey, the key factors currently exerting the greatest influence on the collaboration among supply chain members have been identified, alongside coordination-enhancing factors that emerge as potential solutions to these challenges. In the final chapter of the study, these two bodies of information are integrated to establish a relational framework model, whereby each identified inhibiting factor is linked to a specific supply chain coordination tool. This approach aims to provide means to address, at least partially, the cooperation barriers identified.

The model also considers the possibility of coordination through contractual agreements. Additionally, it offers negotiation scenarios as potential solutions and addresses societal impacts generated by changes in consumer behavior. Furthermore, opportunities presented by Industry 4.0 and 5.0 are included as promising approaches within the field of supply chain coordination, and thus their adoption is recommended within the model.

The model depicted in *Figure 2* is constructed based on the identified inhibiting factors and the supply chain coordination tools reviewed. The foundational level of the model comprises the primary factors extracted from the empirical research that impede coordination within supply chains. To address and mitigate these challenges, or potentially eliminate them entirely, the subsequent level consists of both hard and soft factors capable of improving information flow among supply chain members and the key actors within partner relationships.

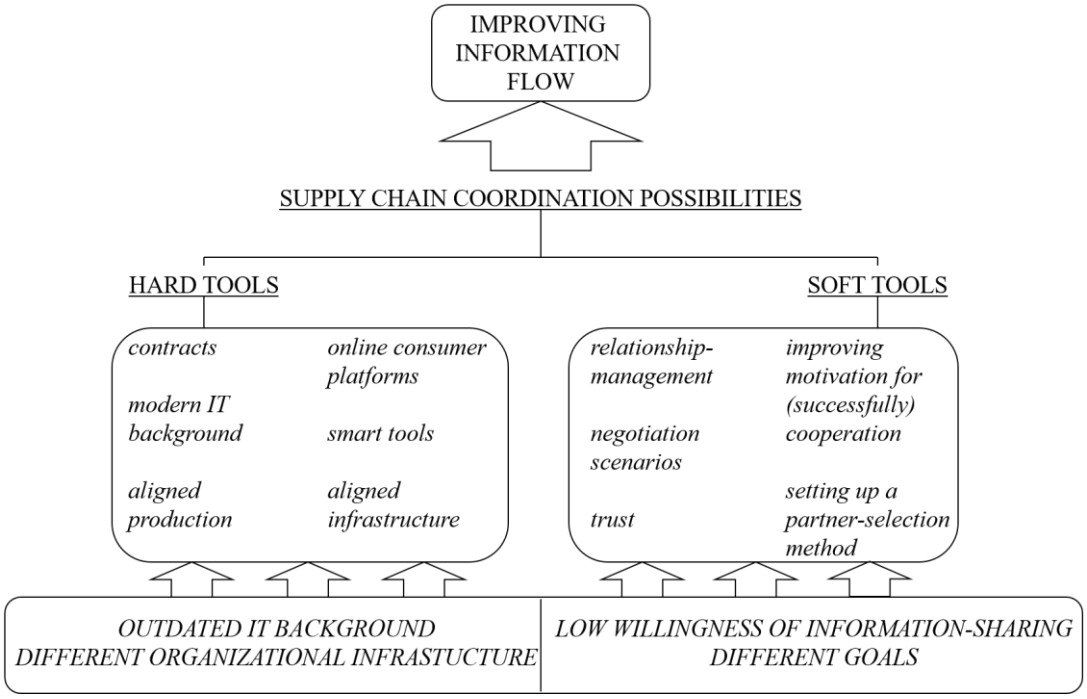

Figure 2. *A relational framework model to improve supply chain coordination*
(source: own construction)

The overarching conclusion drawn is that digitalization has become an indispensable prerequisite in today's business environment. Companies that fail to enter the virtual space, digitize the majority of their value-creating processes, and integrate inter-organizational processes virtually will face significant competitive disadvantages. This constitutes one of the pillars of innovative supply chain coordination: the application of smart tools developed under Industry 4.0 and 5.0 paradigms. These technologies offer multifaceted support to firms, not only by connecting internal processes with partner organizations but also by enabling a closer proximity to the end consumer, thereby providing a more precise understanding of consumer demands and their fluctuations. This, in turn, facilitates faster and more effective responses to such changes. The second pillar primarily relates to decision-makers within firms, their preference systems, and attitudes. It is advisable to deepen relationships with suitably capable partners by leveraging smart tools. This requires, as a first step, the establishment of a criteria framework whereby decision-makers assess and evaluate existing and potential partners. Once such a selection framework is in place, various negotiation techniques and methods, such as the iterative negotiation technique described earlier, can foster mutually beneficial cooperative relationships. These partnerships not only entail the joint definition of common goals and commitment thereto but also support the expression and realization of each firm's individual preferences. The coordinated operation of these two groups of coordination mechanisms forms the foundation for today's innovative opportunities in supply chain coordination.

5. Limitations and future research directions

The results presented in this research are based solely on the opinions of the 102 companies that participated in the research. Thus, its validity is limited, as the factors influencing cooperation defined

by the organizations in the sample are only valid for this sample. Furthermore, the testing of the relationship model is a focus for future research – the researcher would like to test the validity of the model with a small group of experts in the first instance and then test the model more widely. In addition, the number of linkage models and their associated solutions could be extended and better specified if a larger number of studies, including international ones, could be carried out.

Thus, a future research objective is to extend the research sample by conducting a larger number of items, even differentiated by industry, to identify typical problems faced by supply chain members in each industry with regard to collaboration.

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