

## DIGITAL SUPPLY CHAIN CHALLENGES: SMART TOOLS SUPPORTED COOPETITION AND CONTRACT SUPPORTED COOPERATION

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### Abstract

*In the 21st century, the business world has begun to change. The industry 4.0 influences the whole business world. Smart tools help the real-time data-exchange, the better information-flow. The supply chains are counting many members nowadays, that is the reason why this smart tools could help the supply chain members. But this growth also includes the problem of coordination; to manage the increased number of chain members is getting to be more difficult but at least so important in the case of efficiency. To decrease the replenishment times and the delivery period, to choose the cost-saving shipping methods are just one of the most important factors to get profit across satisfying all of the customers. Supply chain coordination recommends the contracts to coordinate the relationship of chain members. There are many contract types to use, but it is a very important thing to choose the one which fits the best to the specific relationship. It means if a wrong one is chosen it will not coordinate the chain and neither the partners' relationship. So the choice has strategic importance. The paper analyzes two companies; their attitudes – what do they prefer in the construction of contracts (prices, quantities, discounts, etc.), the different level of dominance – so in short the factors which influence the choice of the companies. A numerical example for the case study is also included to compare the contracts.*

**Keywords:** Supply Chain Management, Supply Chain Coordination, Contracts, Smart Tools

### 1. Introduction

The positive and the negative influences of globalization, such as the rapidly developing IT sector, or the dynamically changing needs of customers, had shaped business life. Companies must keep their competitiveness because this is the base of profitable and efficient operations – and to reach these goals they have to adapt to the changing environment. The competition is so complex and it is extending constantly in the 21th century. This process had influenced the supply chains as well.

The group of companies is forming a supply chain, if the partners handle the resources together, connect their value-creating processes, share the available information – especially focused on the market demand (Sluis & De Giovanni, 2016; Lorenzo, 2001; Chikán, 1999). In this case, the conditions are realized for a successful partner-relationship based supply chain. Competition is the main motivation of economics, so it can not be eliminated from the relationships and the supply chains. Companies are striving to earn higher profit, because this is their own interests. Thus the level of cooperation can be decreased. But it is not a sustainable solution in the long-term. It is needed to find another solution, where a level of cooperation is higher and the competition is realized at the same time.

This problem is becoming more and more powerful in the 21st century. The number of supply chain members is increasing rapidly and staying in touch is getting to be difficult. The big challenge of the supply chain management is to manage, organize, coordinate the chains. In this case, competition can be considered an aggravating factor, because the question is how can we coordinate optimally if the is a strong competitive situation in the meantime. This is the cooepetition.

## **2. Literature review**

### ***2.1. What is cooepetition?***

The word of cooepetition can be divided into two parts – the first is the ‘coope-’, which refers to the cooperation, and the second is the ‘-tition’, which refers the competition. Coopetition is comprehensible as “to force to cooperation” because its goal is the companies cooperate in the case of the competitive situation as well.

The first appearance of cooepetition was in the second half of the ’90s and was defined as a value-creating synergy between the company and its stakeholders (Brandenburger & Nalebuff, 1996). In the 2000s, cooepetition is getting to have more attention. In 2008 researchers analyzed the connection between the cooepetition and supply chains. From this point of view, cooepetition is defined as a strategy, which helps the efficiency operation between two or more chain members (Gnyawali et al., 2008). The definition of Bengtsson and Kock (2014) and the based on Manzhynski and Biedenbach (2023) it is worth to focused on its paradox nature, so how chain members can cooperate if there is competition in the supply chain. To keep the competitive advantage chain members would not like to share too much information. But the goal of supply chain management and supply chain coordination is to improve the trust and the willingness to share information at the same time because this is the base of efficient cooperation.

Coopetition helps to dissolve the contradiction and motivates the chain members to found a trust-based relationship. In the supply chains, where every member is a seller and buyer at the same time, that is the reason why it is important to know each other’s needs exactly. In this case, the lead times, the cost of production, and storage can be decreased, the economies of scale can be available. According to Wood (2012), the implementation of supply chain management as a strategic tool and the cooepetition can increase the competitiveness of companies, the cooperation of firms, improve the communication between the partners, which are the most important things to satisfy the needs of customers. On the other hand, the COVID–19 pandemic taught the world that firms have to cooperate – sharing the information, the resources for the greater efficiency. That is the reason why supply chain cooepetition (SCC) is getting to be an important topic (Shamout, 2023).

There are other conflicts of interest; some companies would like to have more influences in setting the contract terms, others expect more flexibility from their partners in terms of price, delivery terms, or deadlines. But these problems can be also manageable. The supply chain coordination recommends many tools; the paper deals with coordination with the help of the contracts.

### ***2.2. Contracts in the supply chains***

The concept of supply chain coordination is to synchronize the processes of the chain members, which are connected to the material- and information-flow, as well. The supply chain coordination does not only support to achieve the individual goals; the coordination is realized in the supply chain is the

decision-makers of the chain striving to make strategic decisions to improve the efficient operation of the whole chain (Gupta & Weerawat, 2006).

One of the most interesting topics of coordination are the contracts. These tools give a framework to the cooperation and help to determine the benefits- and risk-sharing mechanisms (Coltman et al., 2009). According to Faludi and Molnár (2017) contracts help to decrease the number and the degree of inequities, which causes many conflicts between the chain members.

There are many contract types, but still, not every type of contract provides a solution to all coordination problems. The coordination power of the contracts is influenced by the members' bargaining power, the level of each members' dominance, or the specificities of the different industries. It means that these factors are not negligible if the goal is to improve and increase the coordination level.

In the following chapter, paper deals with the smart tools, which are also compatible to support the cooperation, and the cooptation.

### **3. Smart tools to support the cooptation**

If companies find the right contract for the cooperation, it is probably not enough. The 21st century has brought the fourth industrial revolution, which simply called the industry 4.0. The rapidly developing IT sector results the changes, because companies need to keep pace with the developments. The competitive advantages depends on the developments.

Industry 4.0 is forced companies to be digitalized. It means, that many processes need to be on the online platform. For this, the modern ERP system has appeared. Its specialty is the adaptable, which means that other modules could connected to the ERP system easily. To synchronize the transportation between the cooperating members, and to choose the best of the cost-saving tools there are three necessarily modules to use: the Resource-Planning System, the Warehouse Management System (WMS), the Transportation Management System (TMS). These tools belong to the logistics 4.0.

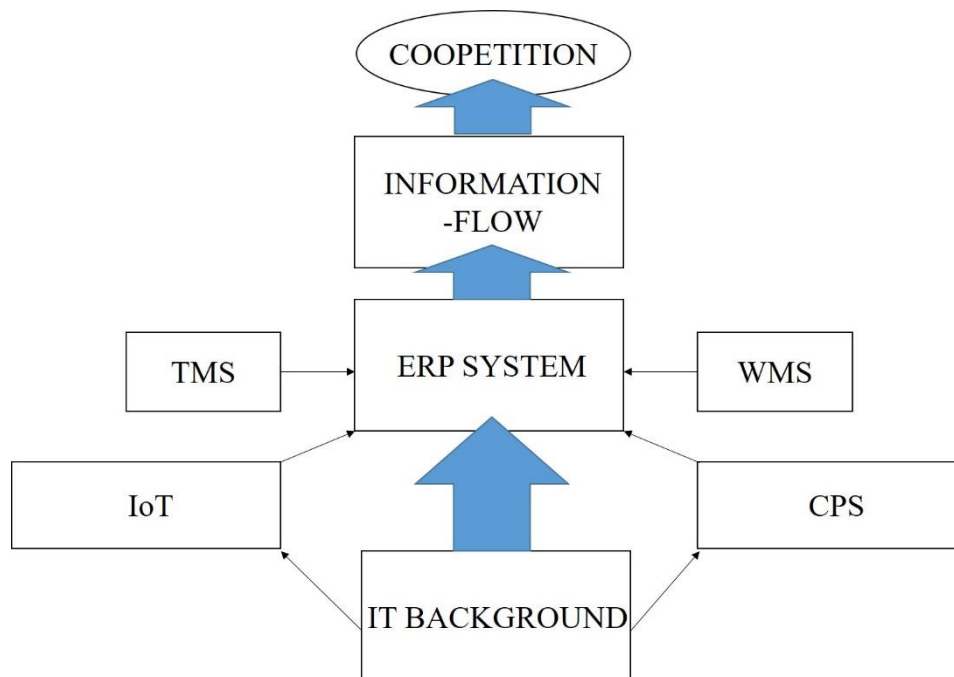
The Resource-Planning System is the mainstay of the digitalization of logistics. It helps to allocate or re-allocate the sources of the enterprise, coordinate the optimal resource allocation and also helps to decentralize the decision-making processes. WMS is another important part of the digitalized logistics. WMS helps to make the inventory processes in the virtual platform – real-time administration of the incoming and outgoing goods, it supports the material handling and helps to the staff of the inventory. TMS plans, optimizes and operates the physical movement of goods. In accordance with the characteristics of the goods (weight, size, special treatment) selects the appropriate mode of transport and means of transportation. It also ensures the availability of documents required for delivery. In Hungary, from 2021, companies operating the construction industry are required to use the intelligent consignment note, because a complete integrated system has been developed for construction companies, where the SKU and the name of the goods are standardized. It means when an item is delivered, it is automatically selected and also automatically prepared the consignment note based on a QR code, which contains all relevant information about delivering goods (Tejesh & Neeraja, 2018; Torabizadeh et al., 2020; Akhmatova et al., 2022; Bauapp, 2023).

The most popular ERP system, the SAP allows the using these modules. It means that they can be integrated in to the ERP system, which allows connection between the members. But industry 4.0 has influenced the supply chain management, as well. It is called supply chain management 4.0 or smart supply chain management. Logistics 4.0 has to support this system.

The Cyber-Physical System (CPS), Internet of Things (IoT) and cloud-based collaborative platforms are the base of every digital or smart solution (Szymczak, 2019). CPS allows the communication

between humans and machines. If companies have the CPS, IoT helps the real-time information-flow and manage the big data. Also for the big data, cloud-based collaborative platforms allow to exchange information in real time. The examples show only the most important tools, and lot of new solutions appear almost every day due to the development of the IT sector. These examples are the best tools to support cooperation. Because they allow the real-time communication and information-flow, which are the base of the appropriate cooperation under competition.

Only thing is fix: firms need to invest into these IT solutions, because this is the only way to keep the competitiveness and make the first step for the cooperation under a competitive situation. *Figure 1* summarizes the structure of a modern firm, and sets out the objectives for achieving the right information sharing and information flow with a strong IT background, as this is the only way to achieve the cooperation.



**Figure 1.** The conditions for cooperation in the era of industry 4.0 (source: own construction)

Problem can be the investment cost of these tools. Some software needs strong IT background, which also means cost, if companies do not have. But the investment costs compared to the logistics cost, which definitely shows a decreasing tendency, the investment for these tools can be worth. Not to mention the fact that nowadays digitalization is inevitable, it is the key to maintaining a competitive advantage.

To invest into these technics, firms need the willingness to share the information. If partners have this attitude, the coordination of their relationship can be improved. But to get the maximum level of coordination, it is recommended to take the partnership withing a framework. The using of contracts can be a good solution. But what is the right choice, which contract should be chosen? The next chapter introduces the problem of contract-choosing through a case study.

#### 4. Case study: to represent the importance of the contract-choosing

The goal of the numerical example is to compare the available contract types in the terms of the wholesale price, the market price, the individual profits, and the ordered quantities, which factors influence the power of the coordination of each type. After, keeping the attitudes of companies in mind the possibly best contract or contracts will be selected to help to coordinate the chain and to improve the cooperation between the partners.

##### 4.1. Introduction of the companies

The research is based on interviews with some supply chain management experts. They want to be anonymous, that is the reason why I will use two companies in the case study with the name of Company A and Company B.

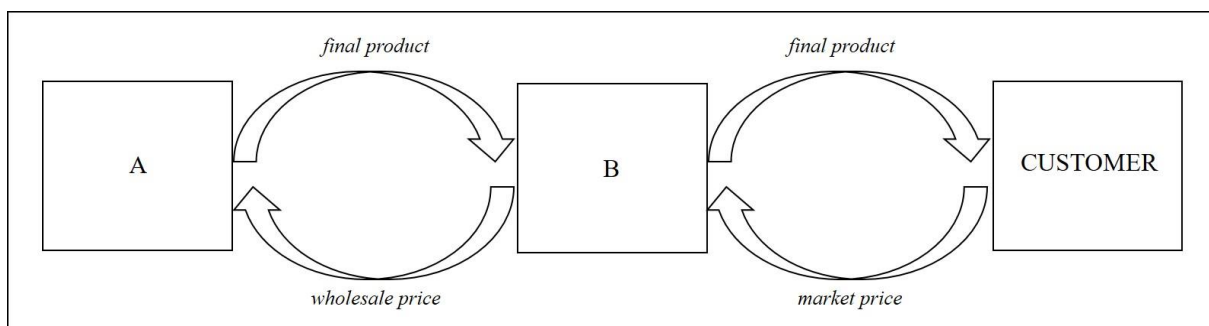
The goals of the interviews were to find out the characteristics of the relationship of chain members, how much is the level of the cooperation, and do they prioritize their own interests or to keep their competitiveness against the information-sharing.

Based on the questions, it was possible to determine the companies' sensitivity of prices – for example, the changes of prices –, the companies' bargaining power and dominance, the willingness of cooperation was clearly defined, and it is known which company prefer the common goals instead of the individual needs.

According to the answers and the literature, I choose 3 contracts, which are fitted to the conditions and specs. The goal of this numerical example is to represent the hypothesis, which says it is strategical importance of the contract-choosing, because it will support the cooperation and the coordination. A contract, which does not fit the type of relationship, the attitudes of the chain members, or the customer specifications will not coordinate the chain. But otherwise, contracts give many advantages and improve the performance of the members and also the whole chain.

Company A and Company B are the members of a supply chain, they have a simple partner relationship, but to improve their performance they would like to use a supply chain contract. Company A determines most of the conditions in the relationship. The expectation of her partner is flexibility – so she works with suppliers who have fast-responsivity competencies. She needs some safety stocks to avoid which can derive from the changing needs. Company B is a trading company and he is considered as a dominant member. He shares information about the demand if he can influence the price determination.

The analyzed section of the supply chain is shown in the *Figure 2*.



**Figure 2.** The analyzed section of the supply chain (source: own construction)

The goal is to choose the right contract, which one will help the companies to be in a cooperative relationship.

#### 4.2. Recommended contracts

The research is based on the contracts, which are the most frequently occurred in the literature (Faludi, 2018). The first three types are chosen: wholesale pricing contract, revenue-sharing contract, and quantity discount contract.

The wholesale pricing contract is a traditional type. The conditions are defined by the seller – now we call Company A –, including the prices for the ordered quantity (Chakraborty et al., 2015). The profit-maximization factor of the Company A is the wholesale price.

The revenue-sharing contract motivates the chain members to a higher level of information-sharing mechanism. The profit of the Company B is divided among the chain members. If the members are aware of the information about the market demand, they are aware of the needs of the direct partners at the same time. With the help of this information, they can eliminate the unnecessary stocks, processes – thus they can decrease the costs but increase the profits. Company B will also be interested in making the profit, because the higher the profit he earns, the higher the amount he can keep. The satisfactory level of information-flow and information-sharing helps the chain members to forecast demand as accurately as possible. Based on these, this type of contract supports cooperation (Krishnan & Winter, 2011). This is the reason why Company B will have a higher revenue-sharing rate.

In the case of the quantity discount contract Company B gets a higher discount, if he purchases a higher quantity of products from the Company A. Thus Company B is motivated to buy the higher quantity, this is the interest of the Company A (Choi et al., 2005).

#### 4.3. The numerical example

The base of comparison is the following factors, shown in *Table 1*.

**Table 1.** Analyzed factors and their notations

NAME		SYMBOL
<i>price</i>	wholesale price	$PC_W$
	market price	$PC_M$
<i>quantity</i>		$Q$
<i>individual profit</i>	Company A	$\Pi_A$
	Company B	$\Pi_B$

Source: own construction

An important issue is the ratio of the individual profit values. Dissatisfaction is caused by the unequal ratio, which may impede the efficient operation of the supply chain. Thus the distribution of the individual profits is also part of the evaluation criteria.

The calculation needs the operation costs of both companies. Revenue-sharing contract needs the rate of the revenue-sharing. The numbers are fictive, the values and the notations are shown in *Table 2*.

**Table 2.** Values and their notations

Cost of Company A	$CT_A$	15 EUR
Cost of Company B	$CT_B$	25 EUR
Revenue's rate of Company A	$\alpha_A$	0.3
Revenue's rate of Company B	$\alpha_B$	0.7

Source: own construction

One of the best values is the individual profit because it shows the efficiency of the companies' operating. The calculation of individual profits is shown in Table 3.

**Table 3.** Calculation of the individual profits

	profit of Company A	profit of Company B
WHOLESALE PRICING	$\Pi_A = (PC_W - CT_A) \cdot Q$	$\Pi_B = (PC_M - PC_W - CT_B) \cdot Q$
REVENUE-SHARING CONTRACT	$\Pi_A = \alpha_A [((PC_M \cdot Q) - (CT_B + CT_A) \cdot Q)]$	$\Pi_B = \alpha_B [((PC_M \cdot Q) - (CT_B + CT_A) \cdot Q)]$
QUANTITY DISCOUNT	$\Pi_A = (PC_W - CT_A) \cdot Q$	$\Pi_B = (PC_M - PC_W - CT_B) \cdot Q$

Source: own construction

The wholesale price plays an important role in this two-part relationship because the second member is price-sensitive. Based on these, the Company B prefers the lower prices. I use the profit equation of the Company A (shown in Table 3) to calculate the wholesale prices. The wholesale price is the partial derivative of the profit equation by the price. In the case of the revenue-sharing contract and the quantity discount contract the wholesale price is calculated with the help of the principle of profit maximization based on volume-dependent sales revenue. The market prices were calculated in each case using the inverse demand function, where the constant values are the following:

- $a = 100$
- $b = 1.5$

Table 4 summarizes the calculation forms of the prices.

**Table 4.** Calculation of the prices

	wholesale price	market price
WHOLESALE PRICING	$PC_W = \frac{a - CT_B + CT_A}{2}$	$PC_M = a - b \cdot Q$
REVENUE-SHARING CONTRACT	$PC_W = \alpha_B \cdot (CT_B + CT_A) - CT_B$	$PC_M = a - b \cdot Q$
QUANTITY DISCOUNT	$PC_W = (1 - \alpha_B) \frac{(PC_M \cdot Q)}{Q} - CT_B + \alpha_B \cdot (CT_B + CT_A)$	$PC_M = a - b \cdot Q$

Source: own construction

The goal of *Company A* to sell as a higher quantity as possible. In the case of wholesale pricing contract, the ordered quantity is derived from the profit equation of *Company B* (Table 3), which is the derivative form of it by the quantity. In the case of revenue-sharing contract and the quantity discount, the ordered quantities are calculated with the help of the sum of the profits. But in the case of the quantity discount in order to represent the essence of the contract, the calculation includes added value. Table 5 shows the equations to calculate the quantities.

**Table 5.** Calculation of the quantities

	quantity
WHOLESALE PRICING	$Q = \frac{a - PC_W - CT_B}{2 \cdot b}$
REVENUE-SHARING CONTRACT	$Q = \frac{a - (CT_B + CT_A)}{2 \cdot b}$
QUANTITY DISCOUNT	$Q = \frac{a - (CT_B + CT_A)}{2 \cdot b} + 10$

Source: own construction

The using of the presented equations results can be calculated, which will be introduced in next chapter.

#### 4.4. Results – evaluation and propositions

The equations you find in the tables help to calculate the comparable factors. *Table 6* summarizes the results of the calculation.

**Table 6.** Results

		<u>WHOLESALE PRICING</u>	<u>REVENUE-SHARING CONTRACT</u>	<u>QUANTITY DISCOUNT</u>
$PC_W$	EUR	45	3	19.5
$PC_M$	EUR	85	70	55
$Q$	100 pcs	10	20	30
$\Pi_A$	100 EUR	300	180	135
$\Pi_B$	100 EUR	150	420	315

Source: own construction



The results show that the best choice is the revenue-sharing contract because it has got the best values. Similar, but a bit worse results represented by the quantity discount. It means that the best choices for the members are the revenue-sharing contract or the quantity discount contract.

## 5. Final discussion

First of all, we need to know the attitudes of chain members, because this is the most important influencing factor both in the cooperation-supporting, both in the contract-choosing. The supply chain has a very complex relationship-system. The members need to cooperate, but they have also represent their own interest. Thus, there is a competition. But they need to cooperate under this competitive situation, which is called cooepetition.

The digitalization is still influencing the business sphere. Companies need to be digitalized, this is the base of the competitive advantages. The various types of smart tools can help the supply chain coordination, the cooepetition and support the cooperation, as well. To help the coordination and also the cooepetition supply chain coordination offers the different types of contracts.

Contract-choosing is a very complex topic, and it can determine the efficiency of the companies. It is based on individual needs, expectations, attitudes but the specifications of some industries also influence the conditions. Therefore, we can say contract-choosing has strategic importance. The assumption is represented with the help of a case study. Three frequently used contract types are compared. The results show one of them is not able to coordinate the chain and the relationship and – according to the numbers – the best choice is the revenue-sharing contract. But is this really true? Take a look behind the numbers.

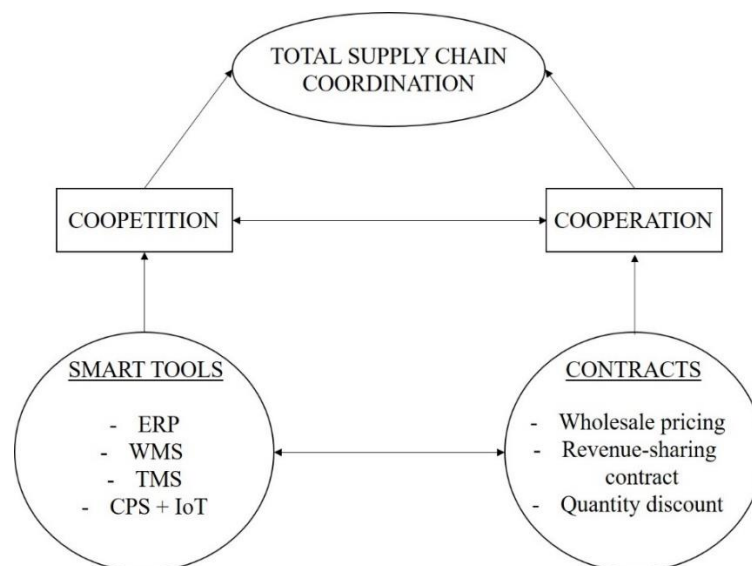
Firstly I deal with the wholesale price contract, because it is a fact, that this type should be excluded from this relationship. Wholesale pricing contract does not meet any of the established criteria. Because of the price-sensitivity, it is not good for the Company B. The highest wholesale price and the highest market price are realized with this contract. Also, in this case, the smallest quantity can be sold, which is very unfavorable for both parties. The market price is high, which suggests that Company B assumes high profit by the sales to the final customer, but the cost and high wholesale price will reduce the amount of this profit, as's shown in *Table 6*. The smallest profits are achieved with this type. Therefore, based on the calculated values and the attitudes of the companies, the type of wholesale pricing contract is not recommended for managing and coordinating this relationship.

In terms of prices, the revenue-sharing contract has the best values. The wholesale price is low, the market price is also low than the wholesale pricing contract. Besides a higher profit can be realized. The other advantage of this type is the fairer revenue sharing rates. The dominance of the Company B appears in the revenue sharing rates. The source of many conflicts can be if the companies share the profit equally. But revenue-sharing contract allows negotiating about the sharing rates. It means that the rates can depend on the parties, thus better rates can be negotiated than what the case study presented.

Quantity discount is a good choice for the Company B. He prefers the lower prices, and because of the essence of the quantity discount contract, the offered market price is the lowest of all cases. Company A needs safety stock, so it is assumed that she prefers the higher quantity to order. Quantity discount contract motivates that, and because of the discount, this type can be also attractive for Company A. There is one big problem with this type aside from the profits. Individual profits thereby the total profit is less than in the case of the revenue-sharing contract. The ratio of profit-sharing is the same, but the amount of profits shows the differences.

In summary, it is a difficult issue to choose the right contract. Primary factor of the evaluation of supply chains' performance is the profit, and of course, this number is the most important for the companies. Higher profit means higher performance. If it were to be decided solely based on the profit numbers, the answer would be clear; revenue-sharing contract should be chosen. But if we also take into account soft factors, such as the trust, loyalty, or the attitudes of companies, quantity discount contract seems like a similarly good choice. The higher quantities and the lower market price pass with the expectations of the companies. Based on the available information, because of the profits, revenue-sharing contract is recommended to use for the successful relationship.

To reach the total supply chain coordination, it is necessary to use the modern, smart tools, and it is also important, that the relationships of the firms could be managed, coordinated. It is a mutually advantageous situation, because if the cooperation is supported by the contracts, the relationship will be framed, and the basis of the cooperation is the cooperation. To support the cooperation and also the cooperation, digital solutions need to be used. Thus, the total supply chain coordination can be reached, if the cooperation and also the cooperation, the information-flow, so the whole partnership will be supported by the smart tools and the contracts, as well (*Figure 3*).



**Figure 3.** Structure of a cooperation and cooperation based supply chain coordination  
(source: own construction)

The model shows that everything is connected to each other. Cooperation is the part of cooperation, that is the reason why that the tools of cooperation also supports the cooperation. Contracts give a framework, make the rules of the relationship. The relationship, which – nowadays – has to be in the virtual world. Thus, the digitalization and the effects of it are unstoppable. Firms need to use the tools of the industry 4.0. This constantly developing process generate many other innovation in the business world, and also in the social sphere.

Rather, the question is companies can make sacrifices for a successful partnership – and if yes, how much sacrifice they are able to make?

## 6. Acknowledgement

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