III. LOGISTICS CHALLENGES AT OPERATIONAL LEVEL

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KEY SUCCESS FACTORS IN MANAGING SUPPLY CHAIN – ISM ANALYSIS

ABSTRACT

Background: The identification of key success factors in managing supply chain (SCM) is one of the main tasks of managers, but still a weakly explored study field. We lack a comprehensive approach, in which financial, infrastructure, logistic, administrative and relational aspects are simultaneously examined. Thus, the aim of the analysis is was to identify the hierarchy of importance of different factors and their common relations among these, which were considered as the most important.

Methods: The study material was collected based on an in-depth interviews with the use of a structured survey questionnaire. The subjects of the study were the employees of Ukrainian company, which operates in dairy industry. Whereas in the analyses, Interpretive Structural Modelling (ISM) was used.

Results: In this study, we distinguished subject constructs, which included success factors in managing supply chain, we determined the level of their significance and we conducted the exemplification of the possible analyses with the use of a case study. Based on the empirical studies, we distinguished autonomous factors (with a low driving force and a low level of dependence) dependent factors (with a high level of dependence and a low driving force) combined (with a high driving force and a high level of dependence) and independent (with a high driving force and a low level of dependence). We used MICMAC analysis in this.

Conclusions: Based on the conducted empirical study, it can be concluded, that determining the significance of different success factors in managing supply chains and using ISM method

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to examine them, allows for a more conscious decision-making in developing supply chains. In the examined case, the most important SCM success factors are analytics, short supply chains and market conditions.

Keywords: supply chain, success factors, ISM, logistics, competitive factors

INTRODUCTION

In the literature of the subject we can find many studies regarding the analysis of the factors, which decide upon the success of the company on the market. They are often described as critical success factors, key success factors, critical factors, key factors or simply success factors. Despite a rich literature about success factors, there are few studies regarding the factors examined from the perspective of vertically integrated companies. Because nowadays businesses compete using supply chains, not single supply chain elements, applying this point of view seems to be reasonable.

In current studies, the success factors have been identified as regards various areas characterizing supply chains, where the focus is put on: the type of supply chain, industry, stakeholder relations, the size of the company or the chosen detailed aspects of chain management.

For example, Power, Sohal and Rahman [2001] determined critical success factors in agile supply chain. Gopal and Thakkar [2016] identified the success factors of the implementation of sustainable supply chain. Kim and Rhee [2012] presented critical success factors for managing green supply chain. Khan et al. [2018] determined the success factors for the implementation of transparent supply chain. Azmat and Kummer [2019] determined success factors for managing humanitarian supply chain. Whereas, Nguyen, Nguyen and Bosch [2017] identified success factors in managing coffee supply chain. Shahabi et al. [2017] determined success factors in managing pharmaceutical supply chain. Małkus [2013] presented success factors of the co-operation with logistic operator (the report had the form of a theoretical study). Matusek [2016] distinguished success factors in sales strategy with relation to suppliers. Hariharan, Suresh and Sagunthala [2019] and Kumar, Singh and Shankar [2015] determined success factors in managing the supply chain of small and medium companies. Leyh and Thomschke [2015] determined success factors regarding the implementation of SCM systems (which collect information scattered in supply chain). Małyszek [2011] distinguished factors influencing the success of partnership in supply chain. Denolf et al. [2018] formulated the set of success factors critical in

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the process of implementing information systems in supply chain. The following study refers to the field of management. The aim of the analysis was to identify the hierarchy of importance of different factors and their common relations among these, which were considered as the most important.

METHODOLOGY

Detailed description of the cyclic delivery synchronization problem was presented in the previous works of the authors The list of key success factors was prepared on the basis of the study of the literature in the field of managing supply chains and on the basis of interviews conducted with several business practitioners. The respondents were representatives of logistic corporations and representatives of production companies on managing positions.

In total, the interviews were conducted with 19 employees. They were the representatives of departments for creating supply chain structure, the managers of supply chain and distribution, the individuals responsible for relations with suppliers and customers as well as the representatives of logistic departments in production companies.

Some authors distinguish different lists of success factors, both in terms of the number as well as the substantial content. For example, Ab Talib, Abdul Hamid and Thoo, A. [2015] distinguished nine basic success factors in managing supply chain. Kumar et al. [2017] identified seven factors. On the other hand, Stonkute (2015) lists seventeen such factors.

Some of the factors, which until now were described in the literature, were reflected in the name of the given constructs, whereas some of them were hidden in test positions of a given construct. Altogether, 24 test positions were formulated and were gathered in 96 subject constructs. At the same time, we prepared a complex and a multi-thematic data base, which could be used as a point of reference of examining different industries. Taking into account that the study concerns supply chain, the list of factors is not equal to that, which is presented in the literature of the subject and concerns different chain elements and products.

At the next stage, the respondents were asked to assess the chosen factors, using the scale 1-5, where 5 meant that the given factor was insignificant, whereas 1 meant that it was a key success factor, on which the competitive advantage of a supply chain could be built. Because of the size of the study, in this study, we presented, only these factors, which were determined as the most significant. So, originally, (as already stated) 96 factors were included in the assessment, and further detailed analysis was conducted for the factors with the biggest score. In total, 56 factors were examined. Altogether, 14 constructs were distinguished for the study. Each of them

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included 4 testing positions. Such as: transport (i.e. possibility of tracking the movement of goods), level of service – suppliers (i.e. flexibility of the supplies of raw materials and components), level of service – customer (i.e. completeness of deliveries), IT (i.e. compatibility of IT systems of supply chains), stocks (i.e. access to the information about the level of supplies of contractors), costs (i.e. analyzing logistic costs), innovations (i.e. co-operation with research units on innovations), market of operations (i.e. access to modern logistic infrastructure), warehousing (i.e. possibility of using the services of the specialized logistic operators), analytics (i.e. KPI factor analysis of supply chain), human factors (i.e. availability of high-qualified logistic personnel), relations (i.e. maintaining positive relationships with local authorities), chain length (i.e. configuring possibly short supply chains, procedural conditions (i.e. implementation of system solutions increasing the level of safety in supply chain).

Several interesting study methods are recommended to the study of supply chains [Adamczak, Domański and Wagener 2016]. Considering that the study recommendation was also dedicated to business practitioners, ISM (Interpretive Structural Modeling) was chosen as the study method, which, at the same time, is not too complicated. The above method is successfully used in examining supply chain. For example, it is used for examining sustainable chains [Movahedipour et.al. 2017], managing supply chain of the road infrastructure projects [Purnima, Megha and Ambardar 2016] or managing risk in supply chain [Nguyen et al. 2018]. This method was also used in the area, which was analyzed, so in the area of key success factors in managing supply chain [Raut, Narkhede and Gardas 2017] and in the analysis of the supply chain of dairy products [Mor, Bhardwaj and Singh 2018]. Different sequences of the conducted analysis according to ISM method were also described in the quoted literature.

The respondents were representatives of a chain placed in dairy industry (the employees of logistics and production). The subject of analyses is a supply chain of milk deliveries and dairy products. The examined company is a key player on the dairy market of Ukraine. The company range has got over 150 products. The chain on the side of supplies is short, because the suppliers come from the local market, whereas the distribution is scattered. The Company is highly integrated on the side of deliveries because of MapXPlus System. The goods are delivered, among others, to Russia, Moldova, Azerbaijan, Georgia, Armenia and to the EU countries. The Company has its own logistic infrastructure, including warehouses and transport fleet. Logistic service of a supply chain is made using own supplies. The Company has got the following certificates: ISO HACCP, ISO 9001:2015, ISO 22000:2018. As a result of an

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unstable political and economic situation dairy industry in 2019 is in decline. The sales and income of companies decreased.

KEY SUCCESS FACTORS BASED ON THE SUPPLY CHAIN IN DAIRY INDUSTRY – ISM ANALYSIS

The ISM analysis was conducted according to the procedure broadly described in the literature of the subject and with the use of „R-3.6.1-win" package, widely known in statistics. At the first stage of the study, the matrix concerning the relations among different success factors SCM was prepared [Dandage et al. 2018].

The following four symbols were used to denote direction of relationship between the barriers (i and j):

V: barrier i influences barrier j.

A: barrier i is influenced by barrier j.

X: barrier i and j influence each other.

O: barrier i and j do not influence each other, since they are unrelated (table 1).

Table 1. Structural self-interaction matrix (SSIM)

Tabela 1. Strukturalna matryca samooddziaływania (SSIM)

i \ j		T	SL-S	SL-R	Inf	PC	W	C	I	MO	S	A	HF	R	CL
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Transport (T)	0	V	V	A	A	0	0	A	A	0	A	X	0	X
2	Service level - suppliers (SL-S)		0	0	A	A	V	X	A	A	A	A	X	0	A
3	Service level – recipients (SL-R)			0	A	A	V	X	A	A	A	A	X	0	A
4	Informatics (Inf)				0	A	A	V	A	0	V	V	X	0	0
5	Procedural conditions (PC)					0	V	V	A	A	X	A	X	A	A
6	Wrestling (W)						0	X	A	A	A	A	0	0	A
7	Costs (C)							0	X	X	A	X	A	0	X
8	Innovations (I)								0	X	V	A	X	0	A
9	Market of operations (MO)									0	V	A	X	0	V
10	Storage (S)										0	A	V	0	0
11	Analytics (A)											0	X	V	V
12	Human factors (HF)												0	V	A
13	Relations (R)													0	A
14	Chain length (CL)														0

Źródło: [opracowanie własne na podstawie przeprowadzonych badań empirycznych].

Source: [own elaboration based on the conducted empirical studies].

The initial reachability matrix emerged when we converted the SIM by substituting V, A, X, and O by 1 and 0; as per the following rules SSIM becomes binary format, for example, 0 or

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1;. (i) If the (i, j) relationship in SSIM is V, the corresponding binary relationship is 1 for (i, j) and is 0 for (j, i). (ii) If the (i, j) relationship in SSIM is A, the corresponding binary relationship is 0 for (i, j) and is 1 for (j, i). (iii) If the (i, j) relationship in SSIM is X, the corresponding binary relationship is 1 for both (j, i) and (i, j). (iv) If the (i, j) relationship in SSIM is O, the corresponding binary relationship is 0 for both (j, i) and (i, j) (table 2) [Yang et al. 2017].

Table 2. Initial reachability matrix

Tabela 2. Początkowa macierz osiągalności

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1	1	1	0	0	0	0	0	0	0	0	1	0	1
2	0	1	0	0	0	1	1	0	0	0	0	1	0	0
3	0	0	1	0	0	1	1	0	0	0	0	1	0	0
4	1	1	1	1	*0*	0	1	0	0	1	1	1	0	0
5	1	1	1	1	1	1	1	0	0	1	0	1	0	0
6	0	0	0	1	0	1	1	0	0	0	0	0	0	0
7	0	1	1	0	0	1	1	1	1	0	1	0	0	1
8	1	1	1	1	1	1	1	1	1	1	0	1	0	0
9	1	1	1	0	1	1	1	1	1	1	0	1	0	1
10	0	1	1	0	1	1	1	0	0	1	0	1	0	0
11	1	1	1	0	1	1	1	1	1	1	1	1	1	1
12	1	1	1	1	1	0	1	1	1	0	1	1	1	0
13	0	0	0	0	1	0	0	0	0	0	0	0	1	0

Źródło: [opracowanie własne na podstawie przeprowadzonych badań empirycznych].

Source: [own elaboration based on the conducted empirical studies].

To get final reachability matrix, the concept of transitivity is introduced, and some of the cells of initial reachability matrix are filled by inference. If a variable 'i' is related to 'j' and 'j' is related to 'k', then transitivity implies that variable 'i' is necessarily related to 'k'. The final reachability matrix is developed after incorporating transitivity concept and is represented in table 3 [Dandage et al. 2018].

Table 3 Final reachability matrix

Tabela 3. Finalna macierz osiągalności

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Driver power
1	1	1	1	***1****	***1****	***1****	***1****	***1****	***1****	0	***1****	1	***1****	1	13
2	***1****	1	***1****	***1****	***1****	1	1	***1****	***1****	0	***1****	1	***1****	***1****	13
3	***1****	***1****	1	***1****	***1****	1	1	***1****	***1****	0	***1****	1	***1****	***1****	13
4	1	1	1	1	***1****	***1****	1	***1****	***1****	1	1	1	***1****	***1****	14
5	1	1	1	1	1	1	1	***1****	***1****	1	***1****	1	***1****	***1****	14

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6	1*	1*	1*	1	0	1	1	1*	1*	1*	1*	1*	0	1*	12
7	1*	1	1	1*	1*	1	1	1	1	1*	1	1*	1*	1	14
8	1	1	1	1	1	1	1	1	1	1	1*	1	1*	1*	14
9	1	1	1	1*	1	1	1	1	1	1	1*	1	1*	1	14
10	1*	1	1	1*	1	1	1	1*	1*	1	1*	1	1*	1*	14
11	1	1	1	1*	1	1	1	1	1	1	1	1	1	1	14
12	1	1	1	1	1	1*	1	1	1	1*	1	1	1	1*	14
13	1*	1*	1*	1*	1	1*	1	0	0	1*	0	1*	1	0	10
14	1	1	1	1*	1	1	1	1	1*	1*	1*	1	1	1	14
Dependence	14	14	14	14	13	14	14	13	13	11	13	14	13	13	

Źródło: [opracowanie własne na podstawie przeprowadzonych badań empirycznych].

Source: [own elaboration based on the conducted empirical studies].

The next step involves extracting of a hierarchical ordering from the reachability matrix by level partitioning. The reason for this step is to make easy construction of the digraph from the reachability matrix. From the final reachability matrix, the reachability and antecedent sets for each success factor are established. The level partition related to this research is shown in table 4 [Yang et al. 2017].

Table 4. Summary of iterations for level partitions

Tabela 4. Podsumowanie iteracji dla podzielonych poziomów

	Reachability set	Antecedent set	Intersection set	Level
1	1,2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14	1,2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14	1,2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14	I
2	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14	1,2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14	I
3	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14	1,2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14	I
4	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	1,2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	I
6	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 14	1,2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 14	I
7	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	1,2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	I
12	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	1,2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	I
5	5, 10	5, 8, 9, 10, 11, 13, 14	5, 10	II
10	5, 10	5, 8, 9, 10, 11, 13, 14	5, 10	II
8	8, 9, 14	8, 9, 11, 14	8, 9, 14	III
13	13	9, 11, 13, 14	13	III
14	14	9, 11, 14	14	IV
9	9	9, 11	9	V
11	11	11	11	VI

Źródło: [opracowanie własne na podstawie przeprowadzonych badań empirycznych].

Source: [own elaboration based on the conducted empirical studies].

The next step was *MICMAC Analysis.* Based on dependence power and driving power matrix (table 5), it is desirable to seek a method by which we can draw up the hierarchical relationship among them and also establish which of the myriad indicators are "stand-alone"

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ones in their impacts, which ones do not hold true, and which ones generate secondary and higher order impacts. Cross impact matrix multiplication applied to classification (MICMAC) can be used as the best tool to meet the purpose [Yang et al. 2017].

As a result of the conducted analyses, it can be said that all success factors are located in the third cluster, which represents factors with a high power of dependence and a high driving force.

Based on the information about the level, at which a success factor is placed and on the information regarding the relations, which are among success factors, we constructed a model, which determined the relationships between the factors. It is a model, mainly including the relationships between variables. For the readiness of the model, we didn't mark the relations resulting from transition and didn't include two-way relations (figure 1).

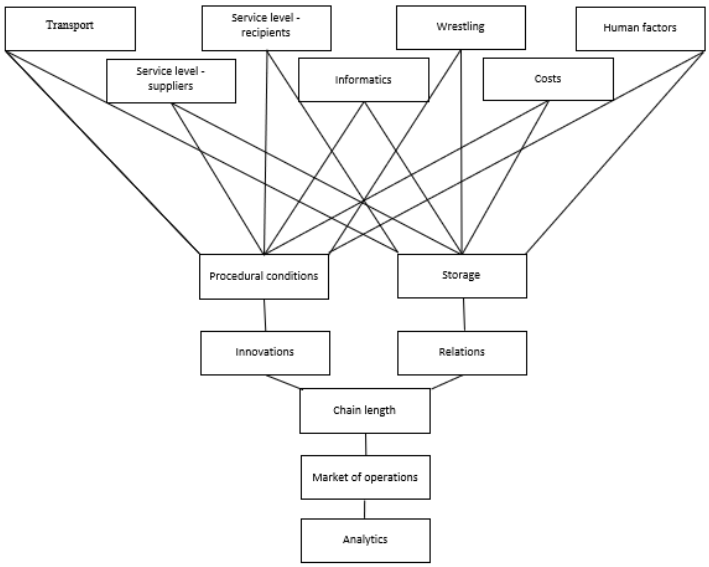

Fig. 1. Model based on ISM technique. Source: [own elaboration based on the conducted empirical studies].

Rys.1. Model oparty na technice ISM. Źródło: [opracowanie własne na podstawie przeprowadzonych badań empirycznych].

The analysis showed that the top success factor of SCM is „analytics", so the analysis of the assessment factors of supply chain: preparation and analysis of reports in the field of logistics, identification and assessment of risk elements in supply chain, as well as systemizing data and improving the methods of collecting data. It is especially important within the context of developing 4.0 technology, which can substantially improve the competitiveness of supply chain. At the fifth level of the presented model we could find "market of operations". In this construct, among others, were included such testing positions as: operating on the markets, which don't need a big capital involvement as well as big availability of warehouse

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infrastructure. This might indicate that the examined company might have gaps in the existing logistic potential.

As a result of the empirical study, it was also concluded that the important success factor of SCM is "the length of supply chain". It is the fourth level in the described model. The respondents, first, pointed to the necessity of simplifying supply chains, so the possibility of co-operation with suppliers, which are close, the possibility of warehouse location near clients and the reduction of supply chain elements. At the next level, we found such factors such as "innovations" and "relations". Probably, in the analysis of the industry of this type, innovations are leading factors. The relations with close and further stakeholders are more and more important, because of the increase of legal provisions, in which industry organizations and authorities are involved as well as the sensitivity on the social involvement of supply chain elements is increasing.

At penultimate level are such constructs as: "procedural modalities" and "warehousing". It is important to standardize processes in supply chain, having appropriate certificates, sustaining a high level of safety in supply chain. Within the last of the mentioned constructs, from the perspective of the examined supply chain, are important: managing flexibly warehouse space and the possibility of using modern logistics centers, as well as the possibility of access to the high-qualified logistic operators.

LIMITATIONS

The analyses with the use of ISM must be conducted on the limited number of variables, otherwise the analysis is too complex and unreadable. Thus, in this study, we included only the most important factors. It should be noticed, however, that depending on the kind of the examined industry, there are different success factors, so in the future, it is reasonable to conduct an analysis among the experts of different groups of industrial processing. Based on this, it will be possible to identify the differences and similarities among the significance of factors in different types of supply chains.

CONCLUSIVE REMARKS

In this study, we identified key success factors characteristic for supply chain management in a dairy industry. As a result of the conducted studies, it turned out that the ability to build short supply chains, access to specialized logistic infrastructure and having analytic skills are

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important in increasing the competitiveness of supply chain. Moreover, considering the analyzed case (as well as competitiveness and market of operations) we can conclude that the examined supply chain is not adapted to high expectations of logistic service.

The presented method of examining supply chain can support management decision-making concerning supply chain development. Considering the large number of success factors (influencing the competitiveness of supply chain) it is important to prioritize them in terms of their significance and the strength of influence.

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