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SUPPLY CHAIN IN THE STRATEGIC APPROACH WITH THE ASPECT OF QUALITY

Abstract: *The paper attempts to adapt the strategy area to the functioning of modern supply chains with the aspect of quality. Theoretical findings concerning the definitions of the term strategy were analyzed, as well as strategic assumptions in relation to the functioning of supply chains with reference to quality area. A proposal of mathematical formula for supply chain strategy equilibrium with the aspect of quality was also presented, taking into account its chosen determinants.*

Keywords: *Supply Chain, Strategy, Quality, Management*

1. Introduction

The epistemological framework of strategy issues in the science of organization management relates to the ways of achieving long-term goals of the organization's activity. Undoubtedly, the issues of strategic approach in reference to the supply chain with the aspect of quality relate to a vast, multi-faceted area and functional spectrum in management theory (Rushton et al., 2017). Strategic management of supply chain is established in the area of the processes of designing, planning, organizing and controlling of supply chain activities with the goal of building net value within enterprises functioning as links of interconnected and interrelated networks. Cooperation between the linked entities should lead to synergy solutions and joint achievements of high level quality comprehensive structure.

This paper is an attempt to identify and analyze only a selected, narrow range of strategic assumptions of the supply chain in reference to quality area. Its purpose is to indicate the theoretical framework of the supply chain in strategic approach with the aspect of quality and to present a proposal of

supply chain strategy equilibrium in reference to the quality area taking into account its chosen determinants.

2. Literature review

2.1. Delimitation of the strategy

The strategy is defined depending on the approach, type of activity, indicated goals, resources and assets and the method of their allocation, as well as decision-making processes occurring in a given organization or legal regulations to which it (the organization) must adapt. Romanowska (2017) defines strategy as an action program that characterizes the main goals of the company and the methods of achieving them. Ciesielski (2009) believes that colloquially it refers to indicating a plan on how an organization can achieve an assumed market position. According to Chopra and Meindl (2016) the strategy is the mechanisms by which enterprises coordinate their decisions regarding structural and infrastructural elements, it is also so-called long-term game plan. The idea of the strategy is to identify ways of gaining a competitive advantage by an enterprise, as

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assumed by majority of Authors.

The essence of the strategy consists in emphasizing the distinctive elements of the organization, pointing to their final recipients, and at the same time emphasizing the distinguishing elements of a given organization in order to make employees aware of its unique, individual features. The strategy can also be characterized as the indication of the basic, long-term goals of the enterprise along with the adoption of directions of activities and allocation of resources in such a way as to enable the achievement of the assumed goals. As part of creating the strategy, the company's mission and vision, its assumptions and organizational goals are formulated, the current situation is also analyzed and assessed, and the possibility of modifying the already developed strategy is accepted. A strategy is considered to be the process of defining the long-term goals and intentions of the enterprise, as well as adopting appropriate directions of activities and allocating resources necessary to achieve the adopted goals (Chandler, 1962). The strategy is also sometimes referred to a concept of complex activities, consisting in the formulation of the goals of the organization with the assumption of their further modification depending on the changes taking place in its environment, the selection of measures necessary to achieve the goals and methods of action that will optimally ensure their distribution and use in order to react to emerging market challenges. According to Drucker (2009), strategy is the art of making a choice in the event of constraining conditions, time pressure or loss of opportunities. Penc (1994), in turn, defines strategy as a concept of systemic action, within which a set of long-term goals of the enterprise is formulated, with the possibility of changing them depending on the situation in its environment, resources or means necessary to achieve the adopted goals. Strategy is also the art of interpreting and finding the meritum and meaning of events taking place in the company itself and

in its environment (Oblój, 2014). Strategy is also understood as a set of goals and action plans that have a positive impact on the company and its development, it is also taking actions and specific behaviors that ensure the company's achievement of long-term goals (Harrison & Hoek, 2014). The strategy is also understood as a plan, pattern, position in relation to competitors, the best way to use the resources and competences of the organization and the ability to quickly identify and take advantage of opportunities (chances) appearing in the environment. It is a continuous and dynamic process of making choices in conditions of uncertainty, aimed at long-term development. At the same time, the strategy connects the customer, the company and its environment, and the interconnection of these elements influences the final shape of the strategy.

2.2. Strategic and quality assumptions in relation to the supply chain

Supply chain management as a decision-making process, according to Lumineau and Henderson (2012) requires knowledge and application of procedures for formulating a mission/vision, operational goals, methods of operation, and most of all, the choice of strategy. The factors shaping the strategy related to the supply chain include communication and modern IT technologies, the level of competitiveness of the supply chain, quality management system, the level and scope of cooperation and trust between individual links of the chain as well as the company's position in the supply chain (leader) (Carter et al., 2017; Cohen & Roussel, 2013; Asadi et al., 2021; Nilashi et al., 2021; Fianko et al., 2021; Chonburi & Kunnapapdeelert, 2021), but also the nature of supply and demand or the type of product. When attempting to adapt the strategy to the operation of supply chains, one should, according to Świerczek (2009), accept a few basic assumptions:

- competitive activity does not concern one enterprise but the

entire supply chain,

- both final recipients and the enterprise are the beneficiaries of the added value generated by the supply chain,
- the effect of the adopted and implemented strategy is gaining a competitive advantage in the entire supply chain.

Initially, logistics strategies covered only one of the spheres of logistics, which was inventory management, however, seeing the need for greater complexity, over the years, logistics strategies began to cover also other areas of the supply chain, taking into account external connections (Spillan et al., 2013). In addition, changes in the approach to supply chain management also influenced strategies - its purpose, scope, essence and view of the relationships between the participants of the supply chain have changed (Pawar et al., 2016).

On the other hand, historically there are two main approaches to the supply chain strategy (Bozarth & Handfield, 2016):

- a strategy based on real demand (pull system, suction and reactive systems), which assumes the production and delivery of goods according to the customer's order, thus enabling a reduction in the level of inventory but requires an excellent flow of information,
- a strategy based on demand forecasts (push system, proactive and pumping systems), which assumes the production of goods in accordance with the assumed amount of demand and then - looking for buyers.

However, the most common in business practice is a combination of both strategies that are directly related to the split point concept which distinguishes between several strategies in the supply chain depending on where there is control based on forecast or customer demand. But the greatest importance is attached to strategies based on

the Porter (1990), in which he distinguished three types of competitive strategies: cost leadership, product and service differentiation, and focusing on defining the customer, product range or geographic market. It is assumed that, despite the changes taking place in logistics strategies over the years, the logistics strategy had to be adapted to the general business strategy of the enterprise. Chopra and Meindl (2016) put forward the thesis that both the logistics strategy and the other strategies related to it should first of all be adjusted to the main competitive patterns. Witkowski (2019), in turn, emphasizes that the selection of the right strategy consists in such a combination of the company's target market position, resources and management system, which in turn will contribute to an increase in added value.

According to Bozarth and Handfield (2019), the goal of the supply chain strategy is to enable the delivery of value to target recipients with the simultaneous development of success factors for a given supply chain, while Blaik (2017) considers the goal of such a strategy to achieve a competitive advantage of value-creating chains and to ensure the efficiency of high-quality processes influencing its creation. At the same time, a clear tendency has recently been observed indicating that building corporate strategies is now mainly based on the criterion of perceptual and conditional quality, understood as pursuit of optimal solutions contributing to confirmed successes, fulfilling accountabilities (American Society for Quality, 2021). Quality in supply chain management should be taken into account starting from its design - already at the strategy level. Quality must be considered at every level - at every link in the manufacturing and distribution chain, quality at suppliers, manufacturers, distributors, retailers, as well as at customers and service providers. Ensuring high quality is the basis of well-functioning economic entities that are oriented to involve all possible functions throughout the supply

chain in this process. The focus on quality in the supply chain usually relates to the quality of the final product, although there are also other quality priorities mentioned in the literature, such as (Malhotra & Robinson, 2005):

- Analyzing the quality of the entire supply chain (transcendent),
- User-based,
- Focusing on the manufacturing-

based process,

- Analyzing adding value to the product in the entire supply chain (value-based).

Table 1 presents the variety of interpretations of quality in the supply chain management process.

Table 1. Variety of Interpretations of Quality in the Supply Chain Management Process (Own elaboration on the basement of: Bozarth & Handfield, 2019; Oblój, 2014; Urban, 2007; Zimon, 2016)

Product quality type	Product content	Role and assumptions about customers	Relation to supply chain management
objective quality	applicable to all products	customers as a homogeneous group	in line with the expectations of managers, it facilitates management
perceived quality	applicable to all products	takes into account the individuality of customers	indispensable in the current changes in management
technical and functional quality	takes into account the content of the service in a universal but limited way	not detailed	takes into account the essence of the service and how it is provided
material, interactive and company quality	considers only the basic ingredients of the product, history and corporate image as part of the product	customers also evaluate quality by historical experience	helps to control the individual components of the product, emphasizes the role of the image
quality of input, process and output	not detailed what constitutes the content	not detailed	useful for management, takes into account the process of providing the service
quality gaps	not detailed	takes into account the expectations and perception of customers	shows how quality is lost
quality at SERVQUAL	main attention is devoted to non-material aspects in services, high universality of attributes	takes into account the expectations and perception of customers	allows a quantitative representation of the quality level
other defining the quality of service based on attributes	tailored to selected service industries	takes into account the perception of service quality in industries	allows a quantitative representation of the quality level
SQ-Need quality	not detailed	takes into account the complex psychological nature of customers	moderate usefulness, difficulty transfer into management

Table 1. Variety of Interpretations of Quality in the Supply Chain Management Process (Own elaboration on the basement of: Bozarth & Handfield, 2019; Oblój, 2014; Urban, 2007; Zimon, 2016) (continued)

Product quality type	Product content	Role and assumptions about customers	Relation to supply chain management
hygiene, improvement and double threshold attributes	not detailed	shows how customers respond to various factors	there are three types of attributes useful in quality management
quality at TQM	for various types of services	focus on customer needs	defined for the management concept, it emphasizes the importance of the human factor
quality at SIX SIGMA	for various types of services	measurement of quantitative characteristics related to customers	defined for the management concept, it focuses on processes and quantitative assessment

Table 1 shows that the quality may be multidimensional, it relates to the needs and expectations of customers and the environment, taking into account the appropriate supply chain management process. In this process, the organization of cooperation, goal-oriented and highly innovative operating standards are very important. Quality-based supply chain management focuses on integrating the business processes of all organizations that are links in the supply chain network in order to measure, analyze and continuously improve products, services and processes, creating added value for each intermediate and end user of the market.

The limitations that must be considered in the discussion on the need to the change of management methods, while changing the strategy to setting quality as the main priority, include primarily the customer (contractor) satisfaction perspective. The essence of improving quality must be based on increasing the value of the product or service for the customer (value-added perspective), because quality is not the only predecessor of customer satisfaction, which contributes to subsequent purchases (Milanovic et al., 2013; and Shaikh et al., 2021). So sometimes, in accordance with the law of marginal utility, the negative consequences for the added value of a

product outweigh the positive effects resulting from improving the quality of the product.

The supply chain strategy is understood as undertaking activities closely related to material, information and financial flows along with the way of managing them. A key element of any strategy is the pursuit of competitive advantage and the identification of new opportunities in the field of quality growth, the perception of supply chain enterprises and their resources, as well as the relationships between employees and customers, suppliers and other organizations (Rushton et al., 2017; and Samad et al., 2021). Therefore companies try to build their supply chains in such a way that at the lowest possible cost they would be able to meet the expectations and needs of customers than competing companies do. However, in order to achieve such an effect, an appropriate business and logistics strategy must be adopted, meeting the following conditions (Brdulak, 2012; and Shaikh 2020):

- acceptance of the view of the supply chain from the broadest possible perspective,
- covering all activities related to this area with logistic management,
- lead to the centralization of logistics management referred to quality

aspect along with assigning it an appropriate rank in company management,

- the use of broad criteria when assessing the functioning of the supply chain in reference to quality area.

At the same time, Ciesielski and Długosz (2010) believe that the competitive advantage does not have to be the result of the advantages and disadvantages of individual elements of the supply chain, but the developed supply chain strategy may focus on achieving a competitive advantage only in one selected link of the chain supply.

The process of creating a supply chain strategy consists in combining paradigms and logistic principles, goals of enterprises being the links in the chain, customer needs and expectations or contemporary economic trends. As noted by Coyle et al. (2016), it is also worth bearing in mind that the efficiency and effectiveness of the supply chain depends to a large extent on the adopted strategy, because it affects the nature of cooperation between enterprises, the use of capital, technical means, information exchange system, quality system or achievable effects. Making strategic decisions in the supply chain referred to the quality aspect requires greater integration of existing processes, existing structures, greater level of involvement in customer relations, elimination of potential risks and disruptions that may affect the functioning of the supply chain, greater flexibility, quick response to changes, appropriate use of resources, error-free information flow through efficient communication channels and continuous increase of knowledge, both among employees and customers of the company.

From the perspective of the sources of the key factors influencing the success of the supply chain strategy referred to quality area, the following can be distinguished (Matwiejczuk, 2015; and Elmagzoub et al., 2021):

1. Creation of own key success factors by the enterprise by making appropriate investments and shaping logistic processes.

2. Obtaining critical success factors by taking them over from competitors. This solution, however, is associated with the risk of a mismatch between the acquired factors and the company's capabilities.

3. Obtaining critical success factors by collaborating with other organizations in the supply chain, where this collaboration requires a clear definition of the roles and responsibilities of the different actors in the supply chain, in accordance with their resources and skills.

Summing up, the strategies are constantly evolving, striving to increase the level of quality of customer service while maintaining an acceptable level of costs in smooth flow of goods in the whole supply chain. This phenomenon also applies to supply chains that change under the influence of the ongoing market changes. Phenomena such as globalization, the development of information technology, automation and robots, shortened product life cycles, their complexity and mass customization have contributed to changes in the functioning of modern supply chains.

3. Research methodology

The study problem was to indicate and analyze strategic approach in reference to the supply chain with the aspect of quality in relation to multi-faceted area and functional spectrum in management theory as a proposal of supply chain strategy equilibrium with the aspect of quality taking into account its chosen determinants.

The epistemological basis of methodological background of the article refers to the scrutiny of theoretical statements of its objectives. Present theoretical approach to the strategy in the area of supply chain management referred to the quality area was indicated in the literature review. Due to the results of theory analysis the proposition of

the mathematical approach to strategic perspective of supply chain referred to the quality area and its determinants was presented. The solution proposition was based on the game theory as mathematical framework to conceive social science dilemma and indicate optimal decision-making in strategic settings (Watson, 2013). Modeling of the supply chain strategy was a pivotal factor in the processes of planning, organizing and controlling the flow of goods and information referred to the management of the enterprises which are links in the supply chain (Wieland et al., 2016) and is synonymous with a mathematical depiction of supply chain strategy equilibrium referred to the quality area taking into account its chosen determinants. The proposition

concerned deriving a mathematical formula, circumscribing the values for the formula, denominating their ranges and shared relations among values.

4. Research results and discussion

4.1. Dependencies between strategy, quality and the supply chain in the management process

A proposal of illustration of general interdependencies between strategy, quality and the supply chain is presented in Figure 1. These three elements should be closely related to each other in order to effectively management of the organization.

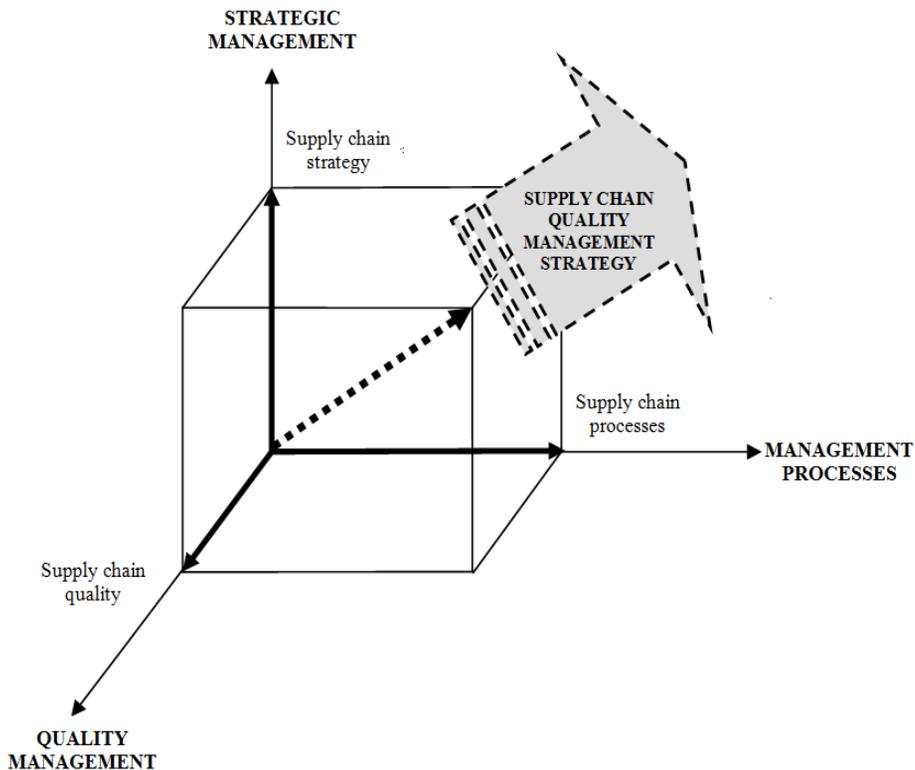


Figure 1. Strategy, Quality, Supply Chain – Interdependencies in the Management

Source: own elaboration.

The result of properly determined relationships between the strategy, quality and supply chain should be, in particular, the following effects:

- creating added value in order to satisfy the end user of a given product and, consequently, to achieve a competitive advantage;
- generating profits from activities which are a reward for creating customer satisfaction;
- increasing the ability to survive on the market as a consequence of maintaining long-term profitability and customer satisfaction;
- transforming the goals of cooperators into a competitive advantage due to cooperation between entities forming the supply chain;
- achieving outstanding logistic competences due to the collective management of shared resources;
- achieving a competitive advantage due to logistic competences;
- increased importance of logistic competences in achieving the goals of cooperating partners, resulting from the intensification of competition and market instability;
- achieving cost leadership thanks to logistics competences, in particular increasing efficiency (reducing costs);
- achieving a strategic advantage thanks to the concentration of logistic competences on the customer, taking into account their multidimensionality and long-term nature;
- creating an integrated logistics network strategy, leading to increased competitive advantage;
- improving coordination and collaboration on the web by serving customers and capturing, analyzing, compressing and disseminating product information;

- enabling the organization of the implementation of products and processes that will increase value for internal and external customers, thereby reducing costs, improving quality and efficiency;
- production of products of above-standard quality, which can be confirmed by obtained product and system certificates;
- guaranteeing a lower price level for products of consistent quality.

4.2. Chosen determinants of supply chain strategy equilibrium with the aspect of quality

This chapter of the article presents the proposed determinants of supply chain strategy equilibrium with the aspect of quality. A sufficient condition was adopted, limiting the area of the environment of supply chains on the market. The transformations in the iteration process were related to the following data:

- n homogeneous products of supply chains compete in the market,
- D is the demand for supply chain products,
- i is a supply chain product,
- j is a supply chain product,
- f_i is a set of inherent properties of the product i of the supply chain, determining its quality,
- f_j is a set of inherent properties of the product j of the supply chain, determining its quality,
- s_i is the strategy of the supply chain which produces the product i ,
- s_j is the strategy of the supply chain which produces the product j ,
- M_i is the sale of the product i of the supply chain,
- M_j is the sale of the product j of the supply chain,
- p_i is the profit from the sale of the product i of the supply chain,

- p_j is the profit from the sale of the product j of the supply chain,
- N_i is the net profit from the sale of the product i of the supply chain,
- N_j is the net profit from the sale of the product j of supply chain.

It is also assumed that:

- $s_i \geq 0$,
- $s_j \geq 0$,
- $f_i p_i \geq f_{i+1}, p_{i+1}, \forall i, i = 1 \div n-1$,
- $M_j = D \frac{f_j s_j}{\sum_{i=1}^n f_i s_i}, j=1 \div n$,
- $N_j = M_j p_j - s_j = D p_j \frac{f_j s_j}{\sum_{i=1}^n f_i s_i} - s_j, j=1 \div n$.

With aim to maximize the net profit from selling the product i of the supply chain, we get:

$$\frac{\partial N_j}{\partial s_j} = \frac{D f_j p_j}{\sum_{i=1}^n f_i s_i} \left(1 - \frac{f_j s_j}{\sum_{i=1}^n f_i s_i} \right) - 1 = 0$$

or

$$f_j s_j^* = \frac{\sum_{i=1}^n f_i s_i^*}{D f_j p_j} (D f_j p_j - \sum_{i=1}^n f_i s_i^*)$$

With regard to the strategy of product i of the supply chain, it is the result of the strategies of all links in the supply chain, as well as a derivative of its previous strategies. The strategy of product i of the supply chain strategy $s(i, t)$ in transaction t can be defined as follows:

$$f_j s_j(t) = \frac{\sum_{i=1}^n f_i s_i(t-1)}{D f_j p_j} (D f_j p_j - \sum_{i=1}^n f_i s_i(t-1))$$

The above formula is especially relevant when the strategies of all links in the supply chain have similar parameters: f_j which is a set of inherent properties of the product i of the supply chain, determining its quality, and p_i which is the profit from the sale of the product i of the supply chain. Realization of the strategy, even with such assumptions, is

rarely a stable process due to different strategic positions of the supply chain links. Balancing of the supply chain strategy taking into account all the components of the strategies of individual links is rarely possible in the economic reality. However, for the analysis of the balance approaching the equilibrium, the application of all strategies of individual links in the supply chain should be considered, due to:

$$Z_t = \sum_{i=1}^n f_i s_i(t)$$

It should also be assumed that the application of the strategies of individual links in the supply chain always takes positive values ($Z_t > 0$), otherwise the interaction between the links could not be implemented. According to this assumption, the iteration procedure can be proposed in the form:

$$Z_t = Z_{t-1} \left(n - \frac{1}{D} \alpha_n Z_{t-1} \right)$$

Two different equilibrium states of the supply chain strategy can be identified:

$$Z_0^* = 0$$

and

$$Z_l^* = D \frac{n-1}{\alpha_n}$$

when $\alpha_n = \sum_{j=1}^n \frac{1}{f_j p_j}$ is a market index

defining the deviation of the parameters of the product i of the supply chain: both the set of inherent properties of the product i of the supply chain f_i , determining its quality and the profit from sales of the product i of the supply chain p_i , from their average levels.

The environment of the equilibrium can be defined using the function:

$$e_t = e_{t-1}(2-n) - \frac{1}{D} \alpha_n e_{t-1}^2$$

if $e_t = Z_t - Z^*$

According to the above formula, the necessary condition to maintain the stability of the equilibrium Z_l^* is when $|l-n| < 1$, where l is the number of links in the supply chain. Then:

$$|e_t| < |e_{t-1}|$$

$$\text{while } \frac{1}{D} \alpha_n e_{t-1} < 1$$

When $n = 1$, then the equilibrium stability record takes the form $|e| < \frac{D}{\alpha_1}$. Then:

$$|Z_{t-1} - \frac{D}{\alpha_1}| < \frac{D}{\alpha_1}$$

The above formula brings the achievement of the equilibrium of the strategy of the l links of the supply chain. The product i of the supply chain is therefore strategic under the above assumptions. Whereas the supply chain strategy in the state of equilibrium with the aspect of quality may be presented in the form as below:

$$s_i = \frac{1}{f_i} (\sqrt{Df_i p_i} - \sqrt{\sum_{j=1, j \neq i}^n f_j s_j^*}) \sqrt{\sum_{j=1, j \neq i}^n f_j s_j^*}, i = 1 \div n$$

$$\arg \max N(i) = \frac{1}{f(i)} (\sqrt{Df_i p_i} - \sqrt{\sum_{j=1, j \neq i}^n f_j s_j^*})^2, i = 1 \div n$$

With regard to the supply chain strategy $s_i(t)$ in transaction t and in the state of equilibrium transaction, taking into account the quality aspect, it can be determined as follows:

$$s_i(t) = \frac{1}{f_i} (\sqrt{Df_i p_i} - \sqrt{\sum_{j=1, j \neq i}^n f_j s_j(t-1)})$$

$$\sqrt{\sum_{j=1, j \neq i}^n f_j s_j(t-1)}, i = 1 \div n, t \in N$$

Also the boundaries of the area can be defined as follows:

$$\frac{Df_i p_i s_i(t)}{f_i s_i(t-1) + \sum_{j=1, j \neq i}^n f_j s_j(t-1)} - s_j(t) \geq 0, \quad i = 1 \div n, t \in N$$

Thereby:

$$0 \leq \sum_{j=1, j \neq i}^n f_j s_j(t-1) \leq Df_i p_i, \quad \forall i = 1 \div n, n \in N$$

and

$$0 \leq s_i(t) \leq Df_i p_i, \quad \forall i = 1 \div n, n \in N$$

The formula presented above is proposed mathematical form of notation of supply chain strategy in the state of equilibrium with aspect of quality. It takes into the consideration selected determinants of supply chain strategy equilibrium resulting from internal and external conditions of supply chain functioning as well as a set of properties of the product of supply chain, determining its quality. It is a kind of a limited view on the supply chain strategy and by attempt to narrow down the determinants it may be a proposal to indicate important dependencies.

5. Conclusion

The strategic objective of economic entity is continued existence and growth, in perspective of rapid changes in the external environment, as well as potential of internal circumstances, and sustaining its equilibrium necessitates permanent modification and adjustment of the strategy to varying conditions. Most advantageous approach to attain this goal is managing an economic

entity due to optimization rules, which are often aided by quantitative and qualitative principles estimation and assessable data. The fundamental paradigm of optimizing management refers to the quantitative and qualitative character of supply chain processes, specially thoroughly signified in the designing and execution of physical flows of materials and goods, as well as many other supply chain activities controlled by measurable decisive factors and estimation indicators, with the objective of common value creation, high quality of supply chain processes, minimizing the costs and assembly of high level of customer service.

Summing up, it can be implicated that the supply chain strategy plays with aspect of quality an important role in the overall business strategy of the supply chain enterprises as an integral part of it. The conditions in which modern enterprises operate, resulting from the influence of globalization, regionalization, constant technological development and changing needs and expectations of customers, determine the further evolution of the supply chain strategy. Similarly, the increasing use of information technology, the emphasis on social and environmental issues as well as the newly emerging expectations and needs of buyers, mean that companies must also take into account these factors when formulating their supply chain strategy and referring to the quality area.

At the same time, this variety of factors influencing the formation of the supply chain strategy with aspect of quality may determine the attempts to limit the formulation of one universal supply chain

strategy. The proposal of supply chain strategy equilibrium presented in the paper may be a kind of hint for business entities forming the supply chain how chosen determinants can influence the supply chain strategy with aspect of quality. Mathematical modeling of strategic interaction between determinants presented in the paper describes the view on supply chain strategy and its equilibrium sets. In reference to the unpredictability of management conditions of the current enterprises functioning in the supply chains, the proposed mathematical model solution seems to be a tool for management of strategies area.

With regards to the proposed solution, two limitations may be indicated. First, enterprises are restricted to provide detailed information on their crucial basement of organizational and economic activity. Information should be precisely indicated which is not common practice for each enterprise and may be recognized as too embarrassing for managers. Second, this solution may be adequate only for stable economic conditions. The benefits of the model solutions use may not be realized or differ significantly in the condition of risk or unreliable economic situation.

For further studies the proposed mathematical model solution may be extended with other different, more detailed information data which would help to dedicate the solutions for concrete branch or type of enterprises. Another possibility of expanding the solution is by including risk aspects or unreliable economic conditions which would make the solution more adequate to nowadays real scenario.

References:

- American Society for Quality, (2021). *Glossary – entry quality*. Retrieved from <https://asq.org/quality-resources/quality-glossary/q>.
- Asadi, S., Nilashi, M., Iranmanesh, M., Ghobakhloo, M., Samad, S., ... & Mohd, S, (2022). Drivers and barriers of electric vehicle usage in Malaysia: A DEMATEL approach. *Resources, Conservation and Recycling*, 177, 105965, doi: 10.1016/j.resconrec.2021.105965

- Blaik, P. (2017). *Logistyka. Koncepcja zintegrowanego zarządzania*. [Logistics. Integrated management concept]. Warszawa: PWE.
- Bozarth, C., & Handfield, R. (2019). *Introduction to operations and supply chain management*. New Jersey: Pearson Education Inc.
- Brdulak, H. (2012). *Logistyka w trudnych czasach – szansa czy ryzyko?* [Logistics in difficult times - an opportunity or a risk?] In: Brdulak, H. *Logistyka przyszłości*. [Logistics of future]. Warszawa: PWE Warszawa, 148.
- Carter, C.R., Kosmol, T., & Kaufmann, L. (January 2017). Toward a supply chain practice view. *Journal of Supply Chain Management*, 53(1), 114-122. <https://doi.org/10.1111/jscm.12130>.
- Chandler, A. D. (1962). *Strategy and Structure*. Cambridge: MIT Press.
- Chopra, S., & Meindl, P. (2016). *Supply Chain Management: Strategy, Planning, and Operations*. New York: Pearson Education.
- Chonburi, Thailand, & Kunnappadeelert, S. (2021). Analyzing the effect of supply chain strategies and collaboration on performance improvement using MIMIC model. *International Journal of Industrial Engineering and Management*, 12(3), 216–225. <https://doi.org/10.24867/IJIEEM-2021-3-289>
- Ciesielski, M., & Długosz, J. (2010). *Strategie łańcuchów dostaw*. [Strategies of supply chains]. Warszawa: PWE.
- Ciesielski, M. (2009). *Instrumenty zarządzania łańcuchami dostaw*. [Instruments of supply chain management]. Warszawa: PWE.
- Cohen, S., & Roussel, J. (2013). *Strategic supply chain management: the five core disciplines for top performance*. New York: Mc Graw-Hill.
- Coyle, J. J. Jr., Langley, C.J., Novack, R.A., & Gibson, B. (2016). *Supply chain management: a logistics perspective*. London: South-Western College Pub.
- Drucker, P. F. (2009). *Zarządzanie XXI wieku – wyzwania*. [Management of 21st century - challenges]. Warszawa: MT Biznes.
- Elmagzoub, M., Syed, D., Shaikh, A., Islam, N., Alghamdi, A., & Rizwan, S., (2021). A Survey of Swarm Intelligence Based Load Balancing Techniques in Cloud Computing Environment. *Electronics*, 10, 21, 2718, doi: 10.3390/electronics10212718
- Fianko, S.M., Amoah, N., Afrifa, S., & Dzogbewu, T.C. (2021). Green supply chain management and environmental performance: The moderating role of firm size. *International Journal of Industrial Engineering and Management*, 12(3), 163–173. <https://doi.org/10.24867/IJIEEM-2021-3-285>
- Harrison, A., & Hoek, R.V. (2014). *Logistics management and strategy: competing through the supply chain*. Harlow: Pearson Education Limited.
- Lumineau F., & Henderson J.E. (2012). The influence of relational experience and contractual governance on the negotiation strategy in buyer-supplier disputes. *Journal of Operations Management*, 30(5), 382-395. doi: <https://doi.org/10.1016/j.jom.2012.03.005>.
- Malhotra M., & Robinson C. (2005). Defining the concept of supply chain quality management and its relevance to academic and industrial practice. *International Journal of Production Economics*, 96, 315-337. doi: 10.1016/j.ijpe.2004.06.055.
- Matwiejczuk, R. (2015). Logistyczne potencjały sukcesu w tworzeniu przewagi konkurencyjnej przedsiębiorstwa. [Logistic potentials of success in creating a competitive advantage of the enterprise]. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu* –

- Strategie i Logistyka w warunkach kryzysu*, 382, 336-375. doi: <http://dx.doi.org/10.15611/pn.2015.382.28>.
- Milanovic, I., Stefanovic, M., Arsovski, Z., Petrovic, D. R., Rankovic, V., & Kalinic, Z. (2013). Supply chain information integration through service oriented architecture. *International Journal for Quality Research*, 7(4), 509-522.
- Nilashi, M., Minaei-Bidgoli, B., Alrizq, M., Alghamdi, A., Alsulami, A. A., Samad, S., & Mohd, S. (2021). An Analytical Approach for Big Social Data Analysis for Customer Decision-Making in Eco-Friendly Hotels, *Expert Systems with Applications*, 186, p. 115722.
- Nilashi, M., Abumalloh, R. A., Almulihi, A., Alrizq, M., Alghamdi, A., ..., & Asadi, S. (2021). Big social data analysis for impact of food quality on travelers' satisfaction in eco-friendly hotels. *ICT Express*. <https://doi.org/10.1016/j.ict.2021.11.006>
- Nilashi, M., Abumalloh, R. A., Minaei-Bidgoli, B., Zogaan, W. A., Alhargan, A., Mohd, S., ... & Samad, S. (2021). What is the impact of service quality on customers' satisfaction during COVID-19 outbreak? New findings from online reviews analysis. *Telematics and Informatics*, 64, 101693, doi: 10.1016/j.tele.2021.101693
- Oblój, K. (2014). *Strategia organizacji*. [Organization strategy]. Warszawa: PWE.
- Pawar, K., Rogers, H., Potter, A., & Naim, M. (2016). *Developments in logistics and supply chain management*. United Kingdom: Polgrave McMillan.
- Penc, J. (1994). *Strategie zarządzania, cz. I. Perspektywiczne myślenie, systemowe działanie*. [Strategies of management. Part I. Perspective thinking, systemic action]. Warszawa: Placet.
- Porter, M. E. (1990). *The competitive advantages of nations*. Cambridge: Harvard Business Review.
- Romanowska, M. (2017). *Planowanie strategiczne w przedsiębiorstwie*. [Strategic planning in enterprise]. Warszawa: PWE.
- Rushton, A., Croucher, P., & Baker, P. (2017). *The handbook of logistics and distribution management: understanding the supply chain*. London: Kogan Page.
- Samad, S., Nilashi, M., Almulihi, A., Alrizq, M., Alghamdi, A.,, & Syed Azhar, S. N. F. (2021). Green Supply Chain Management practices and impact on firm performance: The moderating effect of collaborative capability. *Technology in Society*, 67, 101766
- Shaikh, A., & Alghamdi, A. (2020). IoT, Smart Environments and Interdisciplinary Applications for Technology Management and Sustainable Development. *International Journal of Technology Management & Sustainable Development*, 19, 3, 257-261.
- Shaikh, A., (2020). Guest Editorial: Advances in Deep Learning in Mobile Interactive Algorithms and Learning Technologies. *International Journal of Interactive Mobile Technologies (IJIM)*, 14, 10, pp 4-6.
- Shaikh, A., (2020). Guest Editorial: Impact of Integrated Intelligent Information and Analytical Systems on Society. *Journal of Information Technology Management (JITM)*, 12, 3, pp 1-3.
- Spillan, J. E., McGinnis, M. A., Kara, A., & Yi, G. L. (2013). A comparison of the effect of logistic strategy and logistics integration on firm competitiveness in the USA and China. *International Journal of Logistics Management*, 24(2), 153-179. doi: <https://doi.org/10.1108/IJLM-06-2012-0045>.
- Świerczek, A. (2009). Formułowanie strategii łańcuchów dostaw. [Formulating a supply chain strategy]. *Gospodarka Materialowa i Logistyka*, 8, 2-6.
- Urban, W. (2007). Definicje jakości usług - różnice oraz ich przyczyny. [Definitions of service quality - differences and their causes]. *Problemy Jakości*, 3, 4-9.

- Watson, J. (2013). *Strategy: an introduction to game theory*. New York: WW. Norton and CO.
- Wieland, A., Handfield, R. B., & Durach, C. F. (2016). Mapping the landscape of future research themes in supply chain management. *Journal of Business Logistics*, 37(3), 205-212. doi: <https://doi.org/10.1111/jbl.12131>.
- Witkowski, J. (2019). *Zarządzanie łańcuchem dostaw. Koncepcje, procedury, doświadczenia*. [Supply chain management. Concepts, procedures, experiences]. Warszawa: PWE.
- Zimon, D. (2016). The impact of TQM philosophy for the improvement of logistics processes in the supply chain. *International Journal for Quality Research*, 11(1), 3-16. doi: 10.18421/IJQR11.01-01.

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