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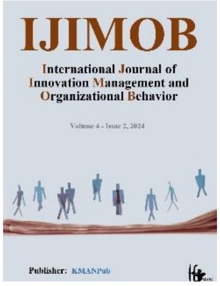

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Development of a Lean Six Sigma Model and Resilient Supply Chain Using Modern Fuzzy Inference Approaches and Design of Experiments (Case Study: Asia Factory)

Maryam. Anjom Shoa[1], Mojdeh. Rabbani[2*], Hassan. Dehghan Dehnavi[3], Mohammad Taghi. Honary[3]

[1] PhD Student, Department of Industrial Management, Yazd Branch, Islamic Azad University, Yazd, Iran
[2] Assistant Professor, Department of Industrial Management, Yazd Branch, Islamic Azad University, Yazd, Iran
[3] Associate Professor, Department of Industrial Management, Yazd Branch, Islamic Azad University, Yazd, Iran

*** Corresponding author email address**: mrabbani@iauyazd.ac.ir

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A B S T R A C T

Objective: The present research aims to develop a Lean Six Sigma model and a resilient supply chain.

Methodology: To develop the Lean Six Sigma model and resilient supply chain using a grounded theory method, interviews with experts were conducted to examine the factors influencing the model's development. Then, the Delphi process and surveys from relevant experts (faculty members, managers of food companies, and supply chain experts) were used to finalize the list of dimensions and components via the grounded theory method and to determine the importance coefficient of each. Finally, the identified input variables were converted into explicit or numerical values using fuzzy inference algorithms by a defuzzification unit. Using the design of experiments technique, the 3^(k-p) method was applied to express the impact of each influencing factor on the output characteristics as a model. Considering the qualitative nature of the research method, the data obtained from the study were analyzed using NVIVO version 11 software in the first step. In the next step, MATLAB software was used for the fuzzy inference section, and finally, MINITAB software was used in the design of experiments section.

Findings: The results showed that all input variables affecting flexibility, capacity, and adaptability were significant at a 95% confidence level. Additionally, Total Quality Management (TQM) had the most significant impact on the variables of flexibility and capacity, while Quality Function Deployment (QFD) had the most significant impact on adaptability.

Conclusion: The proposed model, aiming for integrated information across the food chain, spans from primary agricultural production to the consumer, replacing human mechanisms and potential errors.

Keywords: *Six Sigma, Lean, Resilient Supply Chain, Fuzzy Inference, Design of Experiments*

1 Introduction

In today's competitive world, one of the main concerns of senior managers is profitability and achieving sustainable results. The current era is characterized by customer orientation and audience centrality, where the success of any organization is directly related to the extent to which it meets the needs and desires of its customers and audiences. To fulfill these needs, comprehensive improvement and reform at the organizational level is necessary. Key issues that organizations continuously face include process improvement, increasing customer satisfaction, and reducing organizational costs. Lean Six Sigma can be utilized as a systematic approach to achieve these goals. One of the management models recently and widely used in world-class enterprises is the Lean Six Sigma methodology. The Lean approach emphasizes reducing wasteful and non-value-added activities in a process, while the Six Sigma method aims to reduce process variation through the use of statistical techniques. The simultaneous application of these two tools provides a better opportunity to achieve the desired outcomes (Hundal et al., 2022; Praharsi et al., 2021).

On the other hand, the supply chain has become a critical and vital factor in global markets today; the primary competition occurs not so much between organizations as it does between their supply chains (Fakoor Sagihe et al., 2014). Consequently, the importance of supply chain management and its performance has become one of the twenty-first-century paradigms for improving competitiveness, garnering increased attention from organizations (Hundal et al., 2022). In light of this and the dynamic nature of global trade, it is necessary for supply chains to have the ability to adapt to changes. In other words, the ability to adapt the system to cope with temporary adverse events and manage the incidents caused by changes and the complexity of the business environment is essential. Factors such as the ability to change supply chain design, supply flexibility, agility, etc., alongside the complexity of the business environment and increased competition in various industries, have led to instability and volatility in competitiveness factors. Establishing and maintaining competitiveness requires competencies that create value for customers based on organizational capabilities. Therefore, supply chain resilience is a highly significant feature that aims to protect the supply chain during unforeseen events and challenges, necessitating careful attention (Amani et al., 2020; Fakoor Sagihe et al., 2014).

The lack of structured and scientific studies aimed at developing a comprehensive model for the simultaneous application and connection of Lean Six Sigma and resilient supply chain approaches underscores the need for further scientific research in this area. Moreover, most studies conducted domestically and internationally have examined each of these approaches separately, highlighting the importance of developing a combined model to fill the existing scientific gap concerning the impact of Lean Six Sigma on supply chain resilience. What is important in this context is the development of a model that identifies the factors influencing a resilient supply chain through the application of the Lean Six Sigma approach. The present research aims to answer the main question: How will the development of a Lean Six Sigma model and a resilient supply chain be? Therefore, three specific objectives are designed for this study:

- Determining the factors and sub-factors influencing Lean Six Sigma and resilient supply chain using the grounded theory technique with NVIVO version 11 software (surveying relevant experts, including 12 faculty members, managers of companies, and experts in supply chain and Lean Six Sigma).
- Implementing a fuzzy inference model of Lean Six Sigma and resilient supply chain with expert opinions using MATLAB software (extracting response variables for different conditions of Lean Six Sigma tools and their impact on resilient variables).
- Testing the proposed model using a combined method of design of experiments and fuzzy inference with MINITAB software (designing the experiment model, testing it with response variables extracted from fuzzy inference, and analyzing the significance of relationships).

2 Methods and Materials

The present study is applied in terms of its purpose, mixed exploratory (quantitative and qualitative) in terms of data, and grounded theory in the qualitative section and survey in the quantitative section. The statistical population of this research is the food industry, utilizing experts proficient in the food industry concepts, Lean Six Sigma, and resilient supply chain.

One of the qualitative research methods is the grounded theory method, which is emphasized in this research due to its specific characteristics. Grounded theory is a process for

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generalizing the results of a particular observation to a broader theory. Through this method, a theory is inductively derived from daily experiences, interactions, documents, literature, and observations. The researcher does not start with a theory to prove but begins with a field study and allows related elements to emerge. Therefore, data collection, analysis, and theory are interrelated.

Step One: Evaluation of Indicators Based on Qualitative Method

Grounded theory methodology is a research method for systematically understanding the views and meanings of individuals in a specific situation. This method, characterized by full engagement of the researcher with the study subject and the use of multiple data collection and analysis methods, strives to provide an accurate theoretical understanding of the phenomenon under study. The research steps according to the grounded theory methodology by Strauss and Corbin are as follows:

Open Coding (Description): Statements or phrases (single words or small sets of words) are categorized based on semantic units to which concepts (codes) are attached. Sometimes open coding results in dozens of codes.

Axial Coding (Classification): A process that connects categories to subcategories. This coding is called axial because it revolves around one category, connecting categories at the level of features and dimensions.

Selective Coding: The process of refining categories, integrating them, and linking categories together. In this stage of coding, the relationships between categories are synthesized and explained to formulate a theory and present a model, arranging categories around a central category to develop a systematic theoretical narrative.

Based on open coding, axial coding is performed. This means the researcher identifies an open coding category and focuses on it as the central phenomenon. Then, the researcher returns to the data to build categories around this central phenomenon. Strauss and Corbin (1990) believe the categories built around the central phenomenon are causal conditions, which determine the factors causing the central phenomenon. All actions taken in response to the central phenomenon are called strategies, influenced by broad factors and specific situational factors, known as contextual and intervening conditions. These strategies result in specific outcomes called consequences. The formulation of these relationships is presented as a paradigmatic model.

3 Findings and Results

Based on the analysis of the interviews, the final extracted concepts included 66 open codes, 24 axial codes, and 11 selective codes, which form the Lean Six Sigma and resilient supply chain model (Figure 3). The axial category of causal conditions of the Lean Six Sigma and resilient supply chain model includes the selective codes: Total Quality Management (TQM) and the Deming Cycle. The axial category of contextual factors includes the selective codes: Quality Function Deployment (QFD) and SMED technique. The axial category of intervening conditions includes the selective codes: FMEA technique and benchmarking. The axial category of strategies includes the selective codes: SIPOC analysis and Balanced Scorecard. The axial category of outcomes includes the selective codes: capacity enhancement ability, flexibility, and adaptability.

Step Two: Designing the Model Based on Fuzzy Inference

Decisions made today occur in highly complex environments, and in most cases, the use of experts is necessary. In such decision-making situations, fuzzy theory can significantly help overcome problems. An expert system examines a topic through a set of different states and finally reaches a result using appropriate "if-then" rules. Fuzzy inference is a process that formulates the mapping from inputs to outputs using fuzzy logic. In practical systems, important information comes from two sources. One source is expert individuals who define their knowledge and awareness about the system in natural language. The other source includes measurements and mathematical models derived from physical rules. Therefore, an important issue is combining these two types of information in system design. How can human knowledge be converted into a mathematical formula? Essentially, this conversion is what a fuzzy system performs. Each inference system requires a set of fuzzy membership functions as inputs or outputs and a set of fuzzy rules for its rule engine. Inputs and outputs are two essential elements in the fuzzy inference system. Inputs include some vague and imprecise verbal concepts for a specific event, and outputs are a set of fuzzy or precise features. In fact, the fuzzy inference system helps the researcher perform the process of formulating the mapping from given input data to an output using fuzzy logic.

Based on the presented expert rules (Table 1), the fuzzy inference system is designed for each of the three output variables. Eight input variables are provided, and their effects on the output variables (flexibility, adaptability, and capacity) are assessed based on the Mamdani fuzzy inference system. After executing the above model, the

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pairwise comparison of each variable and its effect on the output variable can be observed.

Table 1

Expert Rules

Total Quality Management	Data-Driven Improvement Cycle	Quality Function Deployment	Waste Reduction	FMEA	Benchmarking	Process Documentation	Balanced Scorecard	Capacity	Flexibility	Adaptability
Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
Very Low	Very Low	Very Low	Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
Very Low	Very Low	Very Low	Low	Very Low	Very Low	Low	Very Low	Very Low	Very Low	Very Low
Very Low	Very Low	Very Low	Low	Very Low	Low	Low	Very Low	Low	Very Low	Very Low
Low	Very Low	Very Low	Low	Low	Low	Very Low	Low	Low	Low	Very Low
Low	Very Low	Very Low	Low	Low	Low	Low	Low	Low	Low	Low
Low	Very Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Low	Very Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Medium	Very Low	Low	Low	Medium	Medium	Low	Low	Medium	Low	Low
Medium	Low	Low	Low	Medium	Medium	Low	Low	Medium	Medium	Medium
Medium	Low	Medium	Medium	High	Medium	Medium	Low	Medium	Medium	Medium
Medium	Low	Medium	Medium	High	Medium	Medium	Low	Medium	Medium	Medium
Medium	Medium	Medium	Medium	High	Medium	Medium	Medium	High	Medium	Medium
High	Medium	Medium	High	High	High	High	Medium	High	Medium	High
High	Medium	Medium	High	High	High	High	High	High	Medium	High
High	High	Medium	High	High	High	High	High	High	Medium	High
High	High	High	High	Medium	High	High	High	High	Medium	High
High	High	High	High	High	High	High	High	High	High	High

Step Three: Testing the Model Using Design of Experiments

Response surface methodology is a set of statistical and mathematical techniques used for building empirical models. The goal of such designs is to optimize the response (output variable), which is affected by several independent variables (input variables). An experiment is a series of tests called runs. In each experiment, changes are made to the input variables to determine the causes of changes in the response variable.

Originally, response surface methodology was developed for modeling empirical responses and later shifted towards modeling numerical experiments. In this methodology, it is assumed that errors are random and converge towards the optimal element as they reduce the effects of disorderly factors. An important aspect of this method is the design of experiments. This strategy was initially developed for fitting experimental models but can also be applied to numerical experiments. The aim of the design of experiments is to select points where the response should be evaluated. The selection of experimental designs can significantly impact the accuracy of estimates and the cost of constructing the response surface model. In a traditional experimental design, screening experiments are conducted in the early stages of the process, i.e., when there are many potential design variables that may have small effects on the response or no effect at all.

In the present research, using the design of experiments technique and the 3^(k-p) method, the impact of the eight input variables on the three output variables—adaptability, flexibility, and capacity—is examined. The results of the design of experiments are presented below.

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Table 2

Implementation of Design of Experiments for Flexibility Variable

Row	Variable	Effect	Coefficient	Standard Deviation	Significance Level
1	Constant	-	5.90	0.00	<0.05
2	Total Quality Management	15.30	7.11	0.00	<0.05
3	Data-Driven Improvement Cycle	8.90	3.90	0.00	<0.05
4	Quality Function Deployment	4.10	1.85	0.00	<0.05
5	Waste Reduction	3.90	2.30	0.00	<0.05
6	FMEA	2.90	1.72	0.00	<0.05
7	Benchmarking	3.50	2.80	0.00	<0.05
8	Process Documentation	5.60	3.10	0.00	<0.05
9	Balanced Scorecard	4.75	2.85	0.00	<0.05

As shown in Table 2, all input variables affecting flexibility are significant at a 95% confidence level, and their regression coefficients have been obtained. Therefore, it can be said that the above variables impact flexibility.

Table 3

Implementation of Design of Experiments for Capacity Variable

Row	Variable	Effect	Coefficient	Standard Deviation	Significance Level
1	Constant	-	1.50	0.00	<0.05
2	Total Quality Management	4.40	2.20	0.00	<0.05
3	Data-Driven Improvement Cycle	0.00	0.00	0.00	<0.05
4	Quality Function Deployment	1.90	1.60	0.00	<0.05
5	Waste Reduction	2.20	1.30	0.00	<0.05
6	FMEA	0.70	0.30	0.00	<0.05
7	Benchmarking	0.60	0.19	0.00	<0.05
8	Process Documentation	2.00	0.83	0.00	<0.05
9	Balanced Scorecard	1.30	0.71	0.00	<0.05

In Table 3, the variables affecting capacity are examined, showing that all variables are significant at a 95% confidence level. As observed, Total Quality Management still has the highest impact on the capacity variable. After that, Quality Function Deployment and waste reduction are significant, followed by Process Documentation and Balanced Scorecard. FMEA and benchmarking have an equal impact on capacity. The Data-Driven Improvement Cycle has a zero impact on the capacity variable.

Table 4

Implementation of Design of Experiments for Adaptability Variable

Row	Variable	Effect	Coefficient	Standard Deviation	Significance Level
1	Constant	-	1.93	0.00	<0.05
2	Total Quality Management	0.00	0.00	0.00	<0.05
3	Data-Driven Improvement Cycle	1.30	1.20	0.00	<0.05
4	Quality Function Deployment	1.70	1.50	0.00	<0.05
5	Waste Reduction	0.43	0.22	0.00	<0.05
6	FMEA	0.45	0.16	0.00	<0.05
7	Benchmarking	0.32	0.19	0.00	<0.05
8	Process Documentation	1.70	0.81	0.00	<0.05
9	Balanced Scorecard	1.90	0.97	0.00	<0.05

It is observed in Table 4 that all eight variables are significant at a 95% confidence level.

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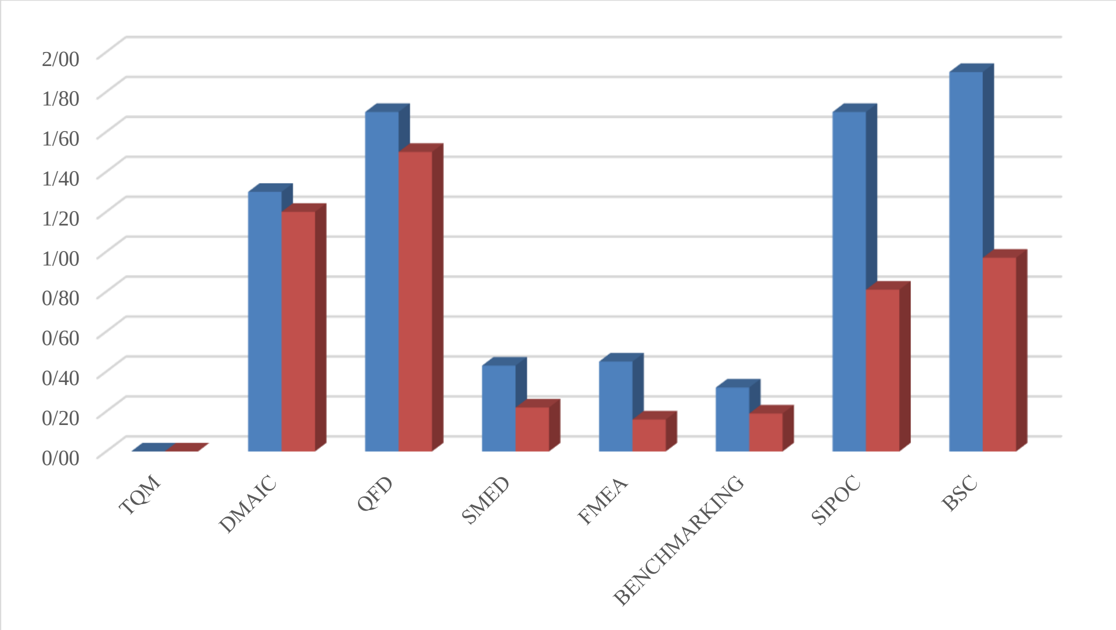
Figure 1

Implementation of Design of Experiments for Adaptability Variable



In Figure 1, it is seen that Quality Function Deployment has the highest impact on adaptability. Following that is the Data-Driven Improvement Cycle, which had zero impact on capacity. After that comes the Balanced Scorecard and Process Documentation. Regarding adaptability, it is observed that Total Quality Management has a zero impact.

4 Discussion and Conclusion

In today's rapidly changing and risky world, supply chains are no longer just a simple sequence of processes; they are a complex network always at risk of disruption. Due to the inefficiency of traditional methods, academic researchers and industry managers have realized the need for resilience and Six Sigma to cope with high complexities, unforeseen events, and designed threats. The resilience and leanness of the supply chain are enhanced by focusing on effective capabilities. Higher resilience enables companies to react and adapt more to changes in the business environment; thus, company performance improves. Ranking the capabilities affecting the success of supply chain resilience helps companies maintain stability under different financial conditions, market demands, and competitive pressures, thereby strengthening their interactions.

The United Nations estimates the world population to be around 9.6 billion by 2050 (United Nations Statistics). This statistic confirms that "food supply" will be one of humanity's greatest challenges in the coming years. As the issue of feeding the world's population gains importance, the process of producing and distributing food products also becomes more complex. Numerous competitive markets with substantial financial turnover have emerged in this domain, creating continuous supply chains (Fakoor Sagihe et al., 2014). These unique chains form a complex network of interconnected entities working together to make food accessible. The supply of raw materials for production is at the beginning of the food supply chain, and logistics and transportation entities ensure timely and quality delivery.

Creating a competitive supply chain is one of the main challenges in many industries; in the current global competition, diverse products must be made available to the customer according to their requests. Customer demands for high quality and fast service have increased pressures that previously did not exist, resulting in companies no longer being able to handle everything alone. In today's competitive market, economic and manufacturing enterprises have found themselves needing to manage and oversee external resources and entities in addition to their internal organization and resources. This necessity is actually for achieving competitive advantages with the goal of gaining a larger market share. Accordingly, activities such as supply and demand planning, material procurement, production and

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product planning, goods maintenance, inventory control, distribution, delivery, and customer service, which were previously all performed at the company level, have now been transferred to the supply chain level. In these circumstances, designing and planning resilient and lean supply chains is a serious challenge due to the increasing complexity of these systems operating in a global market and, therefore, being more prone to disruptions.

Choosing a strategic improvement approach provides many options for organizations. Teams in this approach target the most important strengths and weaknesses of the organization. Implementing resilient and lean supply chains along this path may be limited to certain units or parts of the organization's activities. This approach can help the organization focus on higher-priority opportunities and limit change management to the desired areas. However, there may be inconsistencies between parts implementing resilient and lean supply chains and those not involved, which requires training flexible employees. Additionally, using networks and decentralizing logistics activities, restructuring and current processes, predicting potential and actual threats, and designing practical scenarios are other requirements for increasing the flexibility of the resilient and lean supply chain.

According to the conducted studies, Total Quality Management (TQM) has the greatest effect on flexibility. Given the definition of TQM, continuous improvement of product and service quality through the participation of all company levels and functions, involving suppliers in product improvement processes to leverage their capabilities and experiences is emphasized. This not only allows the company to utilize external resources more easily and align them with the manufacturer's needs but also incorporates the experiences, capabilities, technology, and efficiency of suppliers into the system (Huang et al., 2018; Hundal et al., 2022). Support history shows that internal company coordination and integration of functions, such as integrating support or customer-centric procurement strategies and support management as an integrated activity, are closely related to operational performance.

Further studies indicate that Quality Function Deployment (QFD) has the most significant impact on capacity. Therefore, it can be argued that supply chain management is both a theory and a practical approach aimed at customer satisfaction while reducing costs. With the increasing use of advanced technologies, transforming the supply chain into a supply network is inevitable. Hence, continuous monitoring and evaluation of the company compared to competitors is a step towards strengthening and developing the company's position, and using various techniques ensures this. The powerful tool "Quality Function Deployment" can help in this regard. QFD is a systematic method that improves quality and product development by listening to the voice of the customer. The criteria for measuring and judging product quality are the level of customer satisfaction (Amani et al., 2020; Hundal et al., 2022; Praharsi et al., 2021). Benchmarking customer satisfaction can help decision-makers identify areas for improvement, make strategic decisions, and set targets for achieving optimal satisfaction.

Since the Data-Driven Improvement Cycle has the most significant effect on adaptability, it can be argued that approaches to improvement methods such as the Data-Driven Improvement Cycle and its tools are not a choice but a necessity for all organizations, especially large industries. For any organization, more errors mean higher costs and lower quality, resulting in a reduction in the value created for customers and consequently losing competitiveness and market share (Praharsi et al., 2021; Ruiz-Benítez et al., 2018). To remain in global markets, increasing quality and reducing costs by improving key organizational process indicators and using engineering tools is inevitable.

Studies show that a supply chain that does not sufficiently develop its capabilities to counter and neutralize high levels of vulnerabilities is widely exposed to risk. Conversely, over-investing in capabilities may reduce and lose supply chain profits and benefits. Therefore, developing capabilities that best bridge supply chain vulnerabilities creates a balance between investment and risk, which in the long term improves performance and increases the company's competitiveness. No capability, however powerful, is sufficient alone for achieving competitiveness; a combination of them must be utilized. Since the concept and creation of resilience capabilities and Six Sigma characteristics also rely on a set of capabilities, they can help companies achieve competitiveness. Integrated and dynamic capabilities are hard to sustain under uncertainty, especially in today's business environment. Therefore, competitiveness factors are short-lived and easily influenced by incidents and disruptions. In these conditions, applying resilience principles will be beneficial. In fact, the factors constituting resilience capabilities used for managing incidents and disruptions are the same capabilities that create competitiveness. Therefore, in a changing business environment, resilience plays a key role in maintaining the

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link between integrated and dynamic supply chain capabilities and sustainable competitive advantage.

Additionally, considering the results showing that meeting customer expectations and senior management support are the most influential factors in the study, a flexible supply chain requires senior management support prioritizing customer needs. Understanding customers and their needs is effective in gaining superiority in providing customer service. Managers should prioritize their key customers and focus their attention on them, understanding the increasing cost of losing customers daily. In this regard, the supply chain in the food industry is a critical process. This process lays the foundation for long-term relationships based on commitment and trust between producers, suppliers, and customers. Although the supply chain functions similarly across industries, the food industry is one of the successful examples of leveraging supply chain advantages. Even when the supply chain does not directly impact food companies' performance, it manages the integration of production and distribution operations. Optimal management of food supply chain components in production, distribution, and logistics processes not only enhances company performance levels but also benefits people by providing easy access to food.

Since the results show that Total Quality Management still has the most significant impact on flexibility and capacity variables, and Quality Function Deployment has the most significant impact on adaptability, it can be argued that quality management should be considered not only as a set of engineering and technological changes but also as part of the company's overall strategy. In this way, the company can achieve high effectiveness by designing product and service quality and ensuring quality during the process using methods to prevent product spoilage, control tools, fair use of quality information such as customer feedback, benchmarking, and more. To implement these strategies, the organization must be customer-oriented and maintain its competencies. Given the ever-increasing changes in the business environment and the unpredictability of future changes, organizations can no longer solely rely on strategic planning to face these changes but should also use strategic thinking as an insight and understanding for business effectiveness.

Additionally, the Quality Function Deployment process, by developing a logical design process, creates and generates product quality. In this method, customers express their mental needs during product evaluations, and Quality Function Deployment systematically translates these needs into tangible, designed requirements using a wide range of methods and tools. Quality Function Deployment is a methodology for designing products and services where the customer's voice is the input. Customer needs and desires leverage the development of new or revised product or service requirements.

Rapid and advanced changes in industries and businesses on one hand and the management conditions in domestic economic enterprises and the importance of export development and competition in the global market on the other hand have led organizations to seek strategies and capabilities for producing various products according to customer needs in the shortest time and at the lowest cost, improving quality, creating product and service innovation, and generally enhancing organizational flexibility to respond to environmental needs. Therefore, defining and implementing an appropriate supply chain model is inevitable, and most organizations and companies (manufacturing, services, etc.) are exploring and seeking to understand which factors their customers are most sensitive to. Numerous models have been proposed in this area, each examining the supply chain issue from its perspective. The fundamental issue facing supply chain managers and decision-makers is the absence of a comprehensive model addressing the supply chain issue. Key factors influencing the supply chain must be identified. Creating a supply chain that can respond to unforeseen disruptions, quickly meet changing customer needs, align with environmental responsibilities, reduce costs, and eliminate non-value-added processes should be on the organization's agenda. To this end, an integrated approach can balance conflicts among paradigms and achieve the highest competitive potential. In these conditions, supply chain resilience, in addition to managing business environment changes and complexities, improves company performance in the long term.

Moreover, the Six Sigma implementation method is flexible and does not fit into a specific framework for all levels. Issues related to the organization's human resources, such as creativity, collaboration, teamwork, communication, and motivational issues, are more critical than a superficial focus on technical and statistical issues as emphasized by Six Sigma. These features create and sustain competitiveness through flexibility.

Food safety is a growing issue worldwide, providing positive advantages in accessing large markets. However, producers must understand food safety and quality aspects to achieve this. Traceability information encompasses the entire production process, from the initial stages of raw

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material preparation to the product reaching the consumer, recorded according to company capabilities. Tracing all components of food includes real-time and accurate information, enabling us to reduce food risks and achieve a rapid and effective response to incidents, thereby increasing the reliability of food products. An accurate traceability system should allow quick access to all detailed information on changes made in the food chain. The proposed model, aiming for integrated information across the food chain, spans from primary agricultural production to the consumer, replacing human mechanisms and potential errors.

Authors' Contributions

All authors have contributed significantly to the research process and the development of the manuscript.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

In this research, ethical standards including obtaining informed consent, ensuring privacy and confidentiality were observed.

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