Paper Type: Research Paper

Providing a Structural Model of Lean Sustainable Supply Chain with Total Quality Management Approach in the Automotive Industry

Mohammadreza Zahedi[1],* ID **, Shayan Naghdi Khanachah[2], Mostafa Zahedi[3]**

[1] Department of Management and Industrial Engineering, Malek Ashtar University of Technology, Tehran, Iran; zahedy182@gmail.com.

[2] School of Industrial Engineering, Iran University of Science and Technology, Tehran, Iran; naghdi_shayan@ind.iust.ac.ir.

[3] Department of Computer Engineering, Islamic Azad University, Ardebil, Iran; zahedi_adj_55@yahoo.com.

Citation:

Abstract

Improving supply chain management performance is one of the critical issues to gaining a competitive advantage for companies. In this regard, one of the valuable solutions is the lean approach. A lean approach helps eliminate supply chain waste. On the other hand, considering the existence of the automobile industry in Iran and the presence of many parts manufacturing industries to meet the needs of automobile manufacturers, the implementation of the lean approach in the supply chain of organizations active in this field is essential and creates a competitive advantage in them. At first, by reviewing the literature, eight key factors that cause the supply chain to be clean were identified, and 40 supply chain experts were assisted using a questionnaire. The normality of the data distribution was examined using the Kolmogorov-Smirnov test. The main result of this study was the pattern of factors affecting the purity of the supply chain in the automotive parts industry. This model includes the leveling of factors affecting the supply chain, which provides managers with a comprehensive view and attitude about the relationships between these variables.

Keywords: Supply chain, Lean approach, Auto parts industry, Path analysis, Interpretive structural modeling.

1 | Introduction

Production environments are usually complex and dynamic. As a result, pressure scheduling is inefficient because frequent design updates are required. In addition, to reduce the effects of changes in the production

system, it is necessary to maintain large amounts of buffer reserves to ensure good service. In contrast to production pressure planning methods, lean manufacturing systems use a traction-type strategy in which upstream production begins only in response to downstream customer demand [1]. Lean manufacturing systems typically use Kanban tools to issue new production orders and control inventory [2]. As a result, product accumulation between stations is significantly reduced [3].

A lean manufacturing system has been proven effective in the last few decades [4]. Lean production methods use a complex system of technical measures to increase production performance through waste disposal and continuous improvement of production processes [5].

Since the last decades of the twentieth century, with the decline of Ford manufacturing systems, manufacturers worldwide have sought to create clean and flexible processes to improve the performance of their business network [6].

Today, efforts are focused on streamlining business networks, especially supply chains. After streamlining their internal processes, manufacturers seek to improve their performance by optimizing the processes of other partners in their business network [7]. The performance of each member of the production chain is highly dependent on the behavior and performance of other members [8].

The purpose of lean manufacturing is to reduce waste in human resources efforts, inventory, the time required to deliver the product to the market, and the necessary production space to meet customer demand and, at the same time, produce quality products efficiently and economically [9]. This approach revolves around the elimination of waste [10]. Loss takes on different forms and exists at any time and place. Losses can be hidden in policies, procedures, processes, product design, and operations [11]. It wastes resources but does not add any value to the product. Lean production reduces the cost of production per unit of a product by trying to eliminate waste and, at the same time, improve the product's quality [12]. Utilizing a lean manufacturing methodology reduces production time, increases product quality, increases personnel efficiency, increases market flexibility, reduces inventory, increases the life of machinery and equipment, and ultimately reduces overhead costs [13].

Lean manufacturing goes beyond simple programs or techniques. This methodology is a new approach to aligning vision, culture, and strategy [14]. It must be implemented in an integrated system to create a culture and operating philosophy to modify or eliminate activities that do not add value [15]. In general, activities that add value to the customer pay for and other activities that the customer ignores should be reduced or eliminated [16]. Therefore, the value stream refers to those characteristics of the company that add value to the desired products or services [17].

The supply chain can be considered as a chain that tries to establish effective communication between customers and suppliers through effective management of material, information, and money flow [16]. Zahedi et al. [18] have defined lean strategy as a lean strategy that develops a flow of productive value from supplier to end customer. Sundram et al. [19] defines a lean approach as identifying and eliminating value-added cottage activities wasted in business processes. Tortorella et al. [20] describe a lean base as more output with fewer resources, such as less human effort, less equipment, and less time and space.

The lean supply chain is a strategy based on cost reduction and flexibility, focusing on process improvement through reducing or eliminating waste that flows throughout the product life cycle [21]. Nili et al. [22] formulate the supply chain in this way: a supply chain that eliminates non-value-added, loss-making steps throughout the chain through continuous improvement efforts.

Also, a quality commitment is required throughout the organization to ensure that the products and services are of the right quality [23]. This attitude to quality management throughout the organization manifests itself in what is referred to as total quality management [4]. Comprehensive quality management envisages the same basic principles of quality assurance, total quality control, and quality control throughout the company [22]. Organizations using TQM have gained many benefits, including producing higher quality products, more satisfied customers, reduced costs, improved financial performance, quality performance, innovation, and

enhanced employee satisfaction [24]. In addition, if TQM is successfully implemented, it provides an excellent competitive advantage. Another definition of TQM by TQM is a multidimensional structure: Kainak is presented as a total quality management philosophy that strives for and can achieve continuous improvement in all tasks of an organization [25]. Applying and developing total quality management, despite its many benefits (such as well-known customers, capable employees, higher revenue, lower costs, etc.), also faces many challenges or obstacles [26].

Given that the strategy of the Government of the Islamic Republic of Iran in the auto parts industry is to achieve self-sufficiency and localization of this industry, this situation has created a new problem for companies active in the auto parts industry [14]. Today, the production of knowledge and its optimal application in processes has increased the knowledge and ability of managers and experts in this industry [25]. Therefore, this study seeks to provide a model of supply chain hair factors in the offshore sector of the auto parts industry [22]. Iran's Industrial Engineering and Construction Company is one of the most essential and prominent companies active in the country's offshore sector of the auto parts industry [17]. The supply chain of the Industrial Facilities Company is relatively traditional, which means that most attention is focused on general criteria such as quality, delivery time, and price in the supply chain [23]. Therefore, according to many stakeholders and customers, this company has not been able to obtain their satisfaction as it should, and reforms should be made regarding supplying goods [6].

According to what has been said, this study, conducted in Iran Engineering and Construction Company of Industrial Facilities, seeks to determine the factors affecting the purity of the supply chain in the automotive parts industry by reviewing the literature and the background and statistical analysis [26]. Then, using an interpretive structural approach, explain the research model and validate it from quantitative and qualitative dimensions [25].

Given that the main issue in our country is self-sufficiency in the automotive parts industry and the localization of this industry, this study seeks to provide a model of factors affecting the supply chain in this sector [8].

In the automotive industry, quality problems and rework in the supplier environment will mean more precautionary storage and inspections before the items are distributed to the automaker. It will lead to higher costs and delays and a waste of resources. Therefore, the performance of each member of the supply chain is essential and should be viewed with an integrated view of the chain, and according to this point, the need to create a lean supply chain is felt.

2 | Theoretical Foundations and Research Literature

There are several definitions of the supply chain, with Green Jr et al. [27] defining the supply chain as all the steps that directly or indirectly play a role in meeting customer demand. In terms of supply chain commerce, a network of participants and different operational channels from inside and outside the organization affect the desirability of supply chain outputs [26]. Leite and Braz [28] define a supply chain as the flow of information, payment materials, and raw material services between factories and warehouses.

The supply chain also includes organizations and processes that produce products, information, and services and deliver them to end customers. Supply chains come in many shapes and sizes and can be very complex [8]. The main goal of all supply chains is to reduce costs, increase effectiveness and efficiency, and generally increase profits for all stakeholders [1]. Therefore, scientific and rational management of the supply chain is one of the essential components of leadership. Strategically, a competitive advantage can be achieved [25].

Lean supply chain thinking came into being at the same time as lean manufacturing thinking, which was first formed and implemented in Japan [15]. In a lean supply chain, attention is paid to the continuous improvement of activities through which it is possible to eliminate operations that do not create added value during a supply chain [29]. For this purpose, activities are carried out through which supply time, reduction of economic production, decrease in costs, and increase in profitability can be provided [16].

McIntosh et al. [30] define total quality management as providing high-quality products and services through the participation and cooperation of all stakeholders, working groups, customer orientation, continuous improvement, and process performance using quality management techniques and tools to help increase satisfaction and organizational performance [25].

3 | Research Methodology

The present research is descriptive-survey research in terms of method and applied in terms of purpose. Based on the review and analysis of research literature, this study identified the factors affecting supply chain resilience as described in *Table 2*.

As mentioned, eight factors were identified in the first stage that provide lean apples in the supply chain by reviewing the research literature [26]. A questionnaire was then used to assess the impact of these factors on the auto parts industry's supply chain. In the next step, the factors found to be effective enter the interpretive structural modeling process.

Table 1. Factors affecting supply chain volatility based on literature review.

Row	Variable	Source	Definition
1	Information sharing	[16], [23], [26], [29]	Information sharing enables organizations across the supply chain to promptly understand and plan for their customers' demands.
2	Total quality management	[8], [15], [26]	This includes process standardization, process control, the promotion of a culture of continuous improvement, ISO, and the 5S grooming system (research background).
3	Leadership and management	[10], [14], [24]	In some cases, some are 1) problem recognition, 2) quick and at the same time accurate decisions, 3) development and promotion of lean culture, and 4) definition of values and goals of the organization and development of a strategy to achieve these goals and values.
4	Cooperation throughout the supply chain	[1], [2], [24]	That means having a long-term relationship throughout the chain (supplier, manufacturer, and customer)
5	Application of technology	[20], [23], [24]	Provide appropriate hardware and software to perform tasks and provide services.
6	Employee participation	[8], [14], [17], [24]	Refers to the involvement of the organization's forces, especially experts in the two areas of decision-making and lean execution
7	Minimize delivery time	[17], [20], [24]	Delivery time is between the order being announced and the order being delivered.
8	Flexibility	[5], [6], [17], [24]	The ability of the supply chain to move to a new situation that is more favorable than before

According to *Table 2*, the initial research model based on the factors affecting supply chain volatility can be drawn in *Fig. 1*.
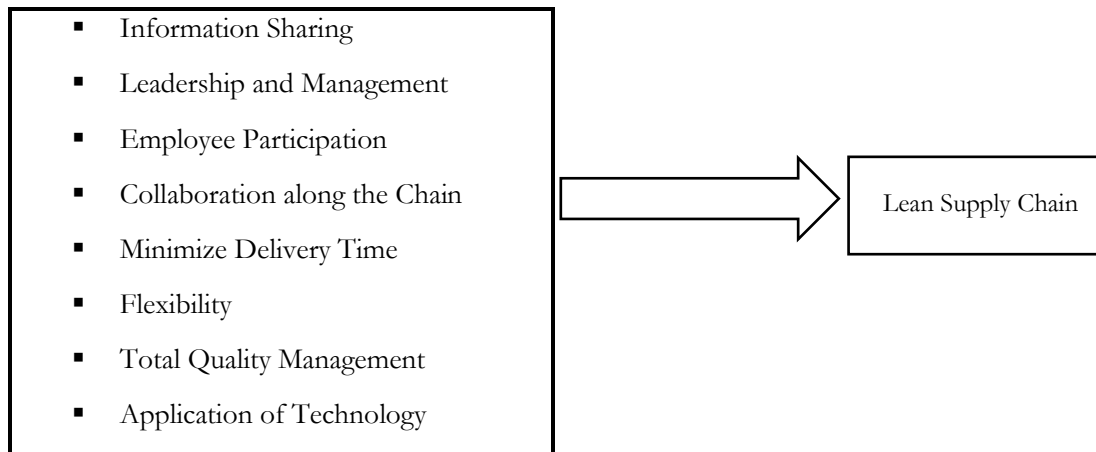
▪ Information Sharing
▪ Leadership and Management
▪ Employee Participation
▪ Collaboration along the Chain
▪ Minimize Delivery Time
▪ Flexibility
▪ Total Quality Management
▪ Application of Technology

→ Lean Supply Chain

Fig. 1. Initial research model [26].

3.1|Validity

The questions of this research questionnaire are all from previous studies, and the literature was extracted. However, to be clear, concise, and appropriate, the questions were provided to 12 statistical sample experts from the automotive parts industry. After reviewing and correcting, the final questionnaire was developed. Hence, the validity of the content was confirmed.

3.2|Reliability

Cronbach's alpha was used to measure each structure's reliability and internal compatibility. For this purpose, Cronbach's induction values of each system were calculated using SPSS software. Considering that all Cronbach's alpha values are above 0.7, the reliability of the questionnaire was also confirmed.

3.3|Community and Statistical Sample

The statistical population of this research is the experts of the auto parts industry in the offshore sector, and 40 of them have been available as a statistical sample. As mentioned, 12 people were selected to assess validity, interpretive structural modeling questionnaires, and qualitative validation. It should be noted that the number of experts in interpretive structural modeling should be 12 to 25 people.

3.4|Data Analysis

In this section, first, using the Kolmogorov-Smirnov test, the normality of data distribution was examined (*Table 2*), and according to the significant levels greater than 0.05, the data distribution is normal.

Table 2. Normality test.

The Significance Level	Structures (Factors)
0.064	Information sharing
0.108	Leadership and management
0.060	Employee participation
0.081	Collaboration along the chain
0.080	Minimize delivery time
0.120	Flexibility
0.094	Total quality management
0.163	Application of technology
0.073	Lean supply chain

Based on the normality of the data, the regression method was used to measure the effect of factors on supply chain purity in the automotive parts industry. The results are shown in *Table 3*.

Table 3. Regression test.

The Significance Level	T-Test	Standard Coefficients β	Non-Standard Coefficients		Independent Variables
			Standard Error	B	
0.000	5.4	0.48	0.574	0.95	Information sharing
0.000	3.34	0.68	0.650	1.46	Leadership and management
0.000	2.34	0.75	0.20	1.92	Employee participation
0.000	3.73	0.65	0.431	1.23	Collaboration along the chain
0.000	2.85	0.73	0.368	1.84	Minimize delivery time
0.000	3.07	0.60	0.457	1.01	Flexibility
0.000	3.76	0.50	0.397	0.82	Total quality management
0.000	2.10	0.89	0.524	1.62	Application of technology

Due to the significant levels greater than 0.05, all factors (independent variables) affect the dependent variable (lean supply chain in the automotive parts industry). Therefore, all eight factors are used in interpretive structural modeling.

3.5|Interpretive Structural Modeling

Structural modeling is an interpretive technique that makes it possible to study the system's complexity and structure the system in a way that is easy to understand. This method's advantages are its comprehensibility for users, integration in combining expert opinions, and applicability in studying complex systems with various components.

This method analyzes the relationship between indicators by analyzing the criteria at several levels. This methodology is summarized in the following steps:

Step 1. Identify the variables related to the problem. As noted, this step was achieved by reviewing the subject literature, the background of the research, and experts' surveys.

Step 2. Form a self-interactive structural matrix. Examining the dependencies of all identified elements in pairs is necessary to prepare a self-structural interactive matrix. For this purpose, the following four symbols are used:

V: To show a one-sided effect.

A: To show a one-sided effect.

X: To show the two-way effect.

O: To show the lack of relationship between two factors.

For this purpose, a questionnaire was first designed, and experts were asked to indicate the type of two-way relationships between the variables using the symbols (V, A, X, O). The results of this section are shown in *Table 4*.

Table 4. Self-interactive compatibility matrix (SSIM).

Row	Variable	8	7	6	5	4	3	2	1
1	Leadership and management	V	V	V	V	V	V	V	
2	Employee participation	A	A	A	V	A	A		
3	Information sharing	A	A	A	V	O			
4	Flexibility	O	X	O	O				
5	Minimize delivery time	A	A	A					
6	Application of technology	V	V						
7	Collaboration along the supply chain	V							
8	Total quality management								

Step 3. Create the initial access matrix.

The above collisions must be converted to zeros and ones to obtain the achievement matrix. The desired matrix can be obtained according to the following rules:

I.   If the cell (i, j) in its matrix has a structural interaction with the symbol V, the corresponding cell in the achievement matrix takes the number one, and its symmetric cell (j, i) takes the number zero.

II. If the cell (i, j) in its matrix has a structural interaction of the symbol A, the corresponding cell gets zero, and its symmetric cell (j, i) receives the number one.

III. If the cell (i, j) in its matrix has a structural interaction of X, the corresponding cell in the acquisition matrix gets the number one, and its symmetric cell, i.e., the cell (j, i), also gets the number one.

IV. If the cell (i, j) in its matrix has a structural interaction with the symbol O, the corresponding cell in the achievement matrix takes the number zero, and its symmetric cell (j, i) also takes the number zero.

V.   If i = j, an access matrix is placed at the input.

The initial access matrix is shown in *Table 5* based on the rules stated.

Table 5. Initial access matrix.

Variables	1	2	3	4	5	6	7	8
1	1	1	1	1	1	1	1	1
2	0	1	0	0	1	0	0	0
3	0	1	1	0	0	0	0	0
4	0	1	0	1	0	0	1	0
5	0	0	0	0	1	0	0	0
6	0	0	0	0	1	1	1	1
7	0	1	1	1	1	0	1	1
8	0	1	1	0	1	0	0	1

Step 4. Create the final achievement matrix.

After obtaining the initial access matrix, considering the property of transferability, if (j, i) are related and also have a relationship (j, k), then (k, i) are related; the final achievement matrix is obtained.

The method of obtaining the access matrix is using the Euler view, in which we add the proximity matrix to the unit matrix and then bring this matrix to the power of n if the matrix elements do not change. The matrix must be constructed according to the Boolean rule. The final achievement matrix is obtained from preparing the initial achievement matrix by entering the transferability rules. *Table 6* adds the values of dependence and influence to the final achievement matrix (*Table 5*).

Table 6. Final matrix table.

Variables	1	2	3	4	5	6	7	8	Infiltrate
1	1	1	1	1	1	1	1	1	8
2	0	1	0	0	1	0	0	0	2
3	0	1	1	0	0	0	0	0	3
4	0	1	0	1	0	0	1	0	2
5	0	0	0	0	1	0	0	0	1
6	0	0	0	0	1	1	1	1	5
7	0	1	1	1	1	0	1	1	7
8	0	1	1	0	1	0	0	1	4
Dependence	1	7	4	3	7	3	4	4	

Step 5. Determine the levels and form an interpretive structural pattern.

The achievement matrix determines the achievable set (output) and the prerequisite set (input) for each variable to determine the level. The feasible set of each variable includes the variables that can be reached through this variable. Need includes variables through which this variable can be reached. To avoid prolonging the article, further explanation is omitted (*Table 6*).

Table 7. Six iterations in determining the levels of factors affecting the lean of the supply chain.

Level	Joint Collection	Output Set	Input Set	Variable
The First Repetition				
	1	8-7-6-5-4-3-2-1	1	Leadership and management
	2	2-5	1-2-3-4-6-7-8	Employee participation
	3-8	2-3-5-8	1-3-6-7-8	Information sharing
First	4-7	2-4-7	1-4-7	Flexibility
	5	5	1-2-3-5-6-7-8	Minimize delivery time
	6-7	2-3-5-6-7-8	1-6-7	Application of technology
	4-7-8	2-3-5-6-7-8	1-4-6-7-8	Application of technology
	7-8	2-3-5-6-7-8	1-6-7-8	Total quality management
The Second Iteration				
	1	1-2-3-4-5-6-7-8	1	Leadership and management
	2	2-5	1-2-3-4-6-7-8	Employee participation
	3-8	2-3-5-8	7-4-1	Information sharing
Second	4-7	2-4-7	8-7-6-5-3-2-1	Flexibility
	5	5	7-6-1	Minimize delivery time
	6-7	2-3-5-6-7-8	8-7-6-4-1	Application of technology
	4-7-8	2-3-5-6-7-8	1	Collaboration along the chain
	7-8	2-3-5-7-8	8-7-6-4-3-2-1	Total quality management
Third Repetition				
	1	1-3-4-6-7-8	1	Leadership and management
	3-8	3-8	1-2-3-4-6-7-8	Information sharing
Third	4-7	4-7	1-4-7	Flexibility
	6-7	3-6-7-8	1-2-3-5-6-7-8	Application of technology
	4-7-8	3-4-7-8	1-6-7	Collaboration along the chain
	7-8	3-7-8	1-4-6-7-8	Total quality management
Fourth Iteration				
	1	1-6-7	1	Leadership and management
Fourth	6-7	6-7	1-6-7	Application of technology
	7-8	7-8	1-6-7	Collaboration along the chain
	7-8	7-8	1-6-7-8	Total quality management
Fifth Repetition				
Fifth	7	1-7	1	Leadership and management
	7	7	1-7	Collaboration along the chain
Sixth Repetition				
Sixth	1	1	1	Leadership and management

Considering the levels of each of the criteria presented in *Table 7*, the interpretive structural model of this research is drawn according to the transferability according to *Fig. 2*.

According to the final interpretive structural model, it can be concluded that apart from the relationship the above factors have with the lean supply chain and affect it, each may also interact.

The loss factor affects customer satisfaction and causes customer dissatisfaction. The factor of continuous improvement has a direct effect on losses. The supplier selection factor has a direct impact on resource control. The training and empowerment factor affects the flow structure of materials. The material flow structure factor immediately affects the information flow factor. The factor of management behavior affects customer relationships, and ultimately, the factor of employee skills affects the structure of information flow.

It should be noted that the above two relations are ignored to avoid the complexity of the model and its quantitative validation. This is because the template can be tested in software.

Validation of the template after designing it, it needs to be validated. This research has validated two quantitative and qualitative dimensions.

Quantitative validation to validate the template quantitatively, smartPLS software version 2 is used, and the template can be drawn in *Fig. 3*.
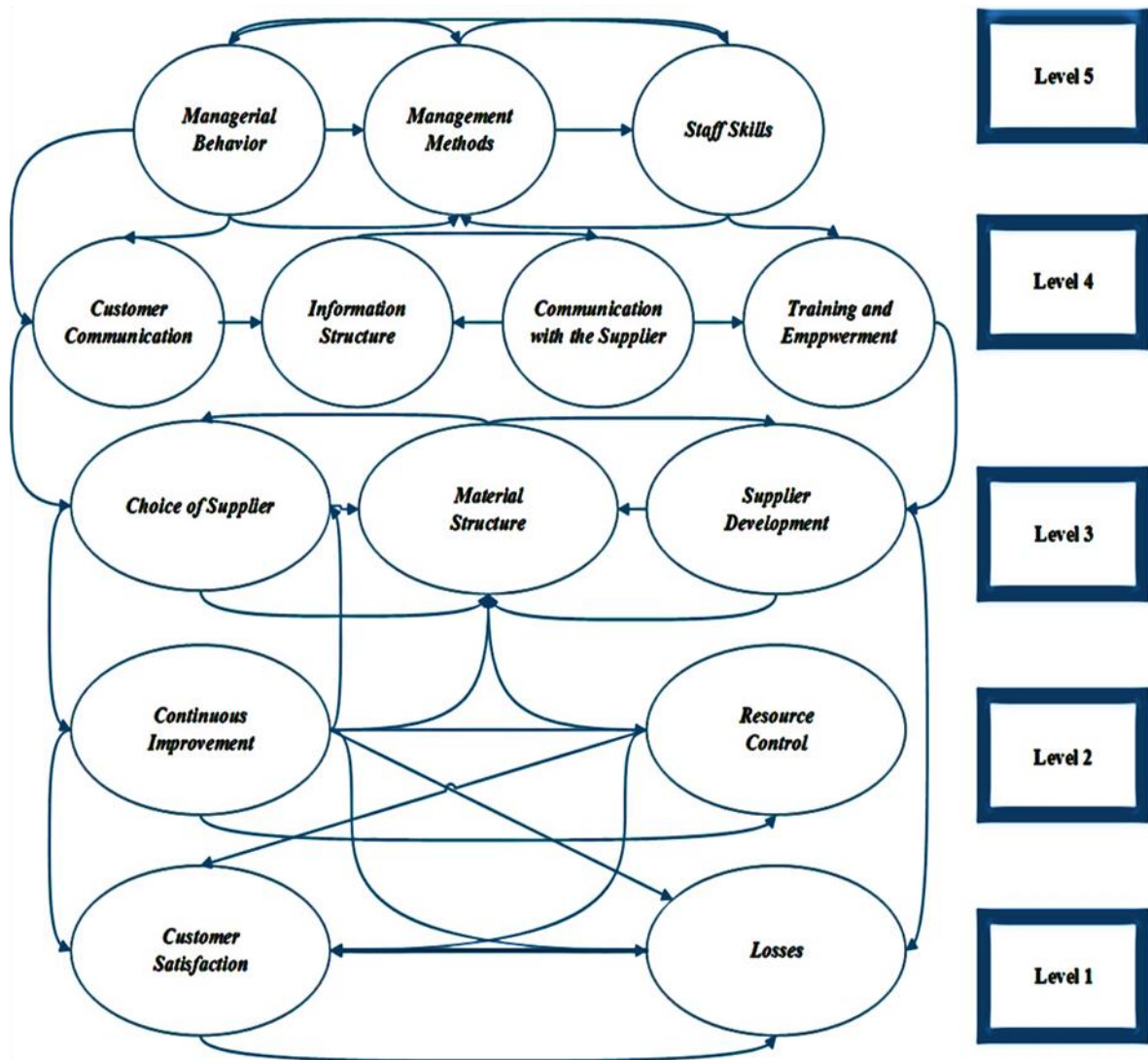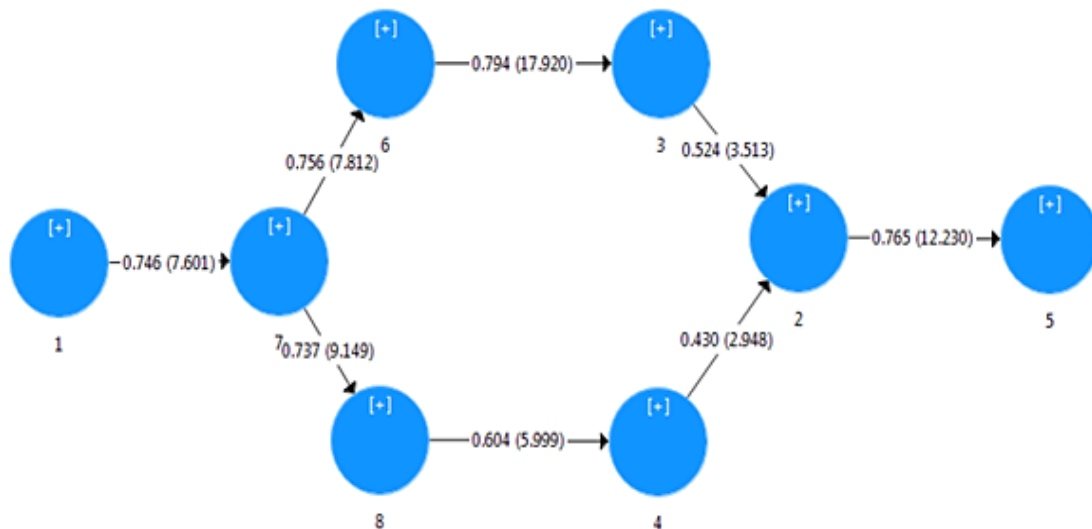
Fig. 2. Structural model of this research.

Fig. 3. Quantitative validation of the model.

It is observed that all the numbers in parentheses are greater than 1.96, and the factor loads are greater than 0.4. Therefore, the structural pattern of interpretation is quantified.

3.6|Qualitative Validation

Regarding quality validation, the following questions were asked by 12 experts:

    I.   If the statistical population of the research changes, is the model still valid?

    II.   Do all variables exist in the real world?

    III.   Are the communications logically valid?

    IV.   Do the variables remain almost constant over time?

    V.   Is it possible to improve the system based on the model variables?

    VI.   Based on the specified variables, can this pattern be generalized to the entire offshore sector of the auto parts industry?

Regarding all the above questions, the experts' answers were positive, which means the qualitative validity of the model and its generalizability to the whole sector of the auto parts industry.

4|Conclusion

Due to the current challenges in the country, including market saturation and fierce competition, the management is determined to be clean at all stages, including the supply chain. The main result of this study is the model of factors affecting the supply chain leanness in the automotive parts industry, which contributes to identifying and empowering the implementation of lean supply chain strategies using the ISM method. This model includes the leveling of factors affecting the supply chain, which provides managers with a comprehensive view and attitude about the relationships between these variables. These variables were identified through a review of the literature and a survey of statistical samples. All eight factors were influential at a 95% confidence level. Then, the interpretive structural model of the factors affecting supply chain volatility was presented. In the interpretive structural model, the degree of influence and the effect of reduction and dependence increase at the bottom-up levels. Therefore, paying more attention to the lower-level variables causes the whole system to become lean.

Thus, the two factors of leadership, management, and cooperation throughout the supply chain are the basis of supply chain volatility in this industry and cause better grounding for higher-level factors. The next priority is the two factors of use of information technology and flexibility, which are at the third level, and the factors at the fourth level are flexibility and use of information technology. The fifth level is employee participation, and the sixth is the delivery time committee factor. According to the levels of the model, leadership, and management are the most influential factors in the model, which is consistent with the research of Sundram et al. [19], Pero et al. [31], and Zahedi et al. [32], and time minimization delivery is the most influential factor, in line with the research of Adebanjo et al. [33] and Razmi et al. [34]. Pay attention. In this model, managerial methods, behavior, and staff skills are the fundamental basis for designing a lean production model because lean implementation principles are impossible without the support of management and skilled human resources. Management methods facilitate information flow and help better communicate with the supplier and the customer. In this model, it is observed that the basis of the model starts from management methods and behavior. In many studies, it has been stated that managers must support the implementation of lean thinking. Ultimately, these factors at the first level lead to eliminating waste and improving customer satisfaction in the industry. In the national document of the country's energy strategy approved by the Cabinet on 4/28/96, in the section on strategies related to the auto parts industry, the following two cases have been mentioned: "development and maximum utilization of all related industries to protect the national interests" and "reduction." Losses and losses in the production, transmission, distribution, and consumption of energy

In this regard, models such as the model presented in this study can be considered. Based on the importance of variables and their placement levels, the following suggestions can be made:

Suggestions based on level 1

Coordinated and accurate planning, considering different solutions and analyzing them, making quick but at the same time correct decisions, solving problems and conflicts between departments, promoting a culture of responsibility.

Suggestions based on level 2

A history of working with suppliers, having mutual trust, and building a solid relationship with them lead to bargaining power and prevents problems such as shortages or poor quality of imported goods.

Suggestions based on level 3

Promote a culture of continuous improvement and accountability, clarify the responsibilities of staff efforts to solve problems, implement 5S (beautification system) and optimize processes, re-engineer activities, and eliminate bottlenecks.

Providing the necessary tools and machinery according to the latest technologies, such as cranes, trailers, and devices required for testing and inspection of delivery equipment by manufacturers' suggestions based on 4.

Creating the necessary infrastructure to use up-to-date information technology systems and sharing information between the departments involved throughout the supply chain. Existing mechanisms in the organization to adapt to adverse environmental conditions, such as specialized personnel and dispersion. Suppliers, the existence of alternatives to essential equipment.

Suggestions based on level 5

Payments commensurate with the expertise and performance of employees and their encouragement, training, and enhancement of staff empowerment motivation in employees to perform tasks better. Using employees' opinions and welcoming their ideas and rewarding creative ideas some general suggestions for achieving a clean supply chain include:

I. Continuous and required training of employees is an undeniable necessity.

II. Promoting teamwork and forming teamwork.

III. Changing attitudes in purchasing to prioritize quality over price.

IV. Creating cordial and friendly environments with discipline in the workplace without discrimination between employees.

4.1 | Limitation

Other factors affect supply chain volatility, such as financial issues and sanctions, which have not been addressed due to some considerations and avoiding complexity and ambiguity in the final research model.

Practical suggestions

I. Increase the accuracy of the model by increasing the statistical volume.

II. Use and compare other supply chain strategies to measure it in manufacturing companies and choose the best strategy to select the best supplier and lean supplier.

III. Take measures to improve all the factors mentioned in the companies.

IV. Create a more competitive and dynamic environment for the interaction of factors and the purity of the supply chain.

V. Pay attention to implementing lean factors in the supply chain and its tools.

Acknowledgments

Funding

Conflicts of Interest

All co-authors have seen and agree with the manuscript's contents, and there is no financial interest to report. We certify that the submission is original work and is not under review at any other publication.

References

[1] Ahi, N. (2015). *Investigating the impact of gscm on sustainable competitive advantage (case study of ISO 14001 holder companies)* [Thesis]. https://ensani.ir/fa/article/field/139?page=50

[2] Asgharizadeh, E., & Ajalli, M. (2016). *Identification and ranking the key dimensions of lean manufacturing using new approach in gas industry.* [presentation]. Proceedings of international conference on science, technology, humanities and business management (pp. 33–11).
https://www.researchgate.net/profile/Rajendra-Kumar-27/publication/347316204_The_Proceedings_of_International_Conference_on_Science_Technology_Humanities_and_Business_Management_ICSTHBM-16_held_in_Bangkok_Thailand/links/5fd9bb7745851553a0bd7761/The-Procee

[3] Aghdaie, M. H., Zolfani, S. H., & Zavadskas, E. K. (2013). Decision making in machine tool selection: An integrated approach with SWARA and COPRAS-G methods. *Engineering economics*, *24*(1), 5–17.

[4] Nili, M., Seyedhosseini, S. M., Jabalameli, M. S., & Dehghani, E. (2021). A multi-objective optimization model to sustainable closed-loop solar photovoltaic supply chain network design: A case study in Iran. *Renewable and sustainable energy reviews*, *150*, 111428. https://doi.org/10.1016/j.rser.2021.111428

[5] Ajalli, M., Saberifard, N., & Zinati, B. (2021). Evaluation and ranking the resilient suppliers with the combination of decision making techniques. *Management and production engineering review*, *12*(3), 129-140. (**In Persian**). DOI:10.24425/mper.2021.137685

[6] Hu, A. H., & Hsu, C. W. (2006). Empirical study in the critical factors of green supply chain management (GSCM) practice in the Taiwanese electrical and electronics industries. *ICMIT 2006 proceedings - 2006 IEEE international conference on management of innovation and technology* (pp. 853–857). IEEE.

[7] Ajalli, M., Mozaffari, M. M., & Salahshori, R. (2019). Ranking the suppliers using a combined SWARA-FVIKOR approach. *International journal of supply chain management*, *8*(1), 907–915.

[8] Amani, M., Ashrafi, A., & Dehghanan, H. (2017). Assessing the barriers to green supply chain adoption using fuzzy DEMATEL technique. *BI management studies*, *5*(19), 147-179. (**In Persian**). https://ims.atu.ac.ir/article_7098.html

[9] Yadav, D. K., & Barve, A. (2015). Analysis of critical success factors of humanitarian supply chain: An application of interpretive structural modeling. *International journal of disaster risk reduction*, *12*, 213–225. DOI:10.1016/j.ijdrr.2015.01.008

[10] Agheleh, H., & Hamidi, N. (2016). Identification and ranking of barriers and obstacles of SMEs green supply chain deployment (case study Qazvin State). *Iranian journal of trade studies*, *20*(80), 171-195. (**In Persian**). https://pajooheshnameh.itsr.ir/article_24068_en.html

[11] Fahimnia, B., Sarkis, J., & Eshragh, A. (2015). A tradeoff model for green supply chain planning: A leanness-versus-greenness analysis. *Omega (United Kingdom)*, *54*, 173–190. DOI:10.1016/j.omega.2015.01.014

[12] Feng, T., Sun, L., & Zhang, Y. (2010). The effects of customer and supplier involvement on competitive advantage: An empirical study in China. *Industrial marketing management*, *39*(8), 1384–1394. DOI:10.1016/j.indmarman.2010.04.006

[13] Ghahremani-Nahr, J., Nozari, H., & Najafi, S. E. (2020). Design a green closed loop supply chain network by considering discount under uncertainty. *Journal of applied research on industrial engineering*, *7*(3), 238–266.

[14] Giannakis, M., Dubey, R., Vlachos, I., & Ju, Y. (2020). Supplier sustainability performance evaluation using the analytic network process. *Journal of cleaner production*, *247*, 119439. DOI:10.1016/j.jclepro.2019.119439

[15] Govindan, K., & Sivakumar, R. (2016). Green supplier selection and order allocation in a low-carbon paper industry: integrated multi-criteria heterogeneous decision-making and multi-objective linear programming approaches. *Annals of operations research*, *238*(1–2), 243–276. DOI:10.1007/s10479-015-2004-4

[16] Micheli, G. J. L., Cagno, E., Mustillo, G., & Trianni, A. (2020). Green supply chain management drivers, practices and performance: A comprehensive study on the moderators. *Journal of cleaner production*, *259*, 121024. DOI:10.1016/j.jclepro.2020.121024

[17] Noorul Haq, A., & Kannan, G. (2006). Design of an integrated supplier selection and multi-echelon distribution inventory model in a built-to-order supply chain environment. *International journal of production research*, *44*(10), 1963–1985.

[18] Zahedi, M., Abbasi, M., & Naghdi Khanachah, S. (2020). Providing a lean and agile supply chain model in project-based organisations. *Annals of management and organization research*, *1*(3), 213–233. DOI:10.35912/amor.v1i3.440

[19] Sundram, V. P. K., Chandran, V. G. R., & Bhatti, M. A. (2016). Supply chain practices and performance: the indirect effects of supply chain integration. *Benchmarking: an international journal*, *23*(6), 1445–1471.

[20] Tortorella, G. L., Miorando, R., & Marodin, G. (2017). Lean supply chain management: Empirical research on practices, contexts and performance. *International journal of production economics*, *193*, 98–112.

[21] Imani, D. M., & Ahmadi, A. (2009). Green supply chain management for a new competitive advantage strategy. *Journal of automobile engineering and related industries*, *1*(10), 14-16. (**In Persian**). https://www.sid.ir/fa/journal/ViewPaper.aspx?ID=164293

[22] Nili, M., Seyedhosseini, S. M., Jabalameli, M. S., & Dehghani, E. (2021). A multi-objective optimization model to sustainable closed-loop solar photovoltaic supply chain network design: A case study in Iran. *Renewable and sustainable energy reviews*, *150*(3), 243–280. DOI:10.1016/j.rser.2021.111428

[23] Hsu, C. W., & Hu, A. H. (2008). Green supply chain management in the electronic industry. *International journal of environmental science and technology*, *5*(2), 205–216. DOI:10.1007/BF03326014

[24] Ip, W. H., Chan, S. L., & Lam, C. Y. (2011). Modeling supply chain performance and stability. *Industrial management and data systems*, *111*(8), 1332–1354. DOI:10.1108/02635571111171649

[25] Jayant, A. (2018). An analytical hierarchy process (AHP) based approach for supplier selection: An automotive industry case study. *International journal of business insights & transformation*, *11*(1), 36–45.

[26] Gao, J., Xiao, Z., Wei, H., & Zhou, G. (2020). Dual-channel green supply chain management with eco-label policy: A perspective of two types of green products. *Computers and industrial engineering*, *146*, 106613. DOI:10.1016/j.cie.2020.106613

[27] Green Jr, K. W., Inman, R. A., Birou, L. M., & Whitten, D. (2014). Total JIT (T-JIT) and its impact on supply chain competency and organizational performance. *International journal of production economics*, *147*, 125–135.

[28] Leite, M., & Braz, V. (2016). Agile manufacturing practices for new product development: industrial case studies. *Journal of manufacturing technology management*, *27*(4), 560–576.

[29] Ghorbani, S., & Naghdi Khanachah, S. (2020). Investigating the reasons for failures and delays in R&D projects with the project management approach. *Annals of management and organization research*, *1*(4), 319–334. DOI:10.35912/amor.v1i4.553

[30] McIntosh, B., Sheppy, B., & Cohen, I. (2014). Illusion or delusion--lean management in the health sector. *International journal of health care quality assurance*, *27*(6), 482–492.

[31] Pero, M., Stößlein, M., & Cigolini, R. (2015). Linking product modularity to supply chain integration in the construction and shipbuilding industries. *International journal of production economics*, *170*, 602–615.

[32] Zahedi, M. R., & Naghdi Khanachah, S. (2021). The effect of knowledge management processes on organizational innovation through intellectual capital development in Iranian industrial organizations. *Journal of science and technology policy management*, *12*(1), 86–105. DOI:10.1108/JSTPM-11-2019-0113

[33] Adebanjo, D., Laosirihongthong, T., & Samaranayake, P. (2016). Prioritizing lean supply chain management initiatives in healthcare service operations: a fuzzy AHP approach. *Production planning & control*, *27*(12), 953–966.

[34] Razmi, J., Seifoory, M., & Pishvaee, M. S. (2011). A fuzzy multi-attribute decision making model for selecting the best supply chain strategy: Lean, agile or leagile. *Advances in industrial engineering*, *45*(Spec. Issue), 127–142.