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Designing an Electronic Supply Chain Management Model to Achieve a World-Class Home Appliance Industry

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ABSTRACT

This study aims to design an electronic supply chain management model to achieve a world-class home appliance industry. This is a mixed methods research and developmental applicative in terms of its purpose. To provide the theoretical foundations, articles, books, and reliable sources available to the researcher have been studied. The statistical sample consists of experts in home appliance manufacturing industries and professors and researchers in the field of world-class production. The sampling method is purposeful using Dimetal techniques and the interpretive structural model. In this research, 15 indicators were identified including electronic infrastructure, core technology, electronic procurement, electronic management of communication with suppliers, information flow, supply chain speed, ability to resist threats, relying on internal capacity, cost, waiting for time, flexibility, sales service, after-sales service, meeting customer expectations and world-class quality. The results indicated that based on the interpretive structural model designed (at three levels of infrastructure, sales, after-sales services, and world-class quality), the low-level components of electronic infrastructure, core technology, electronic procurement, and electronic management of communication with the supplier have the greatest impact. In line with the research findings, suggestions are made for improving the studied industry to reach the world-class in the future.

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1. Introduction

Today, globalization is an important trend in the convergence of countries, particularly in the economic dimension (Dorcheh et al., 2021). As the world is shrinking, organizations need to have a global presence through global distribution systems, otherwise, they will lose their economic enterprises in competition with better rivals (Farsijani et al., 2015).

Currently, in order to gain a world-class status, companies must make significant changes in their business methods and productions (Brinker et al, 2022). For this purpose, world-class production operations are increasingly used by manufacturing organizations with the aim of achieving world-class performance and staying in the competitive environment of today's era. In the process of globalization of production and industry, our producers are forced to modify the traditional, inefficient and ineffective methods of the past and take a new approach to production policies (Mohammadipour et al., 2016).

Supply chain management will include cooperation and coordination with chain partners who can be suppliers, intermediaries, third-party service providers, and customers (Morfield et al., 2019).

The use of electronic tools and e-commerce, especially the Internet, has played an essential role in this regard. E-commerce, also known as the Internet business, refers to buying and selling of goods or services using the Internet and the transfer of money and data to implement them (Banda, 2019). This style of business has had important effects in management research and has helped to expand its application prospects for the analysis of supply chains and networks (Farsijani, 2013).

One of the new patterns in this network economy system is the use of electronic supply chain management, which has received serious attention from business managers and researchers in industrial management due to the requirements of this network. Since 2000, the use and effects of the Internet in supply chain management have been widely discussed in prestigious scientific journals worldwide.

Wu and Chuang (2009) present a conceptual model for understanding the adoption and dissemination of electronic supply chain management in different stages between business partners and state that the technology structure, partnership structure, type of industry, and organization size are effective factors in this field (Mousizadeh, 2013). Electronic supply chain management is the use of web technologies in supply chain management activities, which combines different extents of Internet technologies with supply chain activities (Almajali et al., 2016).

Electronic supply chain management is not only a revolution in the field of goods distribution; it has many advantages including optimization of product data recording, product distribution, and facilitating product audit from upstream to downstream.

This system guarantees part of the success of companies in reaching their goals, which depends on the availability of resources, good cooperation with partners in order to send products to consumers on time, and improve the level of customer service through the Internet (Ishak et al., 2019). Electronic supply chain management, which is the result of using the Internet and information systems in supply chain management, forces companies to evaluate the value proposition of customers and makes them more agile in meeting competitive challenges, which itself has caused the emergence of new world-class production methods (Shekarian et al, 2022). With the emergence of international organizations and creation of regional memorandums, trade has expanded in the global arena, and the products of countries cross political and national boundaries and reach consumers who may not have any cultural and racial kinship with the producers of those goods (Stiri et al., 2015).

Previous research indicates that economic enterprises are able to compete in today's competitive environment when they leave their traditional practices and enter the modern world-class production status. The electronic revolution has accelerated the globalization of the economy by using electronic commerce. The effects of this transformation in production can also be seen in the electronicization of traditional production management techniques and activities, which has caused the emergence of new world-class methods. One of these emerging methods is electronic supply chain management. In the era of e-commerce, electronic supply chain management is the main pillar of this type of business. The mass presence of commercial organizations in a more competitive environment than in the past makes it necessary to link supply chain activities with electronic technologies.

Today, continuous innovation in the form of systems, plans, programs, processes, products, or services is the most vital strategy for creating and maintaining a competitive advantage in world-class production conditions. Sandeep et al., (2016) introduced the lack of a supply chain as one of the most important obstacles for an organization to achieve world-class production. Research shows that long and complex supply chains with a traditional structure usually respond slowly to environmental changes and are unable to respond to the needs of today's organizations and industries due to the weak connection between their components.

On the one hand, the intensive competition in home electronics industry products domestically and internationally, and on ther hand, high demands for these products in the society due to their use in human life, have caused special attention to be paid to this industry. High technology and quick introduction of new products to the market have reduced the life cycle of new products. For this reason, the response to the change in demand and its transfer at the level of the supply chain of the industry must be prompt. In the meantime, the increase in competition in the given industry, along with the environmental pressures and specific requirements for domestic producers at the world-class level necessitates to reduce the price and delivery time and to increase the quality., In addition, Iran's joining the World Trade Organization and the presence of foreign brands and competitors in Iran's home electronics industry, demand better performance of the country in this industry. Many factories and companies in the country are currently working hard and below the nominal capacity. One of the main reasons is "recession". Generally, foreign investments without a proper approach for strengthening new domestic competitive products can be a threat to many of the country's existing home appliance industries. The reasons for the threats can be the competition of foreign goods, sanctions and investment by foreigners in competing countries. Also due to the lack of a comprehensive research and development units and appropriate scientific management, as well as the use of old technologies and traditional tools, it is not possible to compete and develop in today's world. According to the official report of the Ministry of Industry and Mines, despite the increase in demand in the domestic and foreign markets, the production status of the industry, has been declining since 2014 and this trend still continues. Also, the statistics show an increase in imports, a significant decrease in exports, and a decrease in the share of global competition of products in this industry (Report of the Ministry of Industry, Mines and Trade, 2016).

Considering the intensive competition of this industry in the domestic and foreign arena, for the survival of these companies, it is necessary to produce a product at a world-class level, which also requires the use of domestic and foreign resources. Today, senior managers of manufacturing companies use various methods and tools to achieve their goals and business plans, which are based on gaining more market share. In this regard, strategies are considered that lead to the provision of higher quality products at a lower price and greater accessibility. Therefore, they are always trying to achieve a competitive advantage over other competitors by reducing costs and increasing flexibility.

Review of the existing literature indicates that the design and presentation of a world-class electronic supply chain management model can be one of the keys to the success and strong presence of this part of the country's production in the world competition scene. Therefore, the current research seeks to answer: what is the electronic supply chain management model to achieve world-class in the home appliance manufacturing industry?

Accordingly, this study aims at:

•Identifying effective indicators in the electronics supply chain in the home appliance manufacturing industry,

• Determining the relationships between indicators and their effectiveness through the combined approach of interpretive structural modeling, and

• Determining the intensity of relationships between variables through the fuzzy Dimetal technique.

2. Literature Review

Electronic supply chain management

Supply chains for acquisition, storage, and conversion of data into data are composed of a storage and flow structure and develop beyond the boundaries of an organization (Rafipour, 2016). An electronic supply chain is a set of processes involving a company and its main partners, managed in an integrated manner with the potential of new technological solutions that enable the planning of processes and objectives and the sharing of information related to the entire chain. In order to accurately understand the characteristics of the electronic supply chain, an analytical model based on the interpretation of two variables can be adopted: 1) the application environment, which includes the processes of implementing the electronic supply chain and collaboration, and 2) the company's technological choices (Piera et al., 2004).

World-class production

In explaining the concept of world-class production as an economic term, it should be recognized using the literature of international economic knowledge, which has been defined by many different people.

Schonberger is the first person who introduced the concept of world-class production. According to him, production in world-class is "a broad agreement on the continuous improvement of quality, cost, waiting time and customer service". According to this researcher, flexibility is also listed as a primary goal and a part of the world-class production system (Schonberger, 1986).

Rubrich considers world-class production to include the application of a number of productivity concepts and believes that the concepts of just-in-time production, total quality management, and employee participation should be properly combined in world-class production (Rubrich, 2004). Green provides a more comprehensive definition that global benchmark organizations are organizations that provide the best performance in the world-class of their related industries. Some other experts have listed the characteristics of world-class production to show the strengths and differentiation of world-class production compared to local production, and in this way, they have tried to define the concept of world-class production. By accepting the six features of quality, price, customer service, delivery speed, flexibility, and responsiveness as important indicators in the definitions of experts in this field, and then explaining them with the literature of international economic knowledge, it is possible to distinguish the major elements of global standards (Farsijani, 2013). The following sections review some of the most important domestic and international research.

Farsijani et al. (2019) in a research using the fuzzy Delphi method titled "Improving supply chain integration to achieve world-class production by using the analysis of the importance of performance in Iran's home electronics industry" have extracted the dimensions and indicators of the integrated supply chain from the subject literature, which includes three dimensions of internal integration, supplier integration, and customer integration.

Shahriari Nia et al. (2019), in a research entitled "A hybrid approach to develop a structural model of factors affecting cooperation in the supply chain of home appliance industries" showed that the effect of variables affecting cooperation is different in terms of levels and precedence and backwardness. It also provides a choice about the strength of variables that can provide a suitable basis for managers' decision-making in order to develop supply chain cooperation.

Olfat et al. (2017), in their research entitled "Identifying the factors that create supply chain cooperation in Iran's home appliance industry", while simplifying the complex concept of supply chain cooperation by identifying various effective factors, determine the factors for the successful implementation of chain cooperation. The factors that should be focused and invested on in the home appliance industries.

Diabat and Jebali (2020), conducted a research titled "Design of multi-product and multi-period closed-loop supply chain network under the law of return of goods". The research carried out sensitivity analysis research in order to obtain how some parameters of the model affect the decision made, the integration of the reverse supply chain, and its structure when there is no regulatory constraint on the returns.

Ishak et al. (2019), conducted a research titled "Designing an Electronic Supply Chain Management System". The result of this research is an electronic supply chain management program that can prepare a company to conduct transactions with suppliers and customers.

3. Methodology

This research is developmental-applicative in terms of its purpose because the researcher seeks to provide a model for the development of electronic supply chain management and its achievement to the world-class using a mixed methods approach of interpretive structural modeling and Dimetal fuzzy. The study used a historical approach (gathering information) and survey questionnaire for data collection. Also, in order to provide the theoretical basis of the research, articles, books, and reliable sources available to the researcher were used.

The statistical sample of the research is made up of experts in home appliance manufacturing industries and professors and researchers in the field of world-class production. The sampling method is purposeful. The methods used in this research are Dimetal techniques and interpretive structural model. The used software were EXCEL and MICMAC.

4. Findings

The statistical sample included 25 experimental experts and theoretical experts. The qualitative part of this study is based on the opinions of 25 experts in the field. 18 males and 7 females participated in the study. In terms of age, 3 people were less than 35 years old, 10 people were between 35 and 45, and 12 people were over 45. In terms of education, 11 of the experts had master's degree and 14 were PhD holders. Finally, 13 people had 10 to 20 years of work experience and 12 people had more than 20 years of work experience as shown in Table 1.

Table 1. Demographic characteristics of experts

Demographic characteristics		Percent	Frequency
Gender	Male	72%	18
	Female	28%	7
Age	Less than 35 years	12%	3
	35 to 45 years	40%	10
	45 years and more	48%	12
Education	Masters	44%	11
	Ph.D	56%	14
Years of Work Experience	10 to 20	52%	13
	Over 20	48%	12

Based on the literature, the components of the supply chain management model were identified as shown in table 2.

Table 2. Identified and symbolized variables

Sign	Variable	Source
D01	Electronic infrastructure	Nikolopoulos et al (2021)
D02	Core technology	Yang, et al (2021)
D03	Electronic procurement	Dohale, et al (2021)
D04	Electronic management of communication with suppliers	Mertzanis et al (2021)
D05	Information flow	Finkenstadt et al (2021)
D06	Supply chain speed	Olfat et al. (2017)
D07	Ability to resist threatening factors	Shahriari Nia et al. (2019)
D08	Relying on internal capacity	Parast et al (2021)
D09	Cost	Ahlqvist, et al (2021)
D10	waiting time	Nikolopoulos et al (2021)
D11	flexibility	Yang, et al (2021)
D12	sale services	Nikolopoulos et al (2021)
D13	after sales service	Diabat & Jebali (2020)
D14	Responding to customer expectations	Ishak et al. (2019)
D15	World class quality (ISO 60335 for household appliances)	Ishak et al. (2019)
D16	World class electronics supply chain	Farsijani et al. (2019)

In Dimetal technique, the opinions of experts were collected first.

Table 3. Calculation of direct correlation matrix.

	D01	**D02**	**D03**	**D04**	**D05**	**D06**	**D07**	**D08**	**D09**	**D10**	**D11**	**D12**	**D13**	**D14**	**D15**	**D16**
D01	0	3.5	3.5	3.25	3.5	3	4	3	4	3	4	4	4	4	3	3.75
D02	1	0	4	4	4	3	3.5	4	3.25	4	3.25	3	3.5	3.5	4	3.25
D03	1	4	0	3	4	3	4	3.75	3	4	3	4	3	4	4	4
D04	1	4	4	0	4	3	4	3.5	4	3.5	4	3	4	4	3	4
D05	1	1	1	1	0	3	3	4	3	3	3.75	4	4	3	3	3
D06	1	1	1	1	4	0	4	4	3.5	3	3.25	3	4	3	3	3
D07	1	1.25	1.75	1	1	1	0	3	3	4	4	4	4	3	4	3
D08	2	2	2	1	1	2	4	0	1.75	3.25	4	4	3	3	3	3.5
D09	2	1	1	2	2	1	1	1	0	1.25	4	3	3	3.75	4	3.75
D10	2	2	1	2	1	1	1	1	2	0	1	3	3	4	3.25	3.5
D11	2	1	1.25	2	1	1	2	2	2	4	0	3.25	4	3	4	3.5
D12	2	1	1	1	2	2	1	1	1	1	1	0	3.75	3.25	4	3.25
D13	1	1	2	1	2	1	1	1.5	1	2	1	3.5	0	4	3	4
D14	1	1.75	1.25	2	1	2	1	1	1	1	1	3.5	4	0	3	3
D15	1	2	1	1.25	2	1	1.5	1.5	1	1	1	1.75	1	2	0	2.25
D16	2	1	1	1	1	1	1	1.5	1.75	1.5	1	1	1	1	1	0

Calculation of normal direct correlation matrix

For normalization, first, the sum of all rows and columns of the direct correlation matrix was calculated. The largest sum of rows and columns were represented by k.

For normalization, each row of the direct correlation matrix was divided by k.

$$k = max\left\{max\sum_{j=1}^{n} x_{ij}, \sum_{i=1}^{n} x_{ij}\right\}$$

$$N = \frac{1}{k} * X$$

Table 4. Calculation of normal direct correlation matrix

	D01	D02	D03	D04	D05	D06	D07	D08	D09	D10	D11	D12	D13	D14	D15	D16
D01	0.000	0.065	0.065	0.061	0.065	0.056	0.075	0.056	0.075	0.056	0.075	0.075	0.075	0.075	0.05	0.07
D02	0.019	0.000	0.075	0.075	0.075	0.056	0.065	0.075	0.061	0.075	0.061	0.056	0.065	0.065	0.075	0.061
D03	0.019	0.075	0.000	0.056	0.075	0.056	0.075	0.070	0.056	0.075	0.056	0.075	0.056	0.075	0.075	0.075
D04	0.019	0.075	0.075	0.000	0.075	0.056	0.075	0.065	0.075	0.065	0.075	0.056	0.075	0.075	0.056	0.075
D05	0.019	0.019	0.019	0.019	0.000	0.056	0.056	0.075	0.056	0.056	0.070	0.075	0.075	0.056	0.056	0.056
D06	0.019	0.019	0.019	0.019	0.075	0.000	0.075	0.075	0.065	0.056	0.061	0.056	0.075	0.056	0.056	0.056
D07	0.019	0.023	0.033	0.019	0.019	0.019	0.000	0.056	0.056	0.075	0.075	0.075	0.075	0.056	0.075	0.056
D08	0.037	0.037	0.037	0.019	0.019	0.037	0.075	0.000	0.033	0.061	0.075	0.075	0.056	0.056	0.056	0.065
D09	0.037	0.019	0.019	0.037	0.037	0.019	0.019	0.019	0.000	0.023	0.075	0.056	0.056	0.070	0.075	0.070
D10	0.037	0.037	0.019	0.037	0.019	0.019	0.019	0.019	0.037	0.000	0.019	0.056	0.056	0.075	0.061	0.065
D11	0.037	0.019	0.023	0.037	0.019	0.019	0.037	0.037	0.037	0.075	0.000	0.061	0.075	0.056	0.075	0.065
D12	0.037	0.019	0.019	0.019	0.037	0.037	0.019	0.019	0.019	0.019	0.019	0.000	0.070	0.061	0.075	0.061
D13	0.019	0.019	0.037	0.019	0.037	0.019	0.019	0.028	0.019	0.037	0.019	0.065	0.000	0.075	0.056	0.075
D14	0.019	0.033	0.023	0.037	0.019	0.037	0.019	0.019	0.019	0.019	0.019	0.065	0.075	0.000	0.056	0.056
D15	0.019	0.037	0.019	0.023	0.037	0.019	0.028	0.028	0.019	0.019	0.019	0.033	0.019	0.037	0.000	0.042
D16	0.037	0.019	0.019	0.019	0.019	0.019	0.019	0.028	0.033	0.028	0.019	0.019	0.019	0.019	0.019	0.000

Calculation of the complete correlation matrix

To calculate the complete correlation matrix, first an identical n×n matrix was formed. Then we subtracted the same matrix from the normal matrix and inverted the resulting matrix. The normal matrix is multiplied by the product matrix to obtain the complete correlation matrix.

$$\mathrm{T} = \mathrm{N} \times (I - N)^{-1}$$

The matrix is the same in all of its domains except the main diameter zero. The obtained matrix is the same as the complete correlation matrix and it can be used to calculate the pattern of causal relationships.

Table 5. Complete correlation matrix (definitive)

SSIM	D01	D02	D03	D04	D05	D06	D07	D08	D09	D10	D11	D12	D13	D14	D15	D16
D01	0.075	0.151	0.149	0.145	0.169	0.145	0.182	0.167	0.182	0.180	0.194	0.229	0.232	0.230	0.218	0.236
D02	0.090	0.086	0.153	0.153	0.172	0.141	0.170	0.179	0.164	0.192	0.175	0.205	0.216	0.215	0.227	0.220
D03	0.090	0.155	0.082	0.135	0.171	0.140	0.177	0.174	0.159	0.191	0.170	0.220	0.207	0.221	0.226	0.231
D04	0.092	0.157	0.155	0.086	0.175	0.143	0.180	0.174	0.180	0.187	0.192	0.209	0.229	0.227	0.215	0.237
D05	0.074	0.080	0.079	0.079	0.074	0.117	0.132	0.150	0.131	0.143	0.153	0.185	0.187	0.169	0.173	0.176
D06	0.075	0.082	0.080	0.081	0.146	0.066	0.152	0.153	0.143	0.147	0.149	0.172	0.191	0.172	0.176	0.180
D07	0.071	0.083	0.089	0.077	0.088	0.078	0.072	0.126	0.126	0.155	0.150	0.178	0.179	0.163	0.184	0.170
D08	0.091	0.099	0.097	0.081	0.093	0.100	0.148	0.079	0.110	0.148	0.156	0.183	0.169	0.167	0.171	0.183
D09	0.082	0.072	0.070	0.088	0.099	0.073	0.083	0.084	0.065	0.096	0.141	0.147	0.149	0.161	0.168	0.168
D10	0.078	0.086	0.067	0.085	0.078	0.069	0.078	0.079	0.096	0.067	0.084	0.140	0.142	0.159	0.148	0.156
D11	0.085	0.076	0.078	0.091	0.085	0.075	0.104	0.105	0.105	0.148	0.074	0.157	0.172	0.155	0.174	0.171
D12	0.073	0.063	0.062	0.061	0.090	0.082	0.074	0.075	0.073	0.080	0.078	0.079	0.146	0.137	0.152	0.143
D13	0.057	0.064	0.079	0.062	0.090	0.066	0.074	0.083	0.073	0.098	0.078	0.142	0.081	0.151	0.136	0.157
D14	0.056	0.076	0.066	0.079	0.073	0.082	0.073	0.075	0.073	0.080	0.077	0.140	0.150	0.080	0.135	0.138
D15	0.049	0.072	0.054	0.058	0.079	0.056	0.073	0.074	0.064	0.070	0.069	0.096	0.084	0.100	0.066	0.139
D16	0.063	0.050	0.049	0.050	0.056	0.051	0.059	0.067	0.072	0.072	0.063	0.074	0.075	0.075	0.076	0.060

Displaying network relation map

A threshold value must be calculated to determine the Network Relationship Map (NRM). With this method, partial relationships can be ignored and the network of significant relationships can be drawn.

Only relations whose values in matrix T are greater than the threshold value will be displayed in NRM.

To calculate the threshold value of relationships, the average values of the matrix T is calculated. The threshold intensity is calculated as 0.123. After the intensity of the threshold is determined, all the values of the T matrix that are smaller than the threshold are zeroed, that is, the causal relationship is not considered.

Table 6. Matrix of significant relationships of study variables

SSIM	**D01**	**D02**	**D03**	**D04**	**D05**	**D06**	**D07**	**D08**	**D10**	**D11**	**D12**	**D13**	**D14**	**D15**	**D16**
D01	X	0.151	0.149	0.145	0.169	0.145	0.182	0.167	0.180	0.194	0.229	0.232	0.230	0.218	0.236
D02	X	X	0.153	0.153	0.172	0.141	0.170	0.179	0.192	0.175	0.205	0.216	0.215	0.227	0.220
D03	X	0.155	X	0.135	0.171	0.140	0.177	0.174	0.191	0.170	0.220	0.207	0.221	0.226	0.231
D04	X	0.157	0.155	X	0.175	0.143	0.180	0.174	0.187	0.192	0.209	0.229	0.227	0.215	0.237
D05	X	X	X	X	X	X	0.132	0.150	0.143	0.153	0.185	0.187	0.169	0.173	0.176
D06	X	X	X	X	0.146	X	0.152	0.153	0.147	0.149	0.172	0.191	0.172	0.176	0.180
D07	X	X	X	X	X	X	X	0.126	0.155	0.150	0.178	0.179	0.163	0.184	0.170
D08	X	X	X	X	X	X	0.148	X	0.148	0.156	0.183	0.169	0.167	0.171	0.183
D09	X	X	X	X	X	X	X	X	X	0.141	0.147	0.149	0.161	0.168	0.168
D10	X	X	X	X	X	X	X	X	X	X	0.140	0.142	0.159	0.148	0.156
D11	X	X	X	X	X	X	X	X	0.148	X	0.157	0.172	0.155	0.174	0.171
D12	X	X	X	X	X	X	X	X	X	X	X	0.146	0.137	0.152	0.143
D13	X	X	X	X	X	X	X	X	X	X	0.142	X	0.151	0.136	0.157
D14	X	X	X	X	X	X	X	X	X	X	0.140	0.150	X	0.135	0.138
D15	X	X	X	X	X	X	X	X	X	X	X	X	X	X	0.139
D16	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

According to the pattern of relationships, it is possible to determine the set of effectiveness and impacts:

Table 7. Complete de-fuzzified (deterministic) correlation matrix

Components	**D-R**	**D+R**	**R**	**D**	
Electronic infrastructure	-1.683	4.082	2.883	1.200	D01
Core technology	-1.632	3.882	2.757	1.125	D02
Electronic procurement	-1.712	3.782	2.747	1.035	D03
Electronic management of communication with suppliers	-1.893	3.783	2.838	0.945	D04
Information flow	-1.250	2.957	2.103	0.853	D05
Supply chain speed	-1.387	2.946	2.166	0.779	D06
Ability to resist threatening factors	-1.287	2.694	1.991	0.704	D07
Relying on internal capacity	-1.442	2.707	2.075	0.632	D08
Cost	-1.204	2.287	1.746	0.542	D09
waiting time	-1.151	2.071	1.611	0.460	D10
flexibility	-1.474	2.238	1.856	0.382	D11
sale services	-1.169	1.765	1.467	0.298	D12

Components	D-R	D+R	R	D	
after sales service	-1.267	1.716	1.491	0.224	D13
Responding to customer expectations	-1.285	1.619	1.452	0.167	D14
World class quality (ISO 60335 for household appliances)	-1.064	1.287	1.175	0.111	D15
World class electronics supply chain	-0.949	1.075	1.012	0.063	D16

The sum of the elements of each row (D) indicates the influence of that factor on other factors of the system. It is clear that land use has the greatest impact on other elements of the system. The sum of the elements of the column (R) for each factor indicates the influence of that factor on other factors of the system. The horizontal vector (D+R) is the degree of influence of the desired factor in the system. The vertical vector (D-R) shows the influence of each factor. In general, if D-R is positive, the variable is considered a causal variable, and if it is negative, it is considered as an effect.

Structural interpretive model

The first step in structural-interpretive modeling is to calculate the internal relationships of the indicators. Expert views are used to reflect the internal relationships between the indicators. The matrix obtained in this step shows which variables are affected and by which variables they are affected. Conventionally, symbols presented in Table 8 are used to identify the relationship the pattern of elements.

Table 8. Modes and signs used in expressing the relationship between the research indicators

O	X	A	V
Absence of relationship	Two-way relationship	Variable j affects i	Variable i affects j

According to the signs presented in Table 8, the structural self-interaction matrix will be as in Table 9.

Table 9. Structural self-interaction matrix of SSIM

SSIM	D16	D15	D14	D13	D12	D11	D10	D09	D08	D07	D06	D05	D04	D03	D02	D01
D01	V	V	V	V	V	V	V	V	V	V	V	V	X	X	X	
D02	V	V	V	V	V	V	V	V	V	V	V	V	X	X		
D03	V	V	V	V	V	V	V	V	V	V	V	V	X			
D04	V	V	V	V	V	V	V	V	V	V	V	V				
D05	V	V	V	V	V	V	V	V	V	V	X					
D06	V	V	V	V	V	V	V	V	V	V						
D07	V	V	V	V	V	V	V	V	X							
D08	V	V	V	V	V	V	V	V								
D09	V	V	V	V	V	V	V									
D10	V	V	V	V	V	X										
D11	V	V	V	V	V											
D12	V	V	X	X												
D13	V	V	X													
D14	V	V														
D15	V															
D16																

The final access matrix of model indicators is presented in Table 11.

Table 9. Structural self-interaction matrix of SSIM

SSIM	D16	D15	D14	D13	D12	D11	D10	D09	D08	D07	D06	D05	D04	D03	D02	D01
D01	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
D02	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
D03	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1
D04	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1
D05	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
D06	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	0
D07	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
D08	1	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0
D09	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
D10	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
D11	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0
D12	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
D13	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0
D14	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0
D15	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 11. The final access matrix of indicators

SSIM	D16	D15	D14	D13	D12	D11	D10	D09	D08	D07	D06	D05	D04	D03	D02	D01
D01	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
D02	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
D03	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1
D04	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1
D05	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
D06	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	0
D07	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
D08	1	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0
D09	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
D10	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
D11	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0
D12	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
D13	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0
D14	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0
D15	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D16	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

The set of outputs includes the criterion itself and the criteria that are affected by it. The set of inputs includes the measure itself and the measures that affect it. Then, the set of two-way relations of the criteria is determined.

After determining the achievement set and the prerequisite set, the subscription of the two sets is calculated. After determining the level, the criterion with the known level is removed from the whole set, the set of inputs and outputs is formed again and the next variable level is obtained.

Table 12. Set of inputs and outputs of each variable and stratification

Sign	Variables	Number of rows	Number of columns	level
D01	Electronic infrastructure	15	4	8
D02	Core technology	15	3	8
D03	Electronic procurement	15	3	8
D04	Electronic management of communication with suppliers	15	3	8
D05	Information flow	11	5	7
D06	Supply chain speed	11	5	7
D07	The ability to resist threatening factors	9	7	6
D08	Relying on internal capacity	9	7	6
D09	cost	7	8	5
D10	waiting time	6	10	4
D11	flexibility	6	10	4
D12	sale services	4	13	3
D13	after sales service	4	13	3
D14	Responding to customer expectations	5	13	3
D15	World-class quality (60335 household appliances ISO)	1	14	2
D16	World class electronic supply chain	0	15	1
Total		133	133	

Therefore, variable D16 is the first level variable. After identifying the variable(s) of the first level, these variable(s) are removed and the set of inputs and outputs is calculated without considering the variables of the first level. The common set of identification and the variables whose commonality is equal to the set of inputs are selected as the second-level variables.

Variables D11, D12, D13, and D14 are second-level variables. Variables D5, D6, D7, D8, D9, and D10 are third-level variables. D1, D2, D3, and D4 variables are the fourth-level variables.

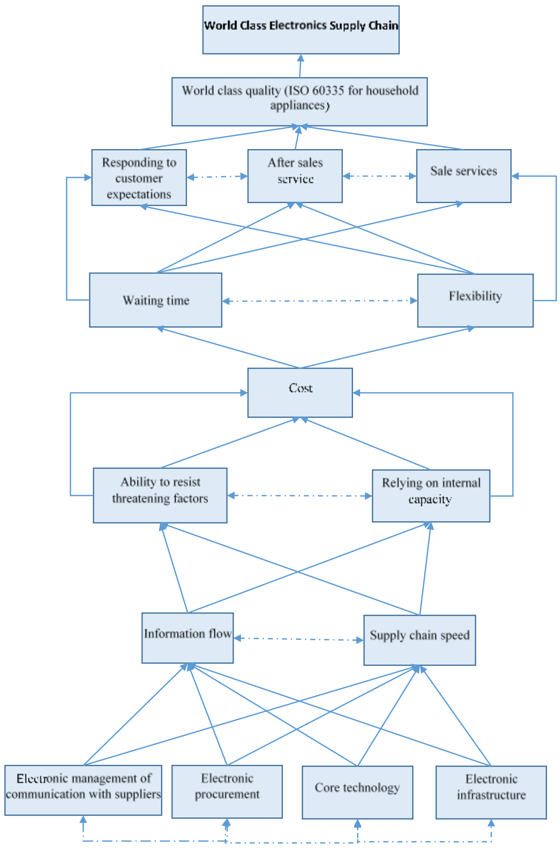

Figure 1. Basic model developed by ISM method

The final pattern of the levels of the identified variables is shown in the figure. In this diagram, only the meaningful relationships of the elements of each level on the elements of the lower level, as well as the meaningful internal relationships of the elements of each row, are considered.

5. Discussion

In the qualitative part, effective indicators were identified in the electronics supply chain in home appliance manufacturing industry to achieve a world class. 15 indicators were identified. These indicators included: electronic infrastructure, core technology, electronic procurement, electronic management of communication with suppliers, information flow, supply chain speed, ability to resist threatening factors, relying on internal capacity, cost, waiting time, flexibility, sales services, after-sales service, meeting customer expectations and world-class quality (ISO 60335 household appliances). Organizations and industries face global competition. For organizations to produce their products at a world-class level in order to succeed in global competition, they must be more integrated at the level of the organization's partners as well as the supply chain. Global supply chain companies never lose sight of customer needs. They effectively identify key customers, assess critical customer success factors, and establish processes at suppliers to deliver quality and responsiveness at the lowest possible cost. Reducing costs and increasing quality are very important in the supply chain, moving towards globalization and customer satisfaction. The continuous increase in competitiveness forces every company to review its production processes in order to reduce costs as much as possible and maximize customer service. Notable keywords in this regard are "zero waste" and "zero damage". There are many different methods and techniques that are required to achieve the above goals. Also, world-class practice is a strategic vision of how a company's productive resources relate to each other and to the environment. Sombultawee et al. (2022) state that the best companies use customer-centric actions at the company level. These services include cost reduction for the customer, quality, time, and flexibility.

Based on the interpretative structural model, a categorized model was designed in 8 levels. The low-level components of electronic infrastructure, core technology, electronic procurement, and electronic management of supplier communication have the greatest impact on the whole model. By improving these factors, it is possible to improve the electronic supply chain management process in home appliance manufacturing industry to achieve the world-class. At this level, creation of internal and external electronic and technological factors are considered. Capability of information technology with the flexibility of the infrastructure, integration of information technology, use of new equipment and tools, and management of correct communication in the electronic platform, all point to the scalability and compatibility of the electronic supply chain with the world-class standards of home appliance industry. Electronic core infrastructure provides the company with the ability to innovate by facilitating information sharing and increasing the quality of production and operational processes of the company. Technology and electronicization deal with the exploitation of related activities in IT performance management such as planning, design, delivery, project management, planning standards, and controls electronically and intelligently. The middle levels of the model deal with information flow and supply chain speed. Continuous developments in the field of communication and information systems and information technology have caused a series of evolution for the supply chain and its capabilities. The supply chain based on the flow of information has the necessary functionality and efficiency and increases the speed and quality by increasing the integration, reducing the sensitivity and friction in the current operations. Information flow supports the cooperation and coordination of supply and demand chains through information sharing.

6. Conclusion

The ability to resist risk factors and relying on internal capacity indicates the importance of a resilience economy in home appliance industry. Economic sanctions have affected all aspects of Iran's economy in recent years. Home appliance manufacturers should work in a competitive environment and increase the quality of their products, and by producing home appliances domestically, the employment of workers should be supported, and people should be satisfied by providing a quality product. Competitiveness and productivity as well as quality are mentioned as important principles. Supporting Iranian goods does not mean offering low-quality and exclusive goods, and the three important principles of "quality, cost price, and after-sales service" should be taken into consideration as central and key points. Cost, waiting time, and flexibility are at the next levels of the model. These factors indicate flexible production in the supply chain. Production volume, variety, desired cost and time, and attracting taste based on flexibility will increase demand coverage, increase quality, reduce cost and create a competitive advantage. With the passage of time, due to the great changeability of the business markets, the diversity of the customers in their demands, and the undesirability of the products, the manufacturers came to the conclusion that by increasing the flexibility, many of the shortcomings of the market can be solved. Emerging advanced technologies and their use in production organizations are considered vital to remain in the competition scene. Using them in production can improve quality, increase production, increase reliability and flexibility.

The next level is after-sales service and meeting customer expectations. Companies that seek to achieve world-class production must adopt a continuous improvement strategy in all dimensions of the organization. A requirement for continuous improvement is to have complete knowledge of customers, suppliers, the performance of competitors, and one's own strengths and weaknesses. By having relationships with other partners in the supply chain, companies will have the opportunity to better understand the needs of customers, respond faster to market dynamics, deliver on time with lower costs and more profit. Sharma et al. (2020) believe that a suitable supply chain and the use of internal and external resources are needed to accelerate the process of responding the customers.

Ozlem (2013) considered world-class production to be a quick response to customers in a competitive environment and introduced the need for correct and integrated communication with customers and suppliers. Compared to other models, the obtained model shows more comprehensiveness in terms of the obtained dimensions, components, and indicators. This issue has been compared with some domestic and foreign studies. The model has identified a number of new components and indicators, which is the breaking point for the current research and the main achievement of the research. The comprehensiveness of the model lies in its locality for the electronic supply chain based on the characteristics of the country.

Based on the results, the following suggestions were made:

Improving efficiency, continuous and directed mobility through diplomacy and active presence in regional and global treaties, complexes, and hubs to use the existing capacities.

-Reducing the weakness in resource efficiency and preventing the wastage of resources and its optimal use to confront the threats to the success of household appliances production.

-Upgrading and increasing the efficiency of home appliance industry by creating alignment in the production goals

-Creating a suitable business environment in line with the expansion of production and economic prosperity in home appliance industry and new products

-Highlighting justice in development through placing customers as the focus in home appliance industry programs in line with the realization of the electronic supply chain with a world-class production approach

-Producing knowledge and using the scientific capacities of the country in home appliance industry

-Carrying out changes in methods through continuous improvement in the production programs of home appliance industry

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