ORIGINAL RESEARCH ARTICLE

Identifying and prioritizing supply chain risks using the ANP and Dematel Model Process (including case study)

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ABSTRACT

Uncertainty is one of the most important challenges in the supply chain that can affect its goals. Therefore, identifying and evaluating risks is of particular importance. If the importance of risks in any industry can be identified, there can be specific measures against them, and the organization can be protected from their damage. Chain risk management can also be a useful approach in organizational and management due to its dynamic nature and the role of the main business functions. Given that the car industry in any country is one of the indicators of development because of its value and special place in industrial production and the after-sales service network, and in terms of its extensive connection to the chains of the previous and later industries, it is a key industry. And it has a high potential for employment and an effective role in economic growth and development. Therefore, this study was devoted to a case study on the supply chain of Iran Khodro Company. The goal is to identify and prioritize the supply chain risks for this company. In this regard, after identifying the effective risks in the supply chain of Iran Khodro Company, according to experts, we used the Dematel-ANP Combined Approach to rank the identified risks and apply the importance of each risk strategy and responsive programs appropriate to them.

Keywords: risk assessment; supply chain; Dematel method; ANP method

1. Introduction

The concept of the supply chain has been widely raised over the past two decades. According to the definitions of supply chains, they are defined as the networks of organizations that are interconnected through upstream and downstream communications in various processes and activities and eventually create value in the form of a product or service in the form of a final customer. Therefore, the chain framework has the main components of supply, manufacturer, warehouse, retailers, and customer. Therefore, membership within the supply chains of large organizations forces them to trust and rely on partners, suppliers, consultants, and other accompanying companies in their market delivery. The importance of chain is that, as we see today, some competitors cooperate with the benefits of chain in some supply chains. There is a need for cooperation, coordination, and management of all currents in this chain, including economics, information, materials, and value, to increase value-added value. The effective management of supply chains has created many competitive advantages for today's organizations. Suppliers for survival in a market are facing increasing pressure on flexibility, time, diversity,

and value. These demands cannot be met solely by making changes within the internal boundaries of organizations, and their effective satisfaction requires improvement in the functions of the chain in which the organization is active. The process of current businesses has led the chains. One of the results of these changes in the supply chain is increased risk, which is transferred to the supply chain. Most of today's life conditions have changed due to the increasing changes in the world in the last century. Subsequently, the conditions that the supply chains are facing and changing from have also changed. And since managers are facing more unknown conditions and new risks, they need to prepare themselves for their active and effective management in today's marketplace, which is characterized by a lack of certainty and confusion for productive and economic agencies. Due to increased data from supply chains, managers are required to monitor their resources and relevant resources outside the organization in addition to addressing their resources and organizations, including the importance of risk management throughout the chain. Supply, in which all members, from production and supply to transportation, warehousing, etc., must be managed during this chain with the dangers that influence the various dimensions of their activities.

2. Statement of the problem

In the last decade, supply chain management has moved out of the invisible and secondary state and has become a strategic element that can have a positive and tangible impact on the organization's activities. Changes caused by technology in market conditions, changing the shape of business practices, new expectations and expectations of existing supply chain partners, and demand for more created value from the end consumer are among the factors in changing the state of supply chain management. The identification of risks within the supply network and the use of coordinating approaches throughout the supply chain members to reduce the vulnerability of the entire supply chain are defined as supply chain risk management. Risk in the supply chain is a potential event that prevents the natural flow of materials and information in the chain and therefore leads to a disruption in the chain. A wide range of risks that exist in the supply chain may have negative effects on the performance of the supply chain. Due to the close relationship between the members of the supply chain, a disruption or risk in any part of the supply chain affects the entire chain and disrupts its performance. Therefore, in order to overcome supply chain risks, organizations must use appropriate strategies to manage and control them. Understanding the supply chain risks that companies face makes it possible for company managers to have a better ability to recognize and deal with unexpected events. The identification of supply chain risks makes it possible to adapt to the chaotic and unsatisfied conditions of the competitive environment and acts as a strategic lever in the competitiveness process of organizations. The supply chain risk assessment and management process can help to make strategic decisions and operational plans to reduce the number of supply chain failures. Therefore, supply chain risk management, as a process of strengthening the supply chain, has a direct effect on the success of the organization. As an old and important industry that has a large share of the country's gross national product, in all parts of its life cycle, the food industry is exploited from natural resources, manufacturing, production, consumption, and after consumption, direct and indirect interaction with the environment. Also, considering that the domestic car market is getting saturated, domestic car manufacturers should focus on the regional and global markets. Considering the necessity of such things as joining the World Trade Organization, increasing international environmental laws, and customers' emphasis on using environmentally friendly green products, it is necessary and inevitable to create green management in the provision of products and services in the country's industries. Automobile manufacturing is one of the most important components of trade and industry in the world, and the supply chain of this industry is one of the most dynamic. The final products of car manufacturers are the result of integration and detailed planning at the level of a powerful supply chain, and the emergence of risk in any part of the chain, especially the parts supplier part, will cause disruption in the entire chain and will result in many losses. In this way, choosing suppliers according to chain risks can be a fundamental measure to prevent and control risk factors in the supply chain; considering the risk, in other words, the supply chain as a criterion for choosing the best

suppliers of automobile manufacturers, is a comprehensive and new approach in the work of selecting suppliers in order to manage and control risks and reduce the vulnerability of the chain towards them. The aim of this research is to develop a new method for calculating risk priority numbers in order to identify and prioritize the risks in the supply chain using an analysis of the state and reasons for failure. In this research, we first identify the risks in the supply chain and then use the network analysis method to weight and prioritize the risks.

3. The importance and necessity of conducting research

Today, environmental issues have become an important concern for manufacturers under legislation and customer guidelines, especially in the United States, the European Union, and Japan. Therefore, green supply chain management as an important innovation helps the organization develop strategies to reach the common goals of profit and market by reducing environmental risks and increasing its environmental efficiency. Due to the fact that a high percentage of the country's industrial units are small and medium-sized, more than half of the workers in the industry sector are involved in different parts of their life cycle (exploitation of natural resources, construction, production, and consumption). They have been directly and indirectly affected by the environment, and in order to properly design and implement the strategy of applying green supply chain management, they need to be aware of the obstacles to applying green supply chain management. In other words, companies must have a set of internal resources and capabilities to successfully apply green supply chain management. Also, these industries must identify the relevant barriers to reaping the multiple benefits of green supply chain management. Due to the increasing environmental awareness of customers, competition, and strict government policies, the method of combining green supply chain management to preserve resources and promote sustainable production is gradually becoming a necessity for the organization. However, it is relatively difficult to successfully carry out green supply chain business and production activities due to the involvement of various risks. These risks and their associated sources tend to disrupt green supply chain performance, thereby reducing environmental and economic performance. Therefore, identifying risks and evaluating solutions in the supply chain is very important in order to know and understand them. Today, risks have become an important part of our lives because they enter into everything we do and participate in. Some people don't want to do something that involves risk, and some people expose themselves to risk. By using risk reduction strategies, all risks can be reduced to a manageable level. In the supply chain, the decision-making process contains risks that can affect the company's progress in introducing a new product, expanding into different markets, and outsourcing production operations. Companies are likely to react well to unexpected events by considering risks in their decision-making and applying appropriate risk reduction strategies. Individuality, uncertainty, and unrecognizability that exist in reality are the key factors that make it difficult to control risks. Therefore, risk analysis, reduction, and control provide recommendations for appropriate decision-making.

4. Definition of supply chain

The supply chain is the chain that covers all activities related to the flow of goods and the conversion of materials, from the raw material preparation process to the final delivery stage to the consumer. **Figure 1** shows an overview of a supply chain.
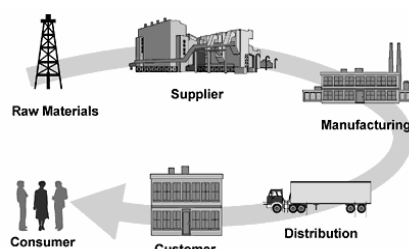

Figure 1. Overview of a supply chain.

5. Research questions

1) The present research is designed to identify supply chain risks (including performing a case study).
2) This research was conducted to answer the following questions
3) What are the most important supply risks of Iran Khodro Company?
4) What is the priority of the risks Iran Khodro Company is faced with?
5) Are the risks capable of affecting each other?

6. Data, society and statistical example research tools

The statistical population of research is Iran Khodro Company. Five experts participated in the polls. In this study, targeted sampling was performed. To select, the reporters completed the questionnaire to perform Delphi rounds and examine the importance of each risk. The sampling method was targeted, and car industry experts were selected for this study. The Delphi method was used to analyze the opinions of the experts. The information needed for the research is one of its essential steps and, in terms of its importance, is sometimes referred to as information collection methods (Hafez Nia, 2008). The method is to be a field-and-athlete from the design of special questionnaires. The type of research applied and research method used in this study is descriptive, which was used to identify the risks and barriers of the supply chain in the automotive industry using the Delphi technique to identify effective supply chain risks.

7. Research background

Taghipour et al.[1] studied "Risk analysis in the management of urban construction projects from the perspective of the employer and the contractor."

Mahboobi et al.[2] discussed "Assessing ergonomic risk factors using combined data envelopment analysis and conventional methods for an auto parts manufacturer", occupational injuries are currently a major contributor to job loss around the world.

Taghipour et al.[3] studied "The impact of ICT on knowledge sharing obstacles in the knowledge management process (including a casestudy)."

Khalilpour et al.[4] studied "The impact of accountant's ethical approaches on the disclosure quality of corporate social responsibility information: an Islamic perspective in Iran."

Mirzaie et al.[5] studied "The relationship between social bearing capacities and conflict, as a result, in the perception of visiting historical sites."

Alamdar Khoolaki et al.[6] studied "Effect of integrated marketing communication on brand value with the role of agency reputation (including a case study)."

Taghipouret et al.[7] studied "A survey of BPL technology and the feasibility of its application in Iran (Gilan Province)."

Mohammad et al.[8] studied "Assessing the effect of the FRP system on compressive and shear bending strength of concrete elements."

Jalili et al.[9] studied "Comparative Study of Khaje Rashid al-Din Views on Rab-e Rashidi Islamic Utopia and Kevin Lynch Ideas."

Taghipour et al.[10] studied "Insurance performance evaluation using the BSC-AHP combined technique."

Rezvani et al.[11] discussed "The design of high-rise buildings with an ecological approach in Iran (Alborz Province)."

Taghipour et al.[12] studied "The identification and prioritization of effective indices on optimal implementation of customer relationship management using TOPSIS and AHP methods."

Taghipour and Yazdi[13] studied "Seismic analysis (non-linear static analysis (pushover) and nonlinear dynamic) on Cable-Stayed Bridge."

Taghipour et al.[14] studied "Investigating the relationship between competitive strategies and corporate performance (case study: Parsian Banks of Tehran)."

Taghipour and Moosavi[15] studied "A look at gas turbine vibration condition monitoring in region 3 of gas transmission operation."

Rahmani et al.[16] studied "Providing health, safety, and environmental management (HSE) programs in the metal mining industry (including a case study)."

Taghipour and Vaezi[17] studied "safe power outlets."

Tarverdizadehet et al.[18] studied "Predicting students' academic achievement based on emotional intelligence, personality and demographic characteristics, attitudes toward education, and career prospects through the mediation of academic resilience."

Azarian and Taghipour[19] studied "The impact of implementing inclusive quality management on organizational trust (case study: education)."

Ghadamzan Jalali et al.[20] studied "Explain the relationship between intellectual capital, organizational learning, and employee performance of Parsian Bank branches in Gilan Province."

Mohammadi et al.[21] studied "Investigating the role and impact of using ICT tools on evaluating the performance of service organizations."

Abdi Hevelayi et al.[22] studied "Predicting entrepreneurial marketing through strategic planning (including a case study)."

Arsalani et al.[23] studied "Investigating the effect of social media marketing activities on brand awareness."

Khorasani and Taghipour[24] studied "The location of an industrial complex using a combined model of fuzzy multiple-criteria decision-making (including a case study)."

Taghipour et al.[25] studied "Risk assessment and analysis of the state DAM construction projects using the FMEA technique."

Hoseinpour et al.[26] studied "The problem solving of bi-objective hybrid production with the possibility of production outsourcing through the Imperialist Algorithm, NSGA-II, and GAPSO Hybrid Algorithms."

Taghipour and Ahmadi Sarchoghaei[27] studied "Evaluation of tourist attractions in Bourujerd County with emphasis on development of new markets by using Topsis Model."

Hashemi et al.[28] studied "The effect of personal factors on increasing the productivity of low-level employees in the General Welfare Department of Tehran Municipality."

Safdarpour et al.[29] studied "The effect of government support on innovation ability (including a case study)."

Ganjali et al.[30] studied "Strategic analysis of household hazardous waste reduction."

Taghipour et al.[31] studied "The impact of managerial factors on increasing the productivity of low-level employees (including a case study)."

Ganjali et al.[32] studied "Investigating the relationship between environmental awareness and the level of education and occupation of people."

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Baghipour Saramiet et al.[33] studied "Modeling of nurses' shift work schedules according to ergonomics: a case study in Imam Sajjad(As) Hospital of Ramsar."

Moradi Lalekaei et al.[34] studied "Measurement of the country of origin of the brand of branding and brand loyalty."

Taghipour et al.[35] studied "Investigating the effect of intelligent ordnance on the level of learning/teaching (including a case study)."

Taghipour et al.[36] studied "The study of the effect of smart schools on the level of learning-teaching in high school."

Taghipour et al.[37] studied "The impact of motives from obtaining ISO 9001 certification on organization performance (including a case study)."

Taghipour et al.[38] studied "The impact of working capital management on the performance of firms listed in Tehran Stock Exchange (TSE)."

Habibi et al.[39] studied "Designing a smart model for managing Iranian chain stores based on business intelligence (case study of Proma chain store)."

Safdarpour et al.[40] studied "The effect of communication on learning ability (including a case study)."

Taghipour[41] studied "Modeling the application of knowledge management systems in order to improve the technology governance in the automotive industry of Iran using the data mining environment."

8. Delphi method

Delphi is a way to structure the process of group communication so that the process in question allows the group to face and deal with a complex problem. Achieving this "structured connection" is possible when the following conditions exist:

- There is a way to provide retribution for the information and knowledge received from the experts.
- There is a way to evaluate expert opinion.
- Experts have the opportunity to change their view.
- Anonymity of the experts.

8.1. The method of using Delphi

The Delphi procedure is usually performed in at least two rounds. Usually, the purpose of the first round is to identify topics related to the research problem. After the end of the first round, the answers received and the second questionnaire will be provided to the experts. The second round and subsequent rounds are more specialized, and their purpose is to rank the various factors based on their importance and analyze them quantitatively.

8.2. Identify the risks in the automotive supply chain

In order to determine the risks in the automotive supply chain, some relevant factors were first extracted from the literature. This section discusses the process of selecting supply chain risks using the method of academic experts (**Table 1**).

Table 1. Risks identified in previous studies.

Component and subcomponent		Row
Increase in the price of fuel and energy carriers.	Economic	1
Fluctuations in financial markets.		2
Increase in production costs.		3

Table 1. (*Continued*).

Component and subcomponent		Row
Liquidity problems, financial ability and purchasing power.		4
Product price change.		5
Overdue claims.		6
Boycott.	Sovereign and political	7
Legal and partnership risks.		8
Contraction and expansion policies of banks.		9
Many varieties.		10
Social issues.		11
Production planning risk.	Planning and production	12
Change in product engineering.		13
Failure of production equipment and machinery.		14
Failure to realize the production plan.		15
Low quality raw materials.		16
Commitment of suppliers.		17
Safety and work accidents.		18
Whiplash effect.	-	19
Quality control processes.	Quality and technology	20
Weakness in information infrastructure.		21
Technology change.		22
Technology transfer risk.		23
After-sales service risk.		24
Air pollution.	Environmental	25
Natural disasters.		26
War		27
Embezzlement		28

8.3. The first round of the Delphi method

During this round, a questionnaire was designed based on the combined factors of **Table 1**, and as the first round of Delphi questionnaire, the experts of this study, which were 7, were shown in **Table 2**.

Table 2. First round of Delphi.

Confirmation	The number of answers that were equal to 4 (a lot) or 5 (very much).	Connoisseur (7)	Connoisseur (6)	Connoisseur (5)	Connoisseur (4)	Connoisseur (3)	Connoisseur (2)	Connoisseur (1)	Factor
-	4	4	3	2	3	4	5	4	1
-	7	5	4	5	4	5	5	5	2
-	3	2	4	3	2	3	4	4	3
-	6	4	4	3	5	4	4	5	4
-	6	5	5	4	5	4	4	3	5
-	2	3	3	3	4	5	2	3	6
-	6	5	3	4	4	4	5	4	7
-	2	3	1	2	4	5	3	2	8
-	5	4	3	5	4	3	4	4	9

Table 2. (*Continued*).

Confirmation	The number of answers that were equal to 4 (a lot) or 5 (very much).	Connoisseur (7)	Connoisseur (6)	Connoisseur (5)	Connoisseur (4)	Connoisseur (3)	Connoisseur (2)	Connoisseur (1)	Factor
-	4	4	3	4	3	5	3	4	10
-	2	2	4	1	4	3	3	2	11
-	6	4	3	5	4	4	5	4	12
-	5	5	3	3	4	4	4	5	13
-	4	4	3	3	4	4	3	4	14
-	4	1	4	4	5	3	4	2	15
-	3	3	3	2	4	5	3	4	16
-	3	4	4	2	2	3	2	4	17
-	5	4	4	4	4	3	3	4	18
-	3	3	3	4	3	4	3	5	19
-	7	5	4	4	5	4	4	4	20
-	5	4	4	3	4	4	4	3	21
-	5	3	4	3	4	4	5	5	22
-	4	4	3	3	5	3	4	4	23
-	4	2	4	3	4	4	3	4	24
-	4	3	4	3	3	4	4	5	25
-	5	4	4	4	4	4	3	3	26
-	2	3	2	4	3	2	3	4	27
-	5	4	5	3	4	3	5	4	28

After collecting the results of the first round of Delphi (**Table 2**), the components have been approved. It is important to note that the risks offered by the general model are the risks of the automotive industry chain and do not agree to all the required components. Because the purpose of extracting indigenous risks is to provide Iran Khodro Company.

8.4. Second round of Delphi

In the first round, the conceptual model variables were evaluated, and as mentioned in **Table 2**, some of these components have been represented. In the first round of experts, in addition to the risks introduced, they also import two risks introduced by two reports in this section, which entered the questionnaire in the second round, including 29 risks of corruption. The office and the 30 risks of creating a lobby through competing companies. **Table 3** shows the second-round results.

Table 3. The second round of Delphi.

Confirmation	The number of answers that were equal to 4 (a lot) or 5 (very much).	Connoisseur (7)	Connoisseur (6)	Connoisseur (5)	Connoisseur (4)	Connoisseur (3)	Connoisseur (2)	Connoisseur (1)	Factor
-	5	4	3	2	4	4	5	4	1
-	2	2	4	3	3	3	4	3	3
-	3	3	4	3	4	5	3	3	6
-	2	3	2	2	4	5	3	3	8
-	5	4	3	5	4	5	3	4	10
-	1	3	4	1	3	3	3	2	11
-	5	4	4	3	4	4	3	4	14

Table 3. (*Continued*).

Confirmation	The number of answers that were equal to 4 (a lot) or 5 (very much).	Connoisseur (7)	Connoisseur (6)	Connoisseur (5)	Connoisseur (4)	Connoisseur (3)	Connoisseur (2)	Connoisseur (1)	Factor
-	3	1	4	3	5	3	4	2	15
-	4	4	3	2	4	5	2	4	16
-	2	3	4	2	2	3	3	4	17
-	3	3	3	5	3	4	3	5	19
-	3	4	3	3	5	2	3	4	23
-	3	3	3	3	4	4	3	4	24
-	5	3	4	3	4	4	4	5	25
-	2	3	2	5	3	1	3	4	27
-	4	4	3	3	3	4	4	5	29
-	2	3	3	5	3	2	3	4	30

After collecting data in the second round, the agreement on variables did not make significant changes, and eventually two options were added to the research risks. Given that there is a sharp difference in the variables, the agreement is slightly. and the continuation of Delphi does not change; Delphi stops in the second round, and the approved components are introduced as the supply chain risk model in the Iranian automobile industry. As a result, the final risks of the research are listed in **Table 4**.

Table 4. Final variables of Iran Khodro supply chain risk assessment.

Component and subcomponent		Row
Increase in the price of fuel and energy carriers (a1).	Economic (A)	1
Fluctuations in financial markets (a2).		2
Liquidity problems, financial ability and purchasing power (a3).		3
Product price change (a4).		4
Boycott (b1).	Sovereign and political (B)	5
Contraction and expansion policies of banks (b2).		6
Many varieties (b3).		7
Production planning risk (c1).	Planning and production (C)	8
Change in product engineering (c2).		9
Failure of production equipment and machinery (c3).		10
Safety and work accidents (c4).		11
Quality control processes (d1).	Quality and technology (D)	12
Weakness in information infrastructure (d2).		13
Technology change (d3).		14
Air pollution (e1).	Environmental (E)	15
Natural disasters (e2).		16
Embezzlement (e3).		17

In this study, we first determine the impact of each of the risks submarines to solve the Dimtel method, the Super Matrix of the DANP method, then execute the other steps.

In the following, considering the values of matrix T, we determine the influence of the main criteria.

According to **Table 5**, it is observed that the main criterion A has more interaction with other core criteria and is more important. Following the steps of the DANP method, we formulated the primary super matrix and the weight of the weightlifting super matrix.

Table 5. T-matrix, influence and effectiveness of the main criteria.

TD	A	B	C	D	E	D
A	0/343954	0/342869	0/357099	0/346428	0/354711	1/745061
B	0/363356	0/345318	0/364717	0/352429	0/364343	1/790163
C	0/359552	0/331191	0/353644	0/339847	0/352986	1/737219
D	0/35667	0/319024	0/343759	0/338305	0/337277	1/695035
E	0/356755	0/311341	0/343099	0/336223	0/330422	1/677839
R	1/780287	1/649742	1/762318	1/713231	1/73974	-
D+R	3/525348	3/439906	3/499537	3/408267	3/417579	-
D−R	−0/03523	0/140421	−0/0251	−0/0182	−0/0619	-

Next, by increasing the weighted super matrix to the power, it is converged to obtain the final weights (**Tables 6** and **7**).

Table 6. Initial super matrix.

w	a1	a2	a3	a4	b1	b2	b3	c1	c2	c3	c4	d1	d2	d3	e1	e2	e3
a1	0/226	0/264	0/264	0/264	0/252	0/256	0/252	0/255	0/254	0/248	0/244	0/247	0/251	0/254	0/254	0/247	0/270
a2	0/247	0/208	0/240	0/241	0/237	0/230	0/228	0/236	0/229	0/240	0/234	0/230	0/231	0/234	0/234	0/221	0/233
a3	0/241	0/240	0/210	0/242	0/234	0/231	0/228	0/223	0/231	0/236	0/240	0/220	0/243	0/221	0/228	0/240	0/227
a4	0/285	0/287	0/285	0/253	0/277	0/283	0/292	0/286	0/286	0/276	0/282	0/303	0/275	0/292	0/284	0/291	0/270
b1	0/320	0/337	0/335	0/324	0/310	0/372	0/370	0/356	0/351	0/374	0/323	0/363	0/350	0/330	0/336	0/338	0/350
b2	0/353	0/339	0/345	0/358	0/360	0/310	0/354	0/329	0/324	0/314	0/354	0/320	0/355	0/321	0/341	0/353	0/332
b3	0/327	0/324	0/320	0/318	0/330	0/318	0/276	0/316	0/324	0/312	0/323	0/317	0/294	0/349	0/323	0/309	0/318
c1	0/235	0/243	0/242	0/239	0/257	0/245	0/250	0/208	0/268	0/280	0/259	0/249	0/253	0/252	0/260	0/244	0/245
c2	0/260	0/261	0/256	0/258	0/242	0/249	0/267	0/271	0/224	0/255	0/257	0/249	0/245	0/258	0/265	0/256	0/265
c3	0/253	0/276	0/262	0/263	0/273	0/259	0/271	0/288	0/268	0/234	0/288	0/282	0/269	0/271	0/254	0/282	0/253
c4	0/252	0/221	0/240	0/241	0/228	0/247	0/213	0/233	0/241	0/231	0/196	0/220	0/233	0/219	0/221	0/219	0/237
d1	0/325	0/330	0/332	0/324	0/334	0/331	0/331	0/335	0/326	0/357	0/345	0/297	0/336	0/365	0/319	0/329	0/301
d2	0/318	0/313	0/308	0/318	0/305	0/299	0/298	0/309	0/309	0/298	0/299	0/330	0/276	0/317	0/306	0/319	0/368
d3	0/357	0/356	0/360	0/358	0/361	0/369	0/371	0/356	0/365	0/345	0/355	0/373	0/388	0/318	0/375	0/352	0/331
e1	0/366	0/336	0/346	0/341	0/344	0/358	0/347	0/345	0/349	0/347	0/326	0/364	0/362	0/366	0/317	0/353	0/373
e2	0/355	0/369	0/370	0/347	0/356	0/348	0/356	0/362	0/362	0/359	0/386	0/347	0/349	0/344	0/352	0/324	0/364
e3	0/280	0/295	0/284	0/312	0/299	0/294	0/297	0/292	0/289	0/294	0/288	0/289	0/289	0/290	0/331	0/323	0/263

Table 7. Weighted super matrix.

w	a1	a2	a3	a4	b1	b2	b3	c1	c2	c3	c4	d1	d2	d3	e1	e2	e3
a1	0/045	0/052	0/052	0/052	0/051	0/052	0/051	0/053	0/052	0/051	0/050	0/052	0/053	0/053	0/054	0/053	0/057
a2	0/049	0/041	0/047	0/047	0/048	0/047	0/046	0/049	0/047	0/050	0/048	0/048	0/049	0/049	0/050	0/047	0/050
a3	0/048	0/047	0/041	0/048	0/048	0/047	0/046	0/046	0/048	0/049	0/050	0/046	0/051	0/046	0/048	0/051	0/048
a4	0/056	0/057	0/056	0/050	0/056	0/057	0/059	0/059	0/059	0/057	0/058	0/064	0/058	0/061	0/060	0/062	0/057
b1	0/063	0/066	0/066	0/064	0/060	0/072	0/071	0/068	0/067	0/071	0/062	0/068	0/066	0/062	0/062	0/063	0/065
b2	0/069	0/067	0/068	0/070	0/069	0/060	0/068	0/063	0/062	0/060	0/067	0/060	0/067	0/060	0/063	0/065	0/062
b3	0/064	0/064	0/063	0/062	0/064	0/061	0/053	0/060	0/062	0/059	0/062	0/060	0/055	0/066	0/060	0/057	0/059
c1	0/048	0/050	0/050	0/049	0/052	0/050	0/051	0/042	0/054	0/057	0/053	0/051	0/051	0/051	0/053	0/050	0/050
c2	0/053	0/053	0/052	0/053	0/049	0/051	0/054	0/055	0/046	0/052	0/052	0/051	0/050	0/052	0/054	0/052	0/054

Table 7. (*Continued*).

w	a1	a2	a3	a4	b1	b2	b3	c1	c2	c3	c4	d1	d2	d3	e1	e2	e3
c3	0/052	0/056	0/054	0/054	0/056	0/053	0/055	0/059	0/055	0/048	0/059	0/057	0/055	0/055	0/052	0/058	0/052
c4	0/052	0/045	0/049	0/049	0/047	0/050	0/043	0/048	0/049	0/047	0/040	0/045	0/047	0/044	0/045	0/045	0/048
d1	0/065	0/066	0/066	0/064	0/066	0/065	0/065	0/065	0/064	0/070	0/068	0/059	0/067	0/073	0/064	0/066	0/060
d2	0/063	0/062	0/061	0/063	0/060	0/059	0/059	0/060	0/060	0/058	0/059	0/066	0/055	0/063	0/061	0/064	0/074
d3	0/071	0/071	0/071	0/071	0/071	0/073	0/073	0/070	0/071	0/068	0/070	0/074	0/077	0/064	0/075	0/071	0/066
e1	0/074	0/068	0/070	0/069	0/070	0/073	0/071	0/070	0/071	0/071	0/066	0/072	0/072	0/073	0/062	0/069	0/073
e2	0/072	0/075	0/075	0/070	0/073	0/071	0/073	0/074	0/074	0/073	0/078	0/069	0/069	0/069	0/069	0/064	0/072
e3	0/057	0/060	0/058	0/063	0/061	0/060	0/060	0/059	0/059	0/060	0/058	0/058	0/058	0/058	0/065	0/064	0/052

According to the final results of **Table 8**, the final weights were identified using all the following criteria (risks). The results showed the superiority of technology change, natural disasters, air pollution, sanctions, contraction and expansion policies, and qualitative control processes.

Table 8. Final weight of sub-criteria.

w	a1	a2	a3	a4	b1	b2	b3	c1	c2	c3	c4	d1	d2	d3	e1	e2	e3
a1	0/052	0/052	0/052	0/052	0/052	0/052	0/052	0/052	0/052	0/052	0/052	0/052	0/052	0/052	0/052	0/052	0/052
a2	0/048	0/048	0/048	0/048	0/048	0/048	0/048	0/048	0/048	0/048	0/048	0/048	0/048	0/048	0/048	0/048	0/048
a3	0/048	0/048	0/048	0/048	0/048	0/048	0/048	0/048	0/048	0/048	0/048	0/048	0/048	0/048	0/048	0/048	0/048
a4	0/058	0/058	0/058	0/058	0/058	0/058	0/058	0/058	0/058	0/058	0/058	0/058	0/058	0/058	0/058	0/058	0/058
b1	0/066	0/066	0/066	0/066	0/066	0/066	0/066	0/066	0/066	0/066	0/066	0/066	0/066	0/066	0/066	0/066	0/066
b2	0/065	0/065	0/065	0/065	0/065	0/065	0/065	0/065	0/065	0/065	0/065	0/065	0/065	0/065	0/065	0/065	0/065
b3	0/061	0/061	0/061	0/061	0/061	0/061	0/061	0/061	0/061	0/061	0/061	0/061	0/061	0/061	0/061	0/061	0/061
c1	0/051	0/051	0/051	0/051	0/051	0/051	0/051	0/051	0/051	0/051	0/051	0/051	0/051	0/051	0/051	0/051	0/051
c2	0/052	0/052	0/052	0/052	0/052	0/052	0/052	0/052	0/052	0/052	0/052	0/052	0/052	0/052	0/052	0/052	0/052
c3	0/054	0/054	0/054	0/054	0/054	0/054	0/054	0/054	0/054	0/054	0/054	0/054	0/054	0/054	0/054	0/054	0/054
c4	0/047	0/047	0/047	0/047	0/047	0/047	0/047	0/047	0/047	0/047	0/047	0/047	0/047	0/047	0/047	0/047	0/047
d1	0/065	0/065	0/065	0/065	0/065	0/065	0/065	0/065	0/065	0/065	0/065	0/065	0/065	0/065	0/065	0/065	0/065
d2	0/062	0/062	0/062	0/062	0/062	0/062	0/062	0/062	0/062	0/062	0/062	0/062	0/062	0/062	0/062	0/062	0/062
d3	0/071	0/071	0/071	0/071	0/071	0/071	0/071	0/071	0/071	0/071	0/071	0/071	0/071	0/071	0/071	0/071	0/071
e1	0/070	0/070	0/070	0/070	0/070	0/070	0/070	0/070	0/070	0/070	0/070	0/070	0/070	0/070	0/070	0/070	0/070
e2	0/071	0/071	0/071	0/071	0/071	0/071	0/071	0/071	0/071	0/071	0/071	0/071	0/071	0/071	0/071	0/071	0/071
e3	0/059	0/059	0/059	0/059	0/059	0/059	0/059	0/059	0/059	0/059	0/059	0/059	0/059	0/059	0/059	0/059	0/059

Based on the final results of the main criteria in **Table 9**, it was found that they were ranked 1 to 5, respectively, economic, environmental and technology, sovereignty and political, and finally planning and production.

Table 9. The final weight of the main criteria.

	Standard weight
A	0/205996
B	0/190772
C	0/157237
D	0/198203
E	0/201176

9. Conclusion

In this study, the general chain risk model indicators were designed to finalize the comments of experts. In the second round of Delphi, two risks in the chain were introduced by experts to form the conceptual model of this study with 30 variables. Finally, the 17 indicators were finalized. After this phase, the chain risk assessment stage was performed in the industry, which used multi-criteria decision-making methods. Finally, the results of this study showed that the economic dimension of this industry is the most important threat and potential factor in disrupting this chain. The following components also show that changes in technology that progress at speed are the most important risk among the sub-components. That is, if the manufacturing plants do not coordinate with these changes, they will suffer losses (to the production status, the profitability of the company, and the quality of the product). The comparison between this study and studies in the past is concluded, most of which confirm the results of this study.

Author contributions

Conceptualization, HST and MT; methodology, HST and MT; software, MT and HST; validation, HST and MT; formal analysis, HST and MT; investigation, MT and HST; resources, HST and MT; data curation, HST and MT; writing—original draft preparation, HST and MT; writing—review and editing, MT and HST; visualization, MT and HST; supervision, HST and MT; project administration, HST and MT. All authors have read and agreed to the published version of the manuscript.

Conflict of interest

The authors declare no conflict of interest.

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