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Identification and Prioritization of Resilience Supply Chain Components in the Isfahan Brick Industry using Theme Analysis and AHP-QUALIFLEX

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Abstract

In today's turbulent and uncertain environment, every company is subject to supply chain disruption. Supply chain disruption can have severe negative consequences on supply chain performance. Therefore, the purpose of this study is to identify and prioritize components of resilience supply chain in Isfahan brick industry. The present study was applied and mixed. Purposeful sampling method was used to identify 10 experts familiar with the study. In the qualitative section, thematic analysis was used for coding and identifying factors. Prioritization of factors in a small portion of the AHP was performed using suppression software. The results showed that the effective factors included 6 general themes of agility, safety and environmental issues, flexibility, crisis preparedness, risk management culture and process and operational issues. That agility component comes first and safety and environmental and social issues come first. Then three car brick manufacturing companies were evaluated with the proposed model and ranked by QUALIFLEX technique. Using research results, managers can measure, compare and improve the level of resilience of their supply chains.

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Introduction

Supply chain management is used to increase organizational effectiveness, increase competitiveness, better customer care and increase profitability. Therefore managing the supply chain relationships with suppliers is an important issue, as it affects the companies and overall supply chain (SC) performance (Ruiz-Benítez et al., 2018). The supply chain is a continuous network that converts raw materials into finished products, so the nature of this chain must be to create a smooth flow of raw materials from the raw materials to the final product (Mensah et al., 2014). In recent years, numerous interruptions and unexpected events of nature (earthquakes, tsunamis, floods, etc.) or human action (cyberattacks, terrorism, incidents ...) regular flows of products, components and materials in Disrupts supply chain length (Tukamuhabwa et al., 2015). Any business activity has an inherent risk of unexpected disruptions that can lead to financial losses and in some cases a company holiday (Scholten et al., 2014).

For this reason, supply chain risk management has been one of the most discussed topics in the literature in the production / operations area (Azar et al., 1998).

In today's turbulent and uncertain environment, every company is subject to disruption to its supply chain. A supply chain disruption is an event that has hampered the normal flow of goods, information and finance in the supply chain. This can have serious and negative consequences for the operation of its financial, operating and market areas. Therefore, understanding exactly how companies can manage their supply chain disruptions has become an important issue among academics and professionals (Jahani et al., 1986). Stakeholders are increasingly encouraged to improve supply chain risk management in order to effectively and successfully tackle the risks of disruption by unexpected events (Mohammed et al., 2019). Creating supply chain resilience can reduce and overcome the risk vulnerability by developing strategies that enable the supply chain to return to its original (or improved) state of function after a disruption (Scott et al., 2014). Supply chains that improve rapidly after disruption are commonly known as resilience chains (Margolis et al., 2018). Serhiy (2009) describe supply chain adaptation to prepare for unexpected events, disaster response and disruption recovery as supply chain resilience. Chowdhury & Quaddus (2017) defined the concept of supply chain resilience as the characteristics of a supply chain network with preventive and reactive capabilities that can reduce disruptive and disruptive events.

Past studies have examined the different phases of the resilience chain. Serhiy (2009) identified three phases of supply chain including awareness, accountability and recovery. Scholten (2014) added the modulation phase to the previous three phases. In addition, Adobor & McMullen (2018) identified four phases of supply chain preparedness, responsiveness, recovery, growth and refinement. But little research has been done on providing a resilient supply chain model in the brick industry and ranking companies using the native model. This study also tries to develop a new theoretical framework for supply chain resiliency in Isfahan. Companies face challenges such as high demand changes, increased competitiveness, reduced product life cycles, and increased customer demand, which increases the complexity of supply chains, making them more volatile and unpredictable.

One of the most important export and export industries in the country is the brick

industry, which fails to design resilient chains in this industry in the event of economic, political and social crises causing irreparable damage to the country's economy. Therefore, this research seeks to answer the following questions: What are the factors affecting the resilient supply chain of Zarnama Brick Company in Isfahan? and what is the resilient chain pattern? This study first identifies the factors affecting the resilience supply chain by examining the previous literature. The next step will be explained by interviewing the experts of resilience supply chain components in the brick industry based on the theme analysis theory. In the next step, component AHP technique is ranked and prioritized and QUALIFLEX technique is ranked by the three main machine brick companies in Isfahan.

Review of literature

Achieving sustainability and resilience in supply chains is an issue that has been of interest to supply chain professionals for the last decade. Resilience is a technology capability that enables the supply chain to manage and mitigate disruptions (Rajesh, 2019). Supply chain resiliency planning seeks to minimize the effects of overall disruption by achieving equilibrium robustness, redundancy, and recovery capabilities (Goldback et al., 2020). Supply Chain Resilience can be described as the ability of the supply chain to return to its original state or move to a new or even more desirable state after being exposed to disruption. In other words, the ability of supply chains to prepare for unforeseen events, respond to disruptions, and recover them by maintaining continuity of operations at the optimal level of continuity and monitoring its structure and performance is defined as supply chain resilience (Azar et al., 1998).

Sony et al. (2014) identified resilience enabler’s model as agility, collaboration, information sharing, sustainability, risk and income sharing, trust, clarity, risk management culture, adaptability and structure. McDonald et al. (2018) stated that supply chain resilience is a disadvantage, without having a significant impact on customer service. Rajesh (2018) also expressed the ability of the supply chain to return from disrupted state to resilience.

In another study, Wang et al. (2018) stated supply chain resilience to reduce disruptions and supply chain upgrades to cope with unpredictable events. Planning for the development of alternative suppliers expressed support for innovators as a resilient supply chain dimension. Also, Aggarwal, S., & Srivastava (2019) stated that senior management commitment and flexibility system design are the most important components of resilience in the supply chain. Table 1 summarizes previous research on supply chain resilience.

Table 1. Summary of previous research

Author (year)	Article description
Aggarwal, S., & Srivastava (2019)	It was found that organizational factors such as commitment of senior management and system design flexibility were the most common cause in the whole system. Also, flexibility and alignment transformation are the most important goal for managers.
Rajesh (2019)	Operation compliance, supply chain coordination, information security, agility, resource flexibility, leadership, backyard storage
Azar et al (2019)	The criteria affecting the resilience of the electricity supply chain are categorized into two broad categories, internal and external. Internal criteria include three important aspects of process, flexibility and agility, and external criteria include the dimensions of actors, economic issues and environmental issues.
Feizi et al. (1998)	Jihadist management, agility, redundancy, flexibility and risk management culture
Adobor & McMullen (2018)	Preparedness, accountability, recovery, growth and rebuilding
Wang et al. (2018)	Specialist recruitment, information security, knowledge sharing, knowledge management, standardization of materials and processes, planning to develop alternative providers, supporting innovators
McDonald et al. (2018)	Increased flexibility, increased inventory, integration demand, increased capabilities, agility, increased capacity, increased accountability
Ravanestan et al. (1396)	Supply chain agility, supplier development planning, product flexibility, supplier evaluation, collaboration with large companies, creating various sales and marketing models
Rajesh and Ravi (2015)	Quality, cost, flexibility, speed, clarity, vulnerability, collaboration, risk awareness, continuity, safety and environmental issues, research & development, technology
Sony et al. (2014)	Agility, collaboration, information sharing, sustainability, risk and income sharing, trust, clarity, risk management culture, adaptability and structure

Material and methods

This research is a library and field study and according to the purpose and nature of the research, a mixed or mixed research method was used by combining qualitative and quantitative methods. Purposeful sampling method was used to identify 10 experts familiar with the study. In the qualitative section, thematic analysis was used for coding and identifying factors. To gauge the validity of the method used by the members (during the interview, the researchers monitored the accuracy of their perceptions of what the interviewees were saying. Participants were asked to endorse this impression) and peer review was used. Reliability was also assessed by using the percent agreement between the two coders (researchers), with 80% agreement indicating qualitative part reliability. In the final step, after organizing and organizing the data, they analyzed it and began the process of extracting meaning from the data through coding. To encode the interviews, the researchers first transcribed the audio files, then, using the thematic analysis method, the codes were identified openly and without restriction.

Prioritization of factors in the quantitative part of AHP was performed using supersession software. QUALIFLEX Technique was used to rank the three major car brick-making companies that were given anonymity.

The steps for implementing the QUALIFLEX method are as follows (Ali Nejad & Esfandiari, 2012).

1. Calculate the weight of criteria (indicators) by one of the weighting methods
2. Determining all possible sequences: In m ranking, there is a different (m!) option.
3. Separately select all the sequences and examine their components according to all criteria.

A) If there is a partial relation of an order to a particular index, one positive score is awarded to it.

B) If equal, zero is awarded to the target.

C) (if there is no relationship) the other way around (negative score one).

Formula 1:

$$I_{jk}(a.b) = \begin{cases} 1 & \text{Coordination} \\ 0 & \text{Equality} \\ -1 & \text{Inconsistency} \end{cases}$$

Formula 2:

$$I_{jk} = \sum_{a.b \epsilon A} I_{jk}(a.b)$$

4. Calculate the sum of the points of coordination, equality and inconsistency of each of the permutations.

And the highest value of I represents the best rating.

5. Calculate the final score of each order by the following formula:

Formula 3:

$$I_k = \sum W_j * I_{jk}(a.b)$$

Results

Step One: Analyze the data using the theme analysis approach

In this research, through interviewing 10 experts who had sufficient knowledge and experience in the field, as well as reviewing theoretical literature and themes analysis, the financing chain components were identified. At this stage, the codes from the interviews were regularly formatted into main themes, and all coded data related to each theme were identified and collected. By further refining and refining the themes, it was attempted to make the themes sufficiently distinct, non-repetitive, and

large to encompass the set of ideas presented in the various sections of the text. Out of the codes obtained from the interview with 10 experts interviewed, 25 concepts were categorized into eight general themes. Table 2 shows this category.

Table 2: Identifying the factors

Inclusive theme	Interpretive theme
Supply chain Disaster Readiness	Diagnosis of the disorder
	Training managers and staff preparedness
	Forecast
Agility	Speed
	Fast response
	Agility in production and operation
	Agility in customer response
	Recovery
Flexibility	Production flexibility and processes
	Customer and supplier flexibility
	Flexibility in transportation
	Flexibility on delivery time
	Self-regulatory
Risk Management Culture	Innovation
	Education
	Risk awareness
Safety and environmental and social issues	Observe safety issues
	Environmental and Social Requirements
	Doing humanitarian activities
	Natural disasters (floods, storms, earthquakes)
Process and operational issues	Equipment
	IT infrastructure
	Preventive mechanisms
	Repair and Maintenance
	Reliability

Second step: Prioritize the main criteria of the model using AHP method

The concept of the research model was used to determine the weight and importance of the criteria. The first six items identified from the previous step were included in the paired comparisons questionnaire and the experts were asked to prioritize the criteria against each other. The final paired comparison matrix was given to the software and the ranking results of the variables are presented in Figure 1.

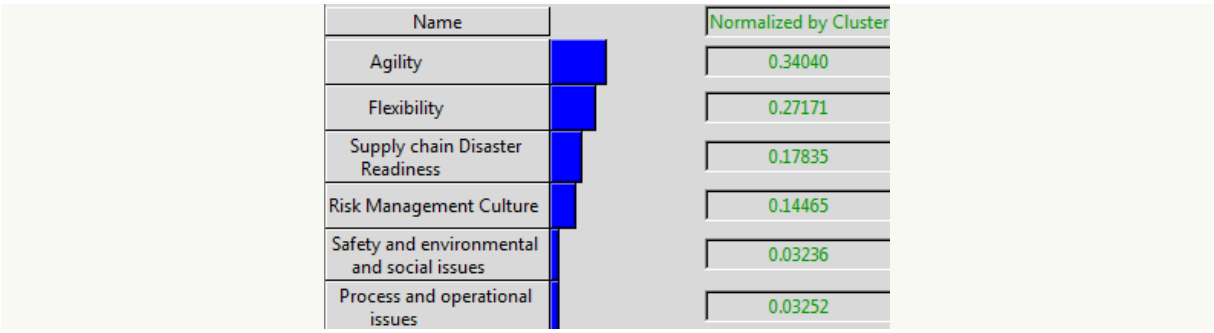

Figure 1. Criteria ranking

Based on the special vector obtained from figure (2) Agility with a weight of 0.340 is the first priority and safety and environmental and social issues with a weight of 0.0323 are the last. Other factors in the order of effectiveness include flexibility, Supply chain Disaster Readiness, risk management culture, and operational and operational issues. The consistency coefficient of the comparisons was obtained as 0.0032, which is less than 0.1, so the comparisons can be assured.

Step Three: Use QUALIFLEX Technique to Rank Companies

QUALIFLEX technique was used to rank the three major car brick manufacturing companies that were given anonymity. Based on the extraction of 6 performance indicators in the brick industry and three manufacturing companies in the industry and referring to documents, information, and interviews with 5 expert and senior industry executives, finally the decision matrix was obtained as table (3).

Table 3. Decision Matrix

Weight	0.340	0.271	0.144	0.0323	0.0325	0.178
Index / Options	Agility	Flexibility	Risk Management Culture	Safety and environmental and social issues	Process and operational issues	Supply chain Disaster Readiness
A1	high	mediocre	mediocre	high	mediocre	mediocre
A2	high	mediocre	Low	mediocre	high	mediocre
A3	Low	Low	mediocre	Low	mediocre	Low

First all possible states are listed in the ranking .Since this issue has three options, so there are six different modes of ranking:

$$Per_1: A_1 > A_2 > A_3$$
$$Per_2: A_1 > A_3 > A_2$$
$$Per_3: A_2 > A_1 > A_3$$
$$Per_4: A_2 > A_3 > A_1$$
$$Per_5: A_3 > A_1 > A_2$$
$$Per_6: A_3 > A_2 > A_1$$

For example, for the first permutation we have three states in terms of the agility index:

$A_1 > A_3$: So it gets a score of one

$A_2 > A_3$: So it gets a score of one

$A_1 = A_2$: So it gets zero points

If we calculate the same operations for six sequences, we will have:

Table4: Calculation of Six Ranking Modes

Weight	0.340	0.271	0.144	0.0323	0.0325	0.178
Per/Index	Agility	Flexibility	Risk Management Culture	Safety and environmental and social issues	Process and operational issues	Supply chain Disaster Readiness
Per_1	2	2	0	3	0	2
Per_2	0	0	1	1	1	0
Per_3	2	2	-2	1	2	1
Per_4	0	0	-2	-1	2	0
Per_5	-2	-2	2	-1	-2	-2
Per_6	-2	-2	0	-3	0	-2

The permutation value of each index is multiplied by its weight and summed as the permutation value of each option, the highest permutation value being the top option.

Table 5. Amount of permutations

permutations	**value**
Per_1	1.674
Per_2	0.503
Per_3	1.209
Per_4	-0.255
Per_5	-1.328
Per_6	-1.674

Since the value of Per_1 is higher than other permutations, the mode 1 is as follows

$$A_1 > A_2 > A_3$$

As a result, they rank first to third according to the ratings of A_1, A_2, A_3, respectively.

Conclusions

Many companies today are subject to supply chain disruptions. The results of these disruptions in the supply chain vary. Researchers have looked at different ways to reduce this vulnerability. But vulnerability cannot be completely reduced and it needs to move to new approaches to mitigate the negative effects of these risks. To maintain and improve supply chain performance after disruption, it is necessary to move towards resilience of the supply chain. Therefore, the purpose of this study was to identify and prioritize components of resilience supply chain in Isfahan brick industry. The results showed that the effective factors included 6 general themes of agility, safety and environmental issues, flexibility, crisis preparedness, risk management culture and process and operational issues.

Whereas agility with a weight of 0.340 is a top priority and safety and environmental and social issues with a weight of 0.0323 are top priority. Then the car brick manufacturing companies were evaluated with the proposed model and ranked by QUALIFLEX technique. A_1, A_2, A_3 ranked first to third, respectively. Two experts in the brick industry as well as two academic experts were made available to examine the validity of the proposed theory, which was understandable to all four. Also, in terms of matching the model in the brick industry with existing research, it can be claimed that this model is not fully compatible with any existing model, but in terms of partial compatibility some criteria in the model can be compared with some other research criteria. The research findings are in line with the research by Rajesh (2019), Sony et al. (2014), Ravanestan et al. (2017) on the role of agility as one of the most important factors in implementing sustainable supply chain in companies. In addition, the results of the studies of Rajesh (2019), McDonald et al. (2018) and Azar et al. (2019) on the effect of flexibility are in line with the results of this study.

Also the results of Sony et al. (2014), Adobor & McMullen (2018) and Feizi et al. (2019) researches showed that crisis preparedness and risk management culture are among the factors of resilience supply chain management that are consistent with the results of this research.

Sony et al. (2014) and Rajesh & Ravi (2015) also showed in their research that safety and environmental issues are factors influencing supply chain resilience and are consistent with the results of this study.

In addition, the results of Azar et al.'s (2019) and Rajesh's (2019) studies on process and operational issues are one of the factors influencing supply chain resilience and are consistent with the results of this study. By identifying six key success factors, this research puts the concept of resilience ahead of the output of supply chain practices and concepts. Through accurate quantitative modeling and analysis of these factors, this research provides a guide for managers to create shared flexibility in supply chains. In the present study, resilience supply chain model in brick industry is presented. It is suggested to identify resilience with the approach of

resistive economy components in the brick industry. In the end, it is suggested that in future research for the ranking of companies, techniques such as ORESTE, etc. will be used. Compare the results of these methods with the QUALIFLEX technique and choose the best way to rank the options.

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