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Evaluation of a Gap Analysis of SAAL Supply Chain Management Strategy in the Construction Industry of Iran

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Abstract

SAAL supply chain management is a comprehensive approach of combining sustainable, Antifragile, agile, and lean strategies. The aim of the current research is to evaluate the SAAL supply chain management strategies using the gap analysis approach in the construction industry. The statistical sample includes 246 of the industry's activists who were randomly selected. First, it is calculated the gap between the existing and ideal situation of each of the indicators and requirements of SAAL supply chain management strategies. Then, the weight of indicators and requirements is determined using the HF-BWM, and based on that, the weighted gap of each is calculated and analyzed. The results of the research show that based on the GWA obtained, Antifragile and Sustainable strategies are the most critical SAAL supply chain management strategies for evaluating the supply chain management performance of Iran's construction industry.

Keywords: Lean, Agile, Antifragile, Sustainable, Supply Chain, Construction

Introduction

Today, one of the most important and vital factors in the construction industry is its supply chain. So, the main competition is more in their supply chains than between organizations and performing activities in different sections on the site (Mojumder & Singh, 2021). As a result, in order to improve competitiveness, the importance of the concept of supply chain management and its performance is one of the paradigms of the last century (Mastos et al., 2020). For this reason, organizations pay more attention to it. This led to the introduction of concepts such as Lean, agile, resilient, green, and sustainable supply chain management as unique strategies for construction supply chain management to aid in improving chain performance (Sadeghi et al., 2022).

On the one hand, the existence of many crises in Iran and the chaotic conditions of the construction industry, on the other hand, have created anarchy/chaotic situation in this industry. In addition, it is difficult to achieve the goals of these new construction supply chain management approaches, and implementing its practices and requirements and troublesome due to many contradictions (Sadeghi et al., 2022). Of course, these approaches have not been fully implemented in Iran's construction industry. However, since these approaches do not have high power to improve the conditions of Iran's construction industry, it needs a new vision for the construction supply chain according to the prevailing conditions in Iran. Therefore, since today's supply chains need new tools to overcome different environmental challenges to survive in dynamic and changing markets, managers should look for strategies that, according to the conditions, can use all the necessary methods and activities to improve the performance and increase the competitiveness of the supply chain. For this reason, evaluating supply chain management strategies is essential (Soheil Sadeghi et al., 2022).

Iran's current situation is very critical, especially after COVID-19. Economic and political crises have also worsened the situation. Almost most of Iran's construction industry activists are non-specialists. In this situation, one approach of managers is to use agile, flexible, and resilient strategies.

However, strategies such as flexible and resilient have a negative view of the situation, so they only try to adapt to the situation so that the situation returns to the previous state (Tembo & NicholasTaleb, 2012; Zarghami & Dumrak, 2021). Since these conditions in Iran will not only not improve but will intensify, it is necessary to change the way of looking at the situation. In other words, the existing conditions should not only be accepted but also welcomed. So, we have to try to take advantage of the existing conditions with a new look. This causes new strategies to be created or existing strategies to be looked at from a new perspective. This issue led Sadeghi et al. (2021) to present the Sustainable Antifragile Agile Lean (SAAL) supply chain strategy.

For this reason, the main issue in the current research is to investigate the gap between the existing and the ideal situation to evaluate the requirements of SAAL supply chain management strategies in the construction industry. Therefore, first, the requirements related to each of the Lean, Agile, Antifragile, and Sustainable strategies are identified. After that, by evaluating and analyzing both existing and ideal situations, the existing gaps should be calculated. In the final stage, based on the relevant weights, the degree of criticality of the GWAs is obtained, and the necessary analyzes are performed.

Since the SAAL strategy is a new strategy, it was determined by studying and reviewing valid domestic and foreign research that the SAAL supply chain management approach has not been used much. Therefore, the leading challenges for its evaluation have not been measured in the supply chain. In the current research, using the gap analysis approach, this topic in the construction industry will be explained and investigated as one of the mother industries in the development of Iran's economy.

In addition, most researchers have studied only two or three approaches simultaneously. Until now, no research, both domestic and foreign, have used the gap analysis approach to evaluate SAAL supply chain management strategies. For this reason, this issue has been addressed in this research. According to what was said, now the main question of this research is what is the biggest gap between the current and ideal situation in the SAAL supply chain management approaches in the construction industry? Which requirements of these approaches should be analyzed more deeply?

Research Literature

Supply Chain Management

Liver and Weber (1982) introduced the term supply chain management for the first time in the famous sense. Houlihan also used it in a series of articles to describe the management of the flow of raw materials across organizational boundaries. This term has been widely used since the 1990s. Researchers define supply chain management as a set of methods to effectively and efficiently integrate suppliers, manufacturers, warehouses, and vendors so that the goods are produced and distributed in the right volume, place, and time so that the cost of the whole system is minimized and the service level requirements are met (Stakdtler, 2008; Taghavi et al., 2021).

Construction Supply Chain

The supply chain is the heart of any operational project. This issue is especially important in construction due to the complex conditions and the existence of multiple stakeholders with diverse demands. Because in construction projects, there is much uncertainty due to their unpredictable environment and the variety of interests (Demir, 2015). On the other hand, the construction supply chain has much more vast and abundant dimensions than other industries. This supply chain consists of phases of design, planning, sourcing, transportation, warehousing, production, executive operations, human resources, delivery, and sales. In other words, a typical supply chain for a construction project includes engineers, architects, prime contractors, material suppliers, and speciality subcontractors who come together to work on a single project. Each of these departments is divided into sub-categories, with various officials and stakeholders (Benton & McHenry, 2010; Sadeghi et al., 2022)..

Because the construction industry provides a variety of physical facilities (e.g. dams, roads, bridges, residential and commercial buildings, factories, recreational facilities, etc.), it has a large impact on society, the environment, and the economy. Therefore, in the supply chain management of construction projects, in addition to the project management approach, lean, agile, and sustainable approaches were also used in various forms (Fahimnia & Jabbarzadeh, 2016; Marchese et al., 2018; Soheil Sadeghi et al., 2022). These new management approaches can be the best way to deal with the complexity of construction projects and the balance between the three sustainability elements that play an important role in the construction industry and the environment compared to other industries in order to achieve maximum performance in the future (Ghazali, 2019; Subani et al., 2020).

With proper synergy between construction project management techniques and supply chain management, favourable conditions can be obtained to reduce delivery time, increase quality, and minimize waste, rapid response to changes in sustainable product production to achieve the goal of benefits realization of domestic and foreign stakeholders, the continuation of activities under unsustainable conditions, and economic and social development for sustainable development (Ma & Kremer, 2016). This is the logical reason to use these new approaches alongside the traditional approach (Dallasega et al., 2018).

SAAL Supply Chain

The fragmented supply chain and short-term thinking of construction companies, the short-term nature of construction projects, and the lack of long-term investment limit the use of capabilities, which is also an obstacle to innovation. On the other hand, tight competition and economic and social crises that push Iran's society towards an anarchy/chaotic environment (critical situation) make project management more complicated and difficult. Now, in the post-COVID-19 era, and with the current crisis intensifying, leaders in the construction industry must take a new look at the issues. A positive view of the crisis in order to accept and exploit it instead of confronting it (Hill et al., 2021; Sadeghi et al., 2022).

Therefore, as R. Greene (2010) said, at a time when Project/Organization are in a critical situation on the one hand and, on the other hand, is in a position of weakness and defence due to the lack of resources, more efficient methods should be used, any of the previous approaches (project management, agile, flexible, resilient, lean, and sustainable) are not responsive in such conditions (Greene, 2010; Sadeghi, 2022). It is true that each of these approaches alone has valuable features, but their capabilities are not enough to deal with the diverse conditions of the construction environment (Soheil Sadeghi et al., 2022). Therefore, in conditions such as the conditions of Iran, which has many crises, innovative approaches should be used in new dynamic ways (Greene, 2010). Because these approaches only try to resist the problems and may not even be responsive. Therefore, it is necessary to take advantage of new approaches or use existing ones in a new way that, in addition to being flexible and resilient against the conditions, take advantage of them and become stronger (Sadeghi et al., 2022; Tembo & Nicholas Taleb, 2012).

In this regard, W. Chan Kim (2005), in the book Blue Ocean Strategy introduced a new strategy as an approach to move from the red ocean to the blue ocean, with the help of innovation in value. The purpose of this strategy is to create value in a chaotic environment (Kim & Mauborgne, 2017). In another example, Nassim Nicholas Taleb (2015) talks about how to benefit from chaos in the book Antifragile. He states that shocks make the system more resistant and resilient, but when a system reaches this level of resilience, it becomes difficult to defeat (Tembo & Nicholas Taleb, 2012).

The Sustainable Antifragile Agile Lean (SAAL) strategy is a supply chain strategy, an Antifragile value-creating efficient paradigm in the construction industry to face such anarchy/chaotic conditions. SAAL supply chain strategy is based on the need for knowledge of the construction supply chain to know who, where, and when is doing what action on the project into the supply chain block. The data collected from the supply chain process is the basis for influence process management (Sadeghi et al., 2022). SAAL strategy, in line with the words of Nassim Taleb and W. Chan Kim, by exploiting agile, lean, flexible, resilient, and sustainable approaches, tries to benefit from crises in addition to responding appropriately to the conditions. In this strategy, an attempt is made to create value by obtaining accurate information and with the help of leverage of turning points and co-creation.

The principles of these supply chain management strategies are not mutually individual and should not be considered in isolation. Although sometimes their principles and characteristics seem different, none is superior to the other. However, since, in practice, managers directly choose and apply a set of strategies without considering the organization's capabilities and needs, in this case, they have to accept the risk of a mismatch between the organization's requirements and needs. Therefore, in different approaches, requirements must be selected and combined that are in accordance with the needs of the industry. Table 1 shows a set of SAAL strategy requirements in the supply chain.

Table 1: SAAL Strategy Measurement Requirements in Supply Chain Management (Sadeghi et al., 2022; Soheil Sadeghi et al., 2022)

#	Sustainable Requirements	#	Antifragile Requirements	#	Agile Requirements	#	Lean Requirements
G1	ISO certificates of suppliers	An1	Fulfilling material supply obligations	A1	Speed and flexibility of response/reaction	L1	Just-in-Time production
G2	Conduct company planning meetings with other stakeholders/within the team	An2	Ensuring supply conditions	A2	Use of information and communication technology and industry 4.0	L2	Use of multi-skilled specialist workforce
G3	Sourcing, purchasing, procurement, packaging, distribution, and sales	An3	Demand-based management	A3	Speed and flexibility in decision making	L3	Mass production
G4	Energy efficiency measures for lighting and heating	An4	Dynamic risk management culture	A4	Production in large and small batches	L4	Standardization of work processes
G5	Use of reusable and recycled materials and pallets	An5	Supply chain flexibility	A5	Reduce delay times	L5	Reduction of production cycle time
G6	Correct use of natural resources	An6	Continuous analysis of the operation chain	A6	Changes in the number of orders according to customer needs	L6	waste reduction
G7	Management commitment	An7	The possibility of using additional capacity without using it in critical situations	A7	Reducing product development cycle time	L7	Stability in demand
G8	Join a local recycling organization	An8	Stockpiling and strategic excess capacity	A8	Modularization	L8	Using Total Productive Maintenance systems (TPM)
G9	Total Environmental Quality Management (TQEM)	An9	Production in small sizes	A9	Reduction of production cycle time	L9	Communication with the customer/ Staff
G10	waste reduction	An10	Modular supplier system	A10	Improve relations with customers/stockholders	L10	Logistics outsourcing
G11	Reducing energy consumption	An11	The possibility of creating or changing approaches in units dynamically and flexibly	A11	Speed in delivery reliability	L11	Using Total Quality Management (TQM)
G12	Transportation route planning	An12	Creating resilient decentralized integrated infrastructures	A12	Reducing delay times	L12	Continuous improvement
G13	Use of filters and pollutant release methods	An13	Ability to make decisions in units and departments			L13	Communication with suppliers
G14	Developing a culture of cooperation, psychological empowerment of employees, and a culture of the year approaches	An14	Creating antifragile financial systems				

Research Methodology

The current research is a descriptive-survey type of research. Also, considering the use of the results of this research in the construction industry, it is practical. The time period was of a cross-sectional type from 2021 to 2023. The research data collection tool includes two types of questionnaires.

The first type of questionnaire is based on the five-point Likert scale to determine the current and ideal situation of the construction industry to evaluate the SAAL supply chain management indicators. The second type of questionnaire is to determine the importance and weight of the primary and secondary indicators of the research, and the Hierarchical Fuzzy Best-Worst Method is used.

Selection of Statistical Population

The statistical community of this research is the companies active in the construction industry of Iran. Due to the limited access to them, random sampling is used. The sample unit of the research includes the employees of the construction industry.

The first questionnaire was distributed among 453 employees of the construction industry by face-to-face and email methods. Finally, 246 questionnaires were completed and returned. Since multi-criteria decision-making techniques use the judgment of experts and experts knowledgeable about the research topic, the statistical community is limited. The statistical population of this part of the research includes people who have at least four years of experience in the construction industry. Therefore, the second questionnaire was completed by 46 construction industry supply chain experts.

Best-Worst Method

According to the criteria and sub-criteria of sustainable supply chain performance (Table 3), a questionnaire is designed by the Best-Worst Method and evaluated by experts. The best-worst method is one of the new multi-criteria decision-making methods introduced by Rezaei (2015). However, human qualitative judgments usually have ambiguous features and do not have standard information in the real world. Therefore, Zhao et al. (2017) created the fuzzy best-worst method. In their research, they said that the using of fuzzy numbers eliminates ambiguities in the respondent's speech. The best-worst method was developed for fuzzy and hierarchical conditions by Sadeghi et al. (2021). The number of questions in the best-worst method is much less than in other methods like AHP, ANP, and SWARA, the calculations are faster and hybrid, and the results are more reliable in the Hierarchical Fuzzy Best-Worst Method (HF-BWM) (Sadeghi et al., 2021). The method of analysis of all three questionnaires to determine the weight of the criteria is HF-BWM. The steps of this method are as follows (Sadeghi et al., 2021):

Step 1: Determining the best and worst criteria: This step could be determined using expert opinions.

Step 2: Comparison of the best criterion with other criteria and other criteria with the worst criterion: Experts used Table 2 to give points.

Table 2: The Consistency Index and Verbal Spectrum of the Fuzzy Best-Worst Method (Guo & Zhao, 2017)

Absolutely Important	Very Important	Fairly Important	Weakly Important	Equally Importance	Linguistic Terms
$\left(\frac{7}{2},4,\frac{9}{2}\right)$	$\left(\frac{5}{2},3,\frac{7}{2}\right)$	$\left(\frac{3}{2},2,\frac{5}{2}\right)$	$\left(\frac{2}{3},1,\frac{3}{2}\right)$	(1, 1, 1)	$\tilde{a}_{BW}$
8.04	6.69	5.29	3.80	3.00	*CR*

Step 3: Creating a model of HF-BWM: In this step, the weight of the factors can be calculated using the nonlinear programming model (Equation 1).

$$\min e^L + \sum_j e_j^L.$$

s.t.

$$\left|\tilde{W}_B - \tilde{a}_{Bj}.\tilde{W}_j\right| \leq e^L, \forall_j$$
$$\left|\tilde{W}_j - \tilde{a}_{jW}.\tilde{W}_W\right| \leq e^L, \forall_j$$
$$\left|\tilde{W}_B{}^j - \tilde{a}_{Bk}{}^j.\tilde{W}_k{}^j\right| \leq e^L{}_j, \forall_j \wedge \forall_k$$
$$\left|\tilde{W}_k{}^j - \tilde{a}_{kW}{}^j.\tilde{W}_W{}^j\right| \leq e^L{}_j, \forall_j \wedge \forall_k$$
$$G\tilde{W}_k^j = \tilde{W}_j.\tilde{W}_k{}^j, \forall_k$$
$$\sum_j R(\tilde{W}_j) = 1, 0 \leq l_j^W \leq m_j^W \leq u_j^W, \forall_j$$
$$\sum_j R(W|k|j) = 1, 0 \leq l_k^{Wj} \leq m_k^{Wj} \leq u_k^{Wj}, \forall_j \wedge \forall_k \tag{1}$$

Step 4: Solving the model by one of the optimization software: By solving this model, the weights of the criteria of each expert are obtained. After solving and calculating the weight of Criteria, weights obtained from each expert are combined with the geometric mean method.

Step 5: Determining the consistency index (CI) by dividing the obtained result by CR to get the compatibility index value (Table 2).

The Results of Analysis the First Phase

The Reliability of the Questionnaire

Construction industry experts have approved the questionnaires. Cronbach's alpha coefficient was used to measure the reliability of the items related to each of the SAAL supply chain management strategies in the first questionnaire. In order to measure the reliability of the second questionnaire in order to determine the priority of SAAL supply chain strategy indicators, The consistency Index has been used. The results of Cronbach's alpha coefficient are shown in Table 3, and the results of the consistency index are shown in Table 4.

Table 3: Cronbach's Alpha Coefficient

SAAL Supply Chain Management Strategies	Number of Items	Cronbach's Alpha Coefficients
Lean requirements	13	0.769
Agile requirements	12	0.712
Antifragile requirements	14	0.728
Sustainable requirements	14	0.791
Total	53	0.814

Cronbach's alpha coefficient of the measured items in each of the SAAL supply chain management strategies is higher than 0.7. Therefore, the reliability of the research questionnaire is at a good level and is confirmed. The obtained values of the consistency index are shown in Table 4.

Table 4: The Consistency Index of the Questionnaire

Sustainable		Antifragile		Agile		Lean		Mian Indicator	
CI	e_3	CI	e_3	CI	e_2	CI	e_1	CI	e
0.028	0.065	0.029	0.067	0.032	0.074	0.028	0.065	0.025	0.057

As can be seen, the questionnaire has consistency. Therefore, its reliability is confirmed.

The Results and Analysis of the First and Second Questionnaires

The current research has been conducted with the aim of analyzing the gap between the current and ideal situation of the construction industry in evaluating the main indicators of the SAAL supply chain management strategy and the relevant sub-indices. For this purpose, first, the average existing situation and then the ideal situation are calculated for each of the SAAL supply chain management requirements in the construction industry. The final results are shown in the first part of Table 5. The columns of this table are set based on the data collected from the first type of questionnaire with a five-point Likert scale. The items of this questionnaire include the requirements of the SAAL supply chain in the construction industry, and it is designed in a two-dimensional way in two existing and ideal situations.

Construction industry experts perform the necessary evaluations based on this questionnaire. Finally, the Gap column of the table shows the difference between the average of the two existing and ideal situations, that is, the amount of the gap.

Table 5: Assessment of the Current Situation and the Ideal Situation of SAAL Supply Chain Management Requirements

The First Questionnaire				The Second Questionnaire			Gap Weighted Average
#	Average		Gap	Normal Weight by FH-BWM	Rank in the Department	Total Rank	
	Present Situation	Ideal Situation					
L1	3.1151	4.2115	1.0964	0.026374	12	1	0.028916
L2	3.2939	4.2559	0.9620	0.022237	14	3	0.021392

The First Questionnaire				The Second Questionnaire			Gap Weighted Average
#	Average		Gap	Normal Weight by FH-BWM	Rank in the Department	Total Rank	
	Present Situation	Ideal Situation					
L3	3.6914	4.6196	0.9282	0.018088	18	5	0.01679
L4	3.2939	4.1519	0.8580	0.011573	28	8	0.00993
L5	2.1656	4.5389	2.3733	0.006646	43	11	0.015772
L6	3.9482	4.8313	0.8831	0.01158	27	7	0.010226
L7	3.6111	4.6943	1.0832	0.024352	13	2	0.026378
L8	3.6556	4.4952	0.8396	0.009162	35	10	0.007692
L9	3.2939	4.2919	0.9980	0.009162	34	9	0.009144
L10	2.1151	3.1996	1.0818	0.005145	50	13	0.005566
L11	4.3131	4.8329	0.5198	0.019788	15	4	0.010286
L12	3.4396	4.1914	0.7218	0.013065	24	6	0.00943
L13	3.1151	4.1486	1.0317	0.006367	45	12	0.006569
A1	2.8231	3.4952	0.6721	0.010594	30	6	0.00712
A2	3.5291	4.4111	0.8820	0.008986	37	8	0.007926
A3	3.9196	4.9499	1.0303	0.006367	44	10	0.00656
A4	2.1161	3.3598	1.2437	0.002995	51	11	0.003725
A5	3.9886	4.1614	0.1728	0.008987	36	7	0.001553
A6	3.3141	4.1614	-0.1527	0.008986	38	9	-0.00137
A7	3.4619	4.9499	1.4880	0.002995	52	12	0.004457
A8	3.1211	4.5291	1.4080	0.014329	20	4	0.020175
A9	2.1362	4.5389	2.4027	0.056236	4	1	0.135119
A10	3.2312	4.2919	1.0607	0.038363	8	2	0.040692
A11	4.6342	4.1115	-0.5227	0.01392	22	5	-0.00728
A12	3.4628	4.9579	1.4951	0.014485	19	3	0.021656
An1	3.2856	4.2115	0.9259	0.008591	40	13	0.007954
An2	3.4619	4.4111	0.9492	0.014315	21	8	0.013588
An3	3.4418	4.4111	0.9693	0.007061	42	14	0.006844
An4	2.8928	4.4958	1.6030	0.010518	32	11	0.016861
An5	3.6196	4.5599	0.9403	0.010519	31	10	0.009891
An6	3.9886	4.9886	1.0000	0.008592	39	12	0.008592
An7	3.5599	4.5982	1.0383	0.018402	17	7	0.019107
An8	3.1211	4.6145	1.4934	0.070555	2	2	0.105367
An9	2.1161	3.3599	1.2438	0.030766	9	6	0.038267
An10	3.2115	4.2559	1.0444	0.052404	6	5	0.054731
An11	3.9886	4.1614	0.1728	0.074874	1	1	0.012938
An12	3.3448	4.4958	1.1510	0.010599	29	9	0.012199
An13	2.651	3.5699	0.9189	0.05362	5	4	0.049272
An14	3.1221	4.6245	1.5024	0.057971	3	3	0.087096
S1	3.9584	4.1211	0.1627	0.012598	25	6	0.00205
S2	4.4418	4.2919	-0.1499	0.043864	7	1	-0.00658
S3	3.8922	4.9285	2.0363	0.027038	11	3	0.055058
S4	2.9694	3.1963	0.2269	0.028252	10	2	0.00641
S5	2.1969	4.6145	2.4176	0.005795	47	11	0.014009
S6	3.9285	4.2913	0.3628	0.013414	23	5	0.004867

#	The First Questionnaire				The Second Questionnaire			Gap Weighted Average
	Average		Gap		Normal Weight by FH-BWM	Rank in the Department	Total Rank	
	Present Situation	Ideal Situation						
S7	3.4151	4.1812	0.7661		0.009617	33	8	0.007368
S8	2.1161	4.5988	2.4827		0.00584	46	10	0.0145
S9	2.8231	4.5291	1.7060		0.005766	49	13	0.009837
S10	3.6196	4.8329	1.2133		0.00825	41	9	0.010009
S11	2.9225	4.1669	1.2444		0.018968	16	4	0.023604
S12	2.8831	4.4359	1.5528		0.002821	53	14	0.004381
S13	3.1161	4.4952	1.3791		0.012424	26	7	0.017134
S14	3.3214	4.4932	1.1718		0.005782	48	12	0.006775

In Table 5, based on the average opinions of each expert, the gap between the current and ideal conditions has been calculated for each SAAL supply chain management indicator. Since the importance of each SAAL supply chain management strategy is not the same, using the HF-BWM method, these indicators were prioritized, and each weight was calculated. These prepared numbers are also given in the second part of Table 5 in the "Normal weight with FH-BWM" column.

In the section ranking column, the rank of each of the sub-indices in its respective section, and in the overall ranking column, the ranking of each sub-indicator in relation to all sub-indices is given. Then, by multiplying the weight of the sub-indices by their average gap, the weighted average of the gap of each of the sub-indices is calculated according to the "Gap Weighted Average[1]" column in Table 5. In the next step, the average analysis of each part of the first questionnaire (LEAN, Agile, Antifragile, Sustainable) is calculated. Table 6 is calculated based on the total average, the gap between the current situation, and the ideal SAAL supply chain management strategies.

In addition, the second part of the column, "Normal weight by FH-BWM", is given the result of prioritizing SAAL supply chain strategies based on the average values of these strategies according to HF-BWM.

[1]GWA

Table 6: The Gap between the Current State and the Ideal State of SAAL Strategies

	The First Questionnaire				The Second Questionnaire		
	Total Average Present Situation	Total Average Ideal Situation	Gap		Normal Weight by FH-BWM	Rank	Gap Weighted Average
LEAN	3.311662	4.340654	1.028992		0.075472	4	0.077660
Agile	3.311501	4.243167	0.931667		0.244230	3	0.227541
Antifragile	3.271814	4.339864	1.068050		0.433962	1	0.463493
Sustainable	3.186014	4.369771	1.183757		0.246336	2	0.291602

As can be seen, according to the opinions and judgments of experts and specialists in the supply chain of the construction industry, the Antifragile strategy ranks first and is the most important strategy. Sustainable, agile, and Lean strategies are in the next ranks respectively. Then, by multiplying the weight of the indicators by their average gap, the weighted average gap of each strategy is calculated according to Table 6.

Since a more detailed analysis of the SAAL strategy plays an essential role in the assessment of supply chain management in Iran's construction industry, the requirements related to these strategies should also be examined. For this purpose, first of all, the degree of criticality of GWAs from the first (Q1), second (Q2), and third (Q3) quadrants of each strategy should be determined.

According to experts, the degree of criticality of GWAs is defined as a quartile spectrum from a low level (values less than the first quartile) to a very high level (values greater than the third quartile) according to Table 7.

Table 7: Critical Degree of GWA

A Degree of Criticality	Low	Medium	High	Very High
GWA rate	Min-Q1	Q1-Q2	O2-Q3	Q3-Max

Now, according to the importance and criticality of the strategy gap, the requirements related to them are analyzed. Considering the importance and weight of competitive strategies of the SAAL supply chain, the above calculations (Table 6) show that the highest GWA is related to Antifragility and sustainable indicators and the lowest GWA is related to Agile and Lean indicators.

This issue shows the importance of Antifragility and Sustainability strategies in the supply chain of the construction industry. Therefore, managers should give more importance to this issue in their supply chain management processes. Fig. 1 shows the existing gaps graphically.

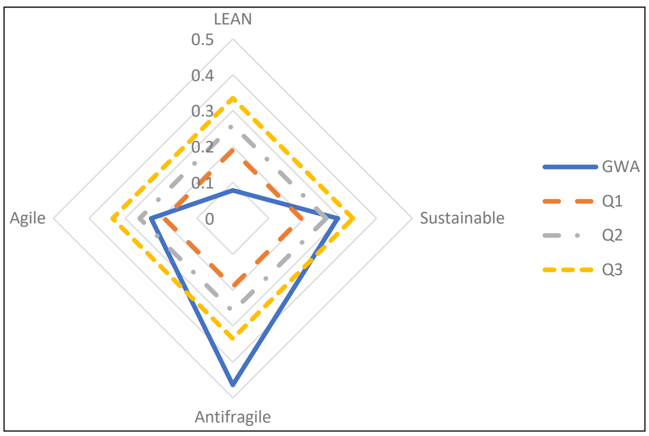

Fig. 1: GWA of SAAL Supply Chain Management Strategies

According to the opinion of experts (Table 5) among the Antifragile requirements, the "Possibility of creating or changing approaches in units dynamically and flexibly" in the supply chain to reduce chain risk and proportional accountability, with a final weight of 0.074874, "Inventory storage and strategic capacity surplus" with a weight of 0.070555 and "Creation of antifragile financial systems" with 0.057971 weight are in first to third priority.

In the Sustainable strategy, "Conducting company planning meetings with other stakeholders/within the team", with a final weight of 0.043864, has the highest importance compared to other requirements related to the sustainable supply chain management strategy indicators. In the Agile strategy, "Decreasing production and commissioning cycle time" with a final weight of 0.056236 has the most important compared to other requirements related to the agile supply chain management strategy indicators. In the Lean strategy, "Just-in-time production", with a final weight of 0.026374, has the highest importance compared to other requirements related to the Lean supply chain management strategy indicators.

In the continuation of the research process, after multiplying the determined weights in the gaps related to the requirements of each of the strategies, balanced gaps were calculated (Table 5). In this way, the distance of each of the requirements will be measured in relation to the first, second, and third quartiles. The results of the checked calculations are shown in Figs. 2, 3, 4, and 5. Therefore, according to the set priorities, it is suggested that managers pay attention to this issue in their planning and make it part of their policy.

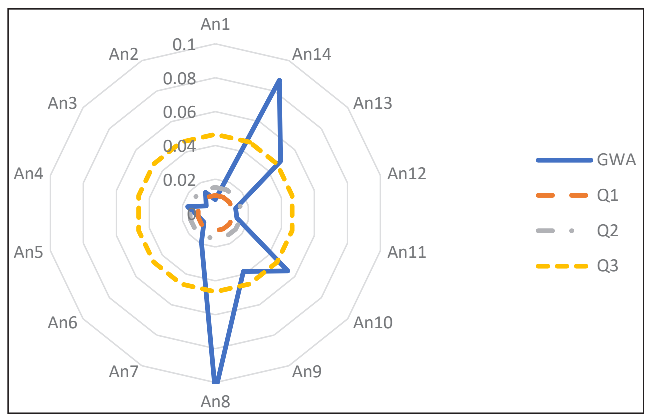

Fig. 2: GWA of Antifragile Strategy Requirements

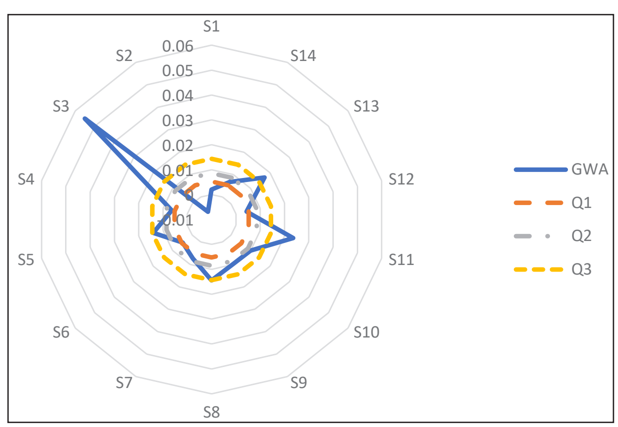

Fig. 3: GWA of Sustainable Strategy Requirements

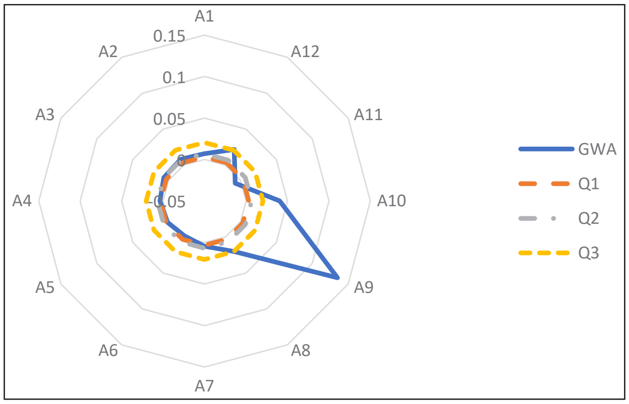

Fig. 4: GWA of Agile Strategy Requirements

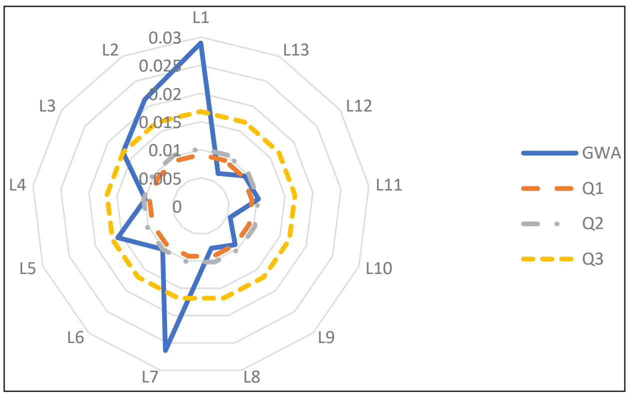

Fig. 5: GWA of Lean Strategy Requirements

As can be seen, the gap between the ideal and existing situation is "very high" or "high" in many requirements. This shows that the supply chain situation of Iran's construction industry is very acute in terms of SAAL strategy.

Managers in this industry should pay a lot of attention to these materials. The main reason for this situation can be the traditional atmosphere governing the construction industry, the inflation of engineers' degrees, few specialized and educated people in this industry, the existence of a large number of uneducated people in this industry, the economic crisis, and the lack of attention to this industry by the Ministry of Economy, Housing and Urban Development and the Parliament.

Conclusion

Considering that the evaluation of the competitive strategies of SAAL supply chain management is of different importance based on the current conditions in the construction industry, in this research, after identifying, investigating, and analyzing the gap in the existing and ideal situation, the weight of indicators and sub-indicators of SAAL supply chain management has been calculated using the FH-BWM decision-making technique and multiplied by the average gap of each. According to the final results of the research in Iran's construction industry, the most GWA for evaluating SAAL supply chain management strategies is Antifragile, Sustainable, Agile, and Lean, respectively.

Since the highest GWA is related to Antifragile and sustainable strategies, respectively, the requirements of these two strategies were investigated with a deeper analysis. The results show the GWA created between the two existing and ideal situations in the Antifragile strategy related to the requirements (sub-indicators) "Possibility of creating or changing approaches in units dynamically and flexibly" in the supply chain to reduce chain risk and proportional accountability, with a final weight of 0.074874, "Inventory storage and strategic capacity surplus" with a weight of 0.070555 and "Creation of antifragile financial systems" with The weight is 0.057971 with first to third priority respectively.

In sustainable strategy, "Conducting company planning meetings with other stakeholders/within the team", with a final weight of 0.043864, has the largest gap compared to other requirements related to the indicators of sustainable supply chain management strategy.

In the end, it is suggested that the managers and experts of Iran's construction industry evaluate the strategies appropriate to the risks facing the industry in order to overcome the prevailing critical conditions in order to formulate appropriate risk management plans. On the other hand, managers of this industry should provide conditions that facilitate customer cooperation between suppliers and industry leaders by sharing information to create a high level of intelligence in the supply chain so that considerable visibility is created at all levels of the supply chain. On the other hand, with the help of smart contracts and the implementation of the system of using modular suppliers, they can increase their antifragility when a problem occurs, and they can replace a supplier faster. In addition, by creating work groups in different departments and giving them the power to make decisions, especially under critical conditions, they should increase the speed of decision-making and take necessary actions so that there is no disruption in operations.

Considering that the construction industry is one of the polluting and high-consumption industries, managers of these industries are required to plan and implement supply chain management processes in order to reduce environmental impacts. In this way, the pollution created is maintained within the permitted standards. This requires replacing new technologies with old technologies.

With this work, the production of pollutants and energy consumption should also be reduced. Therefore, the commitment of managers in making decisions related to sustainable strategy is very important and key for the implementation and use of environmentally friendly technologies. It is suggested to the managers of Iran's construction industry to develop programs related to the optimal use of natural resources, including non-renewable energies, to improve the productivity and performance of the supply chain of this industry.

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