

Drawing Conceptual Model of SAAL's Supply Chain Strategy and its Performance Measurement System

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Abstract

In the challenging environment of the construction industry and especially after the Corona pandemic crisis in Iran, supply chains (SCs) needed to adopt a new management model to continue the activity. Among the investigated approaches, the four sustainable, anti-fragile, agile and lean (SAAL) approaches were given more attention. The main objective of this paper is to draw a conceptual model for SAAL SCs with the aim of improving their operational, economic and environmental performance. For this purpose, several performance measures have been proposed. This concept is drawn based on the literature review of four supply chain management (SCM) approaches and their performance measurement system. Among the measures proposed by SAAL, which affect SC performance, are just-in-time relationships as well as supplier relationships (modular suppliers) and creating anti-fragile infrastructure.

Keywords: Sustainable, Anti-Fragile, Agile, Lean, Supply Chain, Construction industry

Introduction

A SC includes a network of stakeholders, that are linked in order to the presentation of products (goods/services) together through effectively managing the flow of goods/services, money and information to meet business needs (Sadeghi, Akbarpour et al., 2022). The supply chain (SC) is the core of any business. Therefore, in today's

era, the SC plays an most important role in the survival and continuation of the activity and in value creation (Rahiminezhad Galankashi & Mokhatab Rafiei, 2022). As a result, a strategic factor for achieving organisational goals is SCM (Sadeghi, Sadeghi et al., 2022). In order to manage a SC, in addition, to evaluating its performance, it must be well-defined and controlled SCM process; therefore measuring performance is strategic and necessary. In other words, for this purpose, in order to better SCM it is critical to create a performance measurement system that properly reflects the actual SC performance (Barua et al., 2021). The research shows that most of the research is focused on studying single approaches in SC management (Anvari, 2021). Of course, In some cases, In recent years, due to the complexity of the conditions with the simultaneous integration of different approaches such as lean, agile, resilience and green in SCM, efforts were made to create more efficient, simpler and more stable SC to respond to conditions; which resulted in the Leagile, LARG and LARS approaches, etc. (Anvari, 2021; Barua et al., 2021).

However, on the one hand, these approaches are not designed for a complex and project-oriented environment such as the construction industry. On the other hand, these approaches were developed to work in complex and complicated spaces, and they do not have that capability and efficiency in Anarchy/Chaotic space. Because the Anarchy/Chaotic space, which is full of black swans, most of the former approaches are not suitable. Therefore, either new approaches should be used, or they should use the old ones with a new perspective (Sadeghi, Sadeghi, et al., 2022). Therefore, SAAL SCM approaches have been

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adopted to improve SC performance. As a result, the main purpose of the article is to propose a conceptual model for SAAL SC practices and be analysed with the effect of these practices on the SC performance of the construction industry. SAAL strategy was presented by Sadeghi et al. (2020) for the first time. In this research, a comparative research approach with the help of a literature review was

used to develop the conceptual model. In the following, a performance measurement system is also proposed to allow managers and decision-makers of the construction industry to evaluate and control the results obtained from the implementation of SAAL practices. The structure of the article is as Fig. 1.



Fig. 1: Structure of the Article

Approaches of Supply Chain Management

Sustainable Approach

Sustainable supply chain management (SCM) is an organisational philosophy that aims to reduce crises, risks and economic, social and environmental effects for the benefit of the environment, communities, companies and market goals while maintaining the efficiency of these three dimensions (El-Said, 2018). With the increasing pressure of environmentally conscious societies and consumers, strict environmental laws have been set and approved in many European and American countries, which force organisations to effectively address environmental issues in their management and economic plans (Sadeghi, Akbarpour et al., 2022). Organisations have also adopted these environmentally responsive practices along with considering and improving social and economic performance to meet legal requirements. Environmental accountability has also led to sustainable competitive advantage and improved long-term profitability (Anvari, 2021).

El-Said (2018) introduced a Sustainable SC as a kind of “integration of sustainable thinking in the SC, from product design, sourcing, production processes, delivery of the final product to consumers and end-of-life management” (El-Said, 2018). According to Dallasga et al. (2018), if the construction industry evolves, in addition

to recreating the industry environment, it can even undo many of the negative effects, and it creates changes around the world (Dallasga et al., 2018). Singh et al. (2023), said sustainable design is defined as the development of products that are more durable and consume less energy. It avoids the use of polluting materials or methods and can be easily separated for recycling (Singh et al., 2023). In addition, it creates local employment, local cultural and economic development.

Another Sustainable SCM method is reverse logistics, which aims to return recyclable or reusable products and materials to the future SC. Cataldo et al. (2022) It states that the influence of the factors of a sustainable SC may be different in different SC with different processes, different raw materials, product characteristics, logistics/reverse logistics activities, etc. (Cataldo et al., 2022). According to Singh, Kumar et al. Sustainable SCM can reduce the environmental impact of construction activities without compromising quality, cost, reliability, performance or energy efficiency (Singh et al., 2023). Compliance with environmental regulations is very effective not only to minimise environmental damage but also to ensure overall economic benefits (El-Said, 2018).

Some of the Sustainable SC practices found in the literature are (Sadeghi et al., 2022; Singh et al., 2023): 1) Environmental cooperation with suppliers, 2) ISO 14001 certificate, 3) Reducing waste, 4) Reverse logistics, 5) Cooperation with product designers and suppliers to reduce and eliminate the environmental effects of the product, 6) Reduction in the variety of materials used

in product production, 7) customer orientation, 8) Local employment, 9) Use and development of local cultural issues, 10) Psychological empowerment, 11) Good governance and 12) Co-creation.

Antifragile Approach

Today's market is facing higher levels of turbulence and volatility. As a result, SCs are vulnerable to disruption, thus increasing the risk of businesses not continuing. In the past, the main goal in SC design was first to minimise the cost or optimise the service, then flexibility and resilience were emphasised, but today, due to the occurrence of many crises, the emphasis is on continuity of activity or even Antifragility. Antifragility is defined as the ability of the SC to cope with unexpected disturbances (Priyadarshini et al., 2022).

The goal of Anti-fragility analysis and management of SC, unlike resilience and flexibility, is not to prevent the change of unfavourable situations or to tolerate them, but rather to exploit unfavourable situations and strengthen systems (Nikookar et al., 2021). The term resilience is derived from materials engineering. This concept refers to a material that returns to its original state after applying force to it and causing a change in shape. In resilient and flexible SC systems, the goal is to react effectively to the negative effects of disturbances (which can be more or less severe) (Priyadarshini et al., 2022). But the goal of the Antifragility approach is to reduce the impact of disruption by changing the level of effectiveness of a potential threat and strengthening oneself against such events. In other words, Anti-fragility is the ability to recover and strengthen from a disorder, which is related to the development of response capabilities through flexibility, resilience and redundancy (Nikookar et al., 2021).

Nassim Nicholas Taleb states that Anti-fragility is a state beyond resilience. Resilient system is the tendency to return the system to its original state after a disturbance, while Antifragile system tries to take advantage of the disturbance and make the system stronger (Priyadarshini et al., 2022). In this regard, Mishra (2020) suggests the use of Antifragile SC practices to enable organisations to effectively and efficiently implement related contingency plans when faced with black swans, making SC more resilient and Upgrading more flexibly and even profit.

This author suggests strategies based on the following (Mishra, 2020):

Examples of the main Antifragility practices in the context of SC established in the literature: 1) Strategic reserve, 2) Reducing the time of processes, 3) demand-based management, 4) Further strengthening the disaster risk management system, especially at the local level, 5) Antifragile infrastructure, 6) flexible financial system with fair access, 7) Social support, 8) Sustainable natural resource management, 9) the need for more dynamic risk assessment tools, 10) involving the community in cooperation, 11) development of local flexibility, 12) focus from risk management to uncertainty management and 13) Focusing on creating flexibility from risk management.

Agile Approach

The purpose of the SC is to deliver the right product, in the right quantity, in the right condition, to the right place, at the right time and at the right cost (Demir, 2013). As customer needs and market conditions are constantly changing, the SC must adapt to future changes to respond appropriately to market needs and changes (Mostafa et al., 2016). The Agile approach aims to create the ability to respond quickly and cost-effectively to unpredictable changes in markets and levels of environmental turbulence, both in terms of volume and variety (Lu et al., 2011). Ozorhon et al. (2022) believe that: "In order to respond to changing conditions, the Agile SC can be used by integrating business partners to exploit new competencies." (Ozorhon et al., 2022). Lalmi, Fernandes et al. (2022) state that the deployment of an Agile SC approach depends on the following variables: Customer satisfaction, market sensitivity, delivery speed, improving quality and service level, The use of information technology tools, data accuracy, process integration, centralised and collaborative planning, reducing process time, minimising cost, minimising uncertainty, developing trust and minimising resistance to uncertainty. Some of the main Agile practices in the field of SC are (Lalmi et al., 2022): 1) Speed in improving customer service, 2) Centralised and collaborative planning, 3) Use of information technology to coordinate/integrate activities, 4) Speed in improving response to changing market needs and 5) Ability to change order delivery time.

Lean Approach

Lean management approach was developed at Toyota Motor Company in Japan. This system is based on the 3 principles of “automatic” and “Just-in-Time” (JIT) production and “Continuous improvement”. The focus of the Lean approach is primarily on reducing waste as a means to increase real added value to meet customer needs and maintain profitability and continuous improvement. Lalmi, Fernandes et al. (2022) in order to define the concept of Lean production states that the goal of this system is to minimise waste in the downstream SC while making the right product available at the right time and place for the end customer (Lalmi et al., 2022). From the point of view of Silva (2022), the goal of the Lean SC is to eliminate waste (non-value-added steps, rework and waste of materials) along the chain to improve internal efficiency and reduce time, reduce cost, enable economic manufacture and increase overall profitability and flexibility (Silva et al., 2022). While according to Głodziński et al. (2022), A Lean SC involves the integration of all upstream and downstream activities into a coherent whole. However, since extending the Lean approach beyond the manufacturing system to distribution operations leads to potential conflict, it requires smoothing systems from design to operations and markets (Michalski et al., 2022).

The Lean approach to providing added value to the customer seeks ways to reduce demand fluctuations by simplifying, optimising and creating capabilities by using assets more effectively than traditional systems (Demir, 2013; Zhang, 2019). According to the authors, the key principles of Lean methods are: 1) respect for people (Silva et al., 2022), 2) quality management (Sadeghi & Akbarpour, 2022), 3) stretch production (Mostafa et al., 2016) and 4) proving mistakes and preventing them (Lalmi et al., 2022). At the operational level, techniques such as 1) kanban, 2) 5S, 3) visual control, 4) takt-time, 5) Poka-yoke and 6) SMED¹ and 7) LPS². Manufacturing practices such as 1) JIT, 2) TPM³, 3) TQM⁴ to eliminate various types of waste, 4) supplier relationships, 5) cycle/setup time reduction and 6) shop floor management.

¹ Single-Minute Exchange of Die

² Last Planner System

³ Total Productive Maintenance

⁴ Total Quality Management

SAAL Approach

Therefore, as R Greene (2010) said at a time when project/organisation is 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, it should be used more efficient methods, because any of the previous approaches are not responsive in such conditions. Therefore, in conditions which have many crises, either innovative methods should be used or old methods should be used in a new way (Sadeghi et al., 2022). The SAAL strategy is a SC strategy, an Anti-fragile value-creating efficient paradigm in the construction industry to face such anarchy/chaotic 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 (Sadeghi, 2023; Sadeghi & Akbarpour, 2022).

The strategy emphasises developing all employees' individual and team skills simultaneously. In this strategy, an attempt has been made to use the ideas of martial arts such as tai chi and wushu, team games such as football such as tiki taka technique and battlefields such as the strategies of Surena, Genghis Khan or Napoleon.

This has made Co-creation, CRM⁵ (Sadeghi, 2023), IDEA⁶ (Sadeghi et al., 2022), CTA⁷ (Sadeghi, 2022) and War Room five main pillars of this strategy. In this strategy, resilience and flexibility are the shells of the system. In this system, an attempt is made in an acceptable period of time and at an acceptable cost. In this system, in order to respond to the disturbance, with quotes from material engineering and living organisms, we can refer to some kind of reaction states such as rheopectic, thixotropic, anti-thixotropic, dilatant, pseudoplastic, Bingham, cell division and immune system depending on the conditions.

Sadeghi et al. (2023) state that in order to create a SAAL SC, the following principles should be considered in the design: Development of more dynamic risk assessment tools (Sadeghi, 2022), In engaging communities for community action (integration, co-creation and good governance) (Sadeghi et al., 2022), Developing local flexibility in all parts and processes of the SC (Sadeghi et al., 2022), Focusing on uncertainty management

⁵Crew Resource Management

⁶Dynamic Flexible Innovative/Disciplined Approaches

⁷Control Tower Approach

instead of risk management (development of uncertain thinking) (Sadeghi, 2023), Focus on building resilience rather than managing risk (Sadeghi, 2023), Further strengthening the disaster risk management system, especially at the local level (Sadeghi et al., 2022), Antifragile infrastructure (Sadeghi & Akbarpour, 2022), Flexible financial system with fair access (Sadeghi et al., 2022), social support (Sadeghi & Akbarpour, 2022), Sustainable natural resource management and waste reduction and reuse (Sadeghi & Akbarpour, 2022), Using technology as a tool rather than a principle, such as Extended Reality, Artificial Intelligence, Internet of Things, etc., (Rahiminezhad Galankashi & Mokhatab Rafiei, 2022; Sadeghi, Akbarpour et al., 2022), Reacting according to the type of disorder, and not depending and relying on the principles of the approaches, but only using them, such as using the IDEA technique (Sadeghi et al., 2022), Using effective approaches in times of crisis and its development, such as CRM and War Room (Sadeghi, 2022), System modularisation, such as product modularisation, suppliers, employees and even units (Sadeghi et al., 2022), Applying techniques and systems to create decentralised integration, such as blockchains (Sadeghi 2023), Developing a complete and clear view of the entire SC from upstream inventory and supply conditions using an integrated BIM system and Control Tower Approach (CTA) (Sadeghi, 2023).

Measuring Supply Chain Performance

Measuring SCM performance is critical. Many studies regarding the design and implementation of performance measurement criteria in the field of SC have been conducted and are being conducted. According to Ricardianto, Barata et al. (2022), the lack of appropriate SC criteria may lead to customer dissatisfaction, partial optimisation of the organisation's performance, missed opportunities to perform better than competitors and conflicts within the SC (Ricardianto et al., 2022). Therefore, measuring SCM performance is very important.

Performance measurement can lead to facilitating mutual understanding and integration between partners in the SC, while revealing the effects of strategies and potential opportunities in it (Dolatabad et al., 2022). For this reason, various sets of measurement methods and rules have been proposed as tools for evaluating SC performance.

Patidar, Sharma et al. (2022) prioritised SC performance criteria according to their importance to evaluate value-added activities in SC, taking into account qualitative, quantitative, financial and non-financial criteria (supply, production, logistics, marketing and sales and support activities) (Patidar et al., 2022). Romagnoli, Galli et al. (2022) to evaluate the effectiveness of operational systems, propose a performance measurement system consisting of the following criteria: Efficiency, flexibility, responsiveness and quality (Romagnoli et al., 2022). Delivery time as an SC performance measure by Patidar Sharma et al. (2022) is highlighted because, according to the authors, lead time, time to recovery and cycle time uncertainty is a type of supply uncertainty that affects ordering policies, inventory levels and product availability levels (Patidar et al., 2022). Mashayekhy, Babaei, et al. (2022) have proposed a financial and non-financial measurement system to analyse the impact of a set of factors related to the deployment of Internet of Things (IoT) technology on SC performance (Mashayekhy et al., 2022). Ghahremani-Nahr (2022) proposed a block chain-based SC performance measurement system that includes quantitative and qualitative metrics (Nozari & Ghahremani-Nahr, 2022). Quality measures are those that cannot be measured, such as customer satisfaction, flexibility, integration of information and material flow and effective risk management. Quantitative performance measures are measurable.

These metrics attempt to evaluate SC performance in terms of strategic planning, order planning, suppliers, production and delivery: (1) criteria for evaluating SC's strategic planning ability, including the level of product value perceived by the customer, variations against budget, order delivery time, information processing cost, the ratio of net profit against productivity, total cycle time, total cash flow time and energy consumption level; (2) metrics to evaluate SC order planning ability, including customer request time, product development cycle time, forecast accuracy, planning-process cycle time, order entry methods and human resource productivity; (3) supplier evaluation criteria, including supplier delivery performance, supplier delivery time versus industry standard, supplier pricing versus market, purchase order cycle time efficiency, cash flow method efficiency and supplier reservation in procedures; (4) criteria for evaluating SC production performance, including the

percentage of defects, cost per labour hour, capacity utilisation, range of products and services and economic quantity utilisation; (5) criteria for evaluating delivery performance, including quality of delivered goods, on-time delivery of goods, service flexibility, customer needs, the effectiveness of the company’s distribution planning program, the percentage of finished goods in transit and reliable delivery performance. The cash-to-cash cycle (C2C) measure is another important indicator because it connects the activities of input materials with suppliers, and it does so through production operations and outbound sales activities with customers. The C2C criterion is important from the point of view of accounting and SCM (Rahiminezhad Galankashi & Mokhtab Rafiei, 2022).

From an accounting point of view, it measures liquidity and value, which means that it measures the evaluation of the organisation to cover obligations with cash flows. From an SCM perspective, C2C connects input material activities with suppliers and does so through manufacturing operations as well as outbound sales and

logistics activities with customers (Pham et al., 2022). As previously shown, various performance measurement systems have been used and proposed to evaluate SC performance, but they are also criticised. A SC performance measurement system should not limit itself to local performance measurements.

Performance measures should be integrated in order to measure the overall performance of the SC rather than the performance of individual members (Ayyildiz & Taskin Gumus, 2021). Piña-Barcenas et al. (2022) also criticised the measurements used to assess SC performance because they do not provide information about how key business processes are performing. Or how SC has met customer needs and failed to identify opportunities to increase competitiveness, customer value and shareholder value for each organisation in SC (Cedillo-Campos et al., 2022).

Based on the literature review, Table 1 provides an overview of operational, economic and environmental measures that can be used to evaluate the impact of SAAL approaches SC performance.

Table 1: Supply Chain Performance Measures

Indicators	Measures	References
Operational-Social performance	Inventory level	(Qaravi, 2018; Sakikhales & Stravoravdis, 2017; Vinodh & Aravindraj, 2013)
	Stakeholder Orientation	(Liu et al., 2019)
	Customer Orientation	(Alimardani et al., 2014; El-said, 2018; Ma & Kremer, 2016; Zhang, 2019)
	Quality	(Demir et al., 2013; Demir, 2015; Sakikhales & Stravoravdis, 2017; Walker & Matinheikki, 2020)
	Resilience and flexibility	(Demir, 2013; Qaravi, 2018; Zhang, 2019)
	Time	(Demir et al., 2013; Demir, 2015; Mostafa et al., 2016; Qaravi, 2018; Walker & Matinheikki, 2020)
	Delivery	(Cedillo-Campos et al., 2022; Patidar et al., 2022; Sadeghi Soheil, 2023; Sadeghi Soheil 2023)
	Local influence	(Sadeghi, Akbarpour, et al., 2022)
	Decentralised integration and modularise	(Demir, 2013; Qaravi, 2018; Zhang, 2019)
Economic performance	Cost	(El-Said, 2018; Ma & Kremer, 2016; Mostafa et al., 2016; Walker & Matinheikki, 2020)
	Environmental costs	(El-Said, 2018; Lu et al., 2011; Sadeghi et al., 2020)
	Efficiency	(El-Said, 2018; Mostafa et al., 2018; Sakikhales & Stravoravdis, 2017; Walker & Matinheikki, 2020)
	Environmental revenues	(Lu et al., 2011; Mostafa et al., 2016; Zhang, 2019)
Environmental performance	Pollutants	(Mostafa et al., 2018; Sadeghi et al., 2020; Sakikhales & Stravoravdis, 2017; Zhang, 2019)
	Green image	(El-Said, 2018; Sadeghi et al., 2020; Vinodh & Aravindraj, 2013)
	Business waste	(Demir, 2015; Mostafa et al., 2016; Mostafa et al., 2018; Walker & Matinheikki, 2020)

This table has tried to organise and systematise the performance criteria in the literature on SAAL SC. Since controlling and monitoring the SC is important in terms of sustainable development, the main goal of this effort is

to identify performance metrics that enable the evaluation of SC performance at three operational, economic and environmental levels.

Assess SC performance to have information about its position in terms of some important competitive priorities related to its operational aspect. Also, economic performance should be monitored to assess whether some of the approaches that have been implemented helped companies to be sustainable enough to survive the current social and economic crises. This system also considers environmental measures to assess whether sustainable initiatives in the SC can contribute to the bottom line and continue to add value to the various SC partners.

Proposed Conceptual Model

In this section, a conceptual model is proposed to examine the relationships between SCM practices (belonging to SAAL practices) and SC performance (Fig. 2). This conceptual model is an attempt to provide a set of management practices to help design SC that are simultaneously SAAL, and helps to explore the relationships between these types of practices and SC performance. In the next step, it is examined the relationships between SAAL and SC performance.

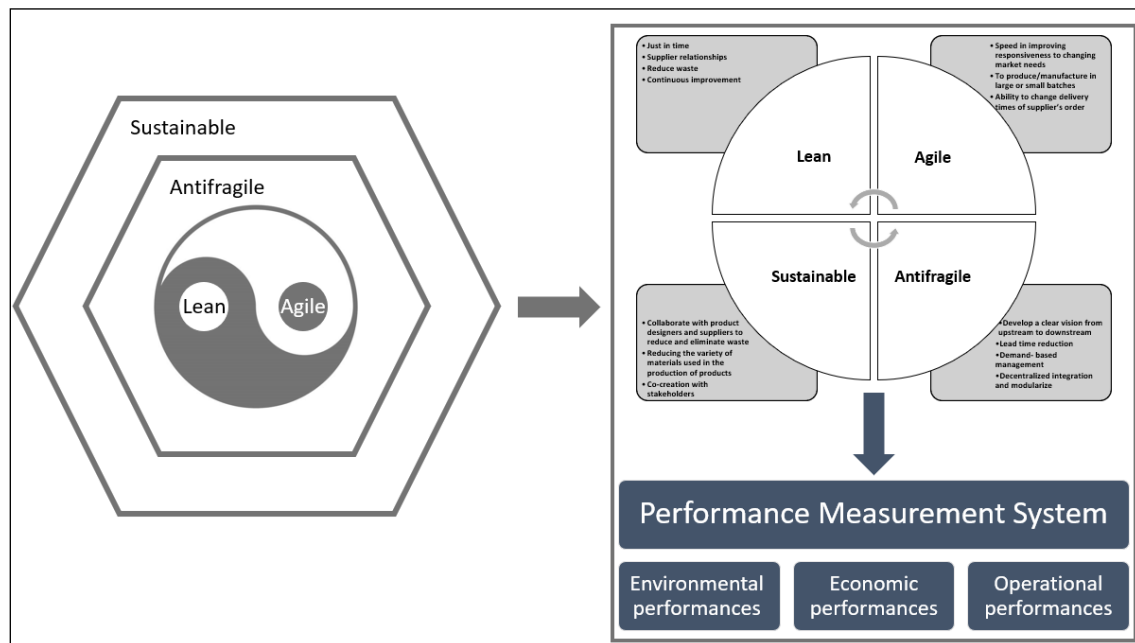


Fig. 2: Proposed Conceptual Model

Contrary to what has been said in some books and articles, Lean is not a part or subset of Agile, but in some cases, they have similar tools and techniques; they are two unique but complementary approaches. The proposed model states that the goal of the SAAL strategy is to first maintain the balance of the SC in critical conditions, such as the ship's gyroscope and then exploit the conditions in three economic, operational and environmental dimensions. So, their main goal is to exploit the conditions while maintaining sustainability.

- SC Performance

In this model, a set of measures are proposed to evaluate the effect of these methods on the performance of the SC from an operational, economic and environmental point

of view. Based on this, in terms of operational-economic-environmental performance, the proposed performance criteria are suggested according to Table 2.

- SCM Methods

Based on the literature review, according to the characteristics and main goals related to SAAAL approaches, SCM practices are presented in Table 2. All of these practices lead to SC with less waste (non-value-added activities), respond to customer needs, can overcome and benefit from disruption and also reduce the environmental effects or even help to improve the environment. These practices were named "SAAL SC practices". In this article, 17 SAAL methods are proposed as described in Table 2 of the SAAL SC practices column:

Table 2: The Effect of SAAL Strategy Practices on Manufacturing Supply Chain Performance

Supply Chain Performance	Operational-Social Performance						Economic Performance			Environmental Performance	Number of Effected
	Inventory Level	Quality	Stakeholder Benefit Realisation	Decentralised Integration and Modularise	Resilience and Flexibility	Time	Cost	Environmental Costs	C2C Cycle	Business Wastage	
SAAL SC Practices											
Just in time	▼		▲	▲	▲	▼	▼		▼		7
Supplier relationships	▼	▲		▲	▲	▼	▼			▼	7
Cycle/setup time reduction					▲	▼	▼		▼		4
Speed in improving responsiveness to changing market needs			▲		▲	▼			▼	▼	5
To produce/manufacture in large or small batches	▼		▲	▲		▼					4
Ability to change delivery times of supplier's order	▼					▼					2
Developing visibility to a clear view of all upstream to downstream processes and response according to the type of event	▼	▲		▲	▲		▼			▼	6
Lead time reduction			▲		▲	▼					3
Demand- based management	▼		▲		▲				▼		4
Reduction in the variety of materials employed in manufacturing the products	▼				▲		▼	▼		▼	5
Collaborate with product designers and suppliers to use sustainable resources and reuse/recycling and reduce and eliminate waste and product environmental impact		▲		▲				▼		▼	4
Ensuring the interests of customers, shareholders and other organizations involved	▼	▲	▲				▼	▼		▼	6
Developing local			▲	▲	▲					▼	4
A more dynamic risk assessment based on uncertainty	▼	▲		▲	▲	▼	▼				6
Creating antifragile infrastructure	▼	▲	▲	▲	▲			▼	▼		7
Continuous access to resources and continuity of operations	▼		▲	▲		▼	▼				5
Social support and social involving (Co-creation)		▲	▲					▼		▼	4
Number of practices	11	7	10	9	10	9	8	5	5	8	

Intention: ▲ increase the performance; ▼ decrease the performance.

● SCM Practices Versus Performance

The proposed model suggests the following relationships between SAAL practices and SC performance measures (Table 2). A total of 11 SAAL actions help to reduce Inventory levels. Seven SAAL actions help to increase

the quality of products along the SC. With regard to Stakeholder Benefit Realisation, the 10 main SAAL practices help improve realisation rates and on-time delivery. According to Decentralised Integration and Modularise, eight actions help to improve the continuity of operations. Ten SAAL methods help to improve

resilience and flexibility. Considering Time as a strategic SC performance measure, nine SAAL methods help to increase the speed and responsiveness of the SC to improve it. Eight SAAL measures positively affect SC costs and lead to their reduction. Five SAAL actions have a positive and direct impact on environmental costs. These methods help to reduce obsolete materials and improve the environmental performance of the product from the design stage. Among the proposed methods, five methods help to improve SC's cash-to-cash cycle. These five methods can cause a faster physical flow of materials and final products, and as a result, the return on investment based on production will also increase. Implementing the eight SAAL Business Wastage measures (i.e., waste materials, water and CO₂ emissions) among SC partners can be reduced waste. Five SC performance, Inventory level, Stakeholder Benefit realisation, Resilience and flexibility, Time and Decentralised integration and modularise has the most effect on the SAAL strategies.

Limitations

This research has limitations that should be mentioned. The conceptual model was developed using anecdotal and empirical evidence available in the literature and no validation where performed. Further research on the impact of SAAL practices on manufacturing SC performance is necessary, both to test the model proposed here and to further understand the field.

Conclusion

The main purpose of this paper is to propose a set of SCM methods to design a SAAL SC, which was called "SAAL methods" and providing a conceptual model that allows analysing the impact of these SAAL practices on SC performance in three operational, economic and environmental dimensions. The proposed conceptual model is theory-based and can be applied to any set of manufacturing SC. From this model, it can be seen that the proposed SAAL measures are more effective measures of SC performance, timeliness as well as supplier relationships. In addition, SC performance metrics with more SAAL implementations that affect them are inventory level, stakeholder benefit realisation and decentralised integration. Also, the proposed model contributes to a deeper understanding of SAAL

approaches in SCM. It provides an integrated model that provides managers with insights on how to SAAL the SC to achieve the organisation's operational, economic and environmental performance goals.

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