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(Research Paper)

Proposing a model of leagile hybrid paradigm practices and its impact on supply chain performance

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Abstract

Purpose: Given the need to simultaneously implement lean and agile paradigms in the supply chain, managers do not know which of these paradigms practices is in priority. Not knowing this, not only will they fail to apply these paradigms properly, but they will also waste significant financial resources. This paper aims to investigate the relationship between the practices of leagile paradigms and their effects on supply chain performance.

Design/methodology/approach: Since military products play a key role in national security enhancement, this research has been conducted in the military product supply chain. The research methodology is typically exploratory, mixed, and descriptive. In terms of its purpose, it is applied research based on identifying and searching for practices and the use of interpretive equations. First, the most important and implementable lean and agile practices were identified in the form of importance feasibility analysis (IFA) matrices. Then, using Fuzzy Interpretative Structural Modeling (FISM), a model was proposed to show the logical relationships and hierarchy between paradigms, practices, and their impact on supply chain performance. The data collection tool was a questionnaire completed by industrial and academic experts. The selection of experts was done purposefully.

Findings: Findings indicated that out of a total of 100 practices introduced in the previous research for lean and agile supply chains, 21 practices in the lean and agility of

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the supply chain of military industries were significant and implementable. The final model of this study illustrated the hierarchical relationships between 21 practices and their effect on the key measures of supply chain performance. This model indicated that lean and agile paradigms were intertwined and their simultaneous implementation led to improved supply chain performance. In this model, supplier-related practices played a driving and fundamental role and became a top priority for implementation.

Research limitations/implications: The variety of military products in the land, air, and sea areas and a large number of industries in each sector, forced the authors to merely select the land area. Although the results of this study can be used in the air and sea areas, one cannot say that implementation of this study by its presented model will fully lead to the leagility of supply chains of the military industries in air and sea sectors.

Originality/value: This is the first study on the supply chain legality in Iran's military industry, wherein an attempt is being made to apply the two paradigms simultaneously in the supply chain and to bridge the gap between theory and practice. Clustering lean and agile practices based on two measures of significance and feasibility, and defining four strategies for implementing these measures, is a new approach to focus on deploying practices that are currently more feasible. Identifying a significant number of supply chain lean and agile practices (100 practices), and demonstrating the interactions between significant and feasible practices in the supply chain of military products are other innovation aspects of this study.

Keywords: Lean and agility paradigms, Supply chain, Interpretative Structural Modeling

1. Introduction

Due to the role played by military products in creating and enhancing deterrence capabilities against external threats, they have particular importance in maintaining and developing national security. Therefore, the most important characteristic for evaluating military products is their ability to create and enhance defense deterrence. At present, the production of military products in the world is taking place with significant growth in variety, speed, and quality. Therefore, diverse, high-quality, and high-speed military products production is essential for any country's military industry. On the other hand, the prevailing economic conditions in Iran have made budget reform and proper consumption management an important necessity. The lean and agile approaches of the military products supply chain can help address these current security and economic challenges. However, the supply chain lean paradigm has been introduced as a new management approach to reduce production costs and products finished prices and increase corporates profits by more selling (Jasti & Kodali, 2019; Santos, Reul & Gohr, 2021), but the leanness of the military products SC by two purposes can help to improve the current situation of the economy in Iran. First, reducing the cost of military products can help better use the country's budget in cultural, social, infrastructure dimensions, etc. Second, by reducing costs and financial resources saved, the military industry can use it to solve current problems and improve production including purchasing new technologies, optimizing old machinery, training and developing human skills, defining improving projects, upgrading security systems, and optimizing processes. Lean SC is a cost-based approach that provides an improvement in supply chain performance, by reducing or eliminating all non-value-added activities at all stages of the product life cycle, from product design to final delivery to the customer (Puram et al., 2021; Robertsone, 2021). SC agility is an approach based on the introduction of new products into turbulent and volatile markets in terms of diverse and varied demand in different volumes of products that is effective in producing diverse products of high quality and high speed. SC agility, as well as is the ability of the company, both internally and externally with key suppliers and customers, to adapt quickly or respond to market changes and meet customer needs and is essential for today's organizations (Sahu et al., 2018; Rahimi et al.,2019; Al-Refaie, Al-Tahat, & Lepkova, 2020).

Given the importance of the two lean and agile paradigms in improving economic and quick response by the supply chain to customer needs, implementing these paradigms are necessary for the military products supply chain. Managers do not know which of these paradigms a priority is. Not knowing this, not only will they fail to apply these paradigms properly, but they will also waste significant financial resources. The previous research has not answered these questions which of these paradigms are seen as a priority and what are the interactions between them? How can they be applied simultaneously? What are the practices of these paradigms? What are the most important and implementable practices? How are their relations? Which practices do play the role of a driver and which one is affected? What is the impact of such practices on supply chain performance? The present study is designed to provide a model of the leagile hybrid paradigm to answer these questions and remove the ambiguity of managers in applying the leagile hybrid paradigm in the supply chain. Since the approach of this article is problem-oriented and has been developed to solve a practical problem, in the literature review part, an attempt is made to focus on research that has introduced a variety of practices of lean and agile paradigms. Then, the research methodology is described and finally, after applying the data analysis techniques, the final model is presented. The results are then analyzed and the theoretical and managerial consequences of the research are explained.

2. Literature review

A supply chain includes all the steps and parts that directly or indirectly affect the supply of customer demand (Santos, Reul & Gohr, 2021). Therefore, the supply chain includes not only the manufacturer and suppliers but also transportation, warehouses, retailers, and customers (Jasti & Kodali, 2019). Focusing on improving supply chain performance is one of the key elements needed to meet customer needs and gain sustainable competitive advantage and therefore is highly regarded by academic managers and researchers (Choi et al., 2016;

Sharma, Sohani, Yadav, 2021). Businesses are heavily dependent on their supply chains for their lives and success. Each business consists of one or more chains of the entire supply chain and plays a role in each chain. Therefore, attention to the supply chain of any business is one of the important priorities of its top managers. Striving to manage this chain effectively is the key to winning (Blanchard, 2010; Bezuidenhout, 2016).

2.1 Lean supply chain and its practices

Today, the term lean refers to a set of activities and strategies to reduce waste and eliminate operations that have no added value (Jasti & Kodali, 2019; Alavi & Janatian, 2020). A lean supply chain is one in which all the steps are needed to produce a product or service, from the supply materials to delivering the finished product to the customer. The concept of value from the customer's point of view is intended and all non-value-added activities are eliminated or reduced as much as possible (Jamali & Karimi asl, 2017; Panneman, 2017).

Rupasinghe & Wijethilake (2021), addressed the lean supply chain as a set of activities from raw material supply to product delivery to the end customer compounded with lean thinking, based on cost reduction and waste throughout the chain, to meet customer demand. The lean supply chain is accomplished by a set of practices. These practices are introduced as a set of activities that organizations use to promote supply chain performance (Azevedo et al., 2010). In other words, these practices are used to implement supply chain paradigms to improve supply chain performance (Carvalho, Cruz-Machado, 2011). In various studies, while emphasizing the importance and necessity of using the lean approach in the supply chain, practices taken to implement this approach have been also introduced. Table 1 presents the results of an earlier study on the introduction of lean supply chain practices.

Table1. The lean supply chain practices in previous studies

Lean Practice	Resource
Just in Time (JIT)	Tortorella , Miorando & Tlapa (2017), Nath and Agrawal (2020)
Total Quality Management (TQM)	Tortorella , Miorando & Tlapa (2017), Nath and Agrawal (2020)
Poka-yoke (fail-proofing)	Takeda et al. (2021)
Quality Control Circle (QCC)	Nath & Agrawal (2020)
Six Sigma	Takeda et al. (2021)
Supplier quality certification	Al-Refaie, Al-Tahat, & Lepkova, (2020)
Total Productive Maintenance (TPM)	Al-Refaie, Al-Tahat, & Lepkova, (2020)
Improving job safety with machinery and equipment	Nath & Agrawal (2020), Takeda et al. (2021)
Cellular manufacturing	Tortorella , Miorando & Tlapa (2017)
Geographical proximity to suppliers	Campos et al. (2016), Takeda et al. (2021)
Computer Integrated Manufacturing (CAM)	Nath & Agrawal (2020)
Statistical Process Control (SPC)	Nath & Agrawal (2020)
5S	Al-Refaie, Al-Tahat, & Lepkova, (2020)
Pull system or Kanban	Rocío, Cristina, Juan (2018), Takeda et al. (2021)
Continuous improvement program and evaluation (Kaizen)	Al-Refaie, Al-Tahat, & Lepkova, (2020)

Lean Practice	Resource
Reduce inventory levels (raw materials, in-process goods, and manufactured goods)	Tortorella , Miorando & Tlapa (2017), Al-Refaie, Al-Tahat, & Lepkova, (2020)
Production and Process Reengineering	Nath & Agrawal (2020)
Reduced lead time and cycle time	Tortorella , Miorando & Tlapa (2017), Takeda et al. (2021)
Production in small batches (reduced batch size)	Campos et al. (2016), Tortorella , Miorando & Tlapa (2017)
Enterprise Resource Planning (ERP)	Nath & Agrawal (2020)
Improving scheduling and production planning	Tortorella , Miorando & Tlapa (2017), Takeda et al. (2021)
Work standardization (standard work method)	Tortorella , Miorando & Tlapa (2017), Al-Refaie, Al-Tahat, & Lepkova, (2020)
Product and process simplification	Nath & Agrawal (2020)
Improvements in technology and application of new equipment	Al-Refaie, Al-Tahat, & Lepkova, (2020)
Value Stream Mapping	Tortorella , Miorando & Tlapa (2017), Al-Refaie, Al-Tahat, & Lepkova, (2020)
Automation	Takeda et al. (2021)
Supplier JIT delivery	Rocío, Cristina, Juan (2018), Nath & Agrawal (2020)
Inter-practice and long-term relationships with suppliers	Campos et al. (2016), Tortorella , Miorando & Tlapa (2017)
Evaluating, monitoring, and ranking suppliers	Tortorella , Miorando & Tlapa (2017), Rocío, Cristina, Juan (2018).
Single source (reducing the number of suppliers)	Campos et al. (2016)
Multiplicity in supply (Supply multiple times)	Tortorella , Miorando & Tlapa (2017), Nath & Agrawal (2020)
Financial and technology aid to suppliers	Takeda et al. (2021)
Electronic Data Interchange (EDI) to share information with suppliers	Rocío, Cristina, Juan (2018), Takeda et al. (2021)
Electronic Data Interchange (EDI) to share information with customers	Tortorella , Miorando & Tlapa (2017), Takeda et al. (2021)
Supplier participation in product design and development	Rocío, Cristina, Juan (2018)
Providing flexible specifications to suppliers	Takeda et al. (2021)
Training and developing suppliers	Tortorella , Miorando & Tlapa (2017), Nath & Agrawal (2020)
Engage and build long-term relationships with customers	Tortorella , Miorando & Tlapa (2017), Takeda et al. (2021)
Resource high utilization rate	Lotfi & Saghari (2017)
Outsourcing	Takeda et al. (2021)
Use of material handling systems	Tortorella , Miorando & Tlapa (2017), Nath & Agrawal (2020)
Multi-tasking forces	Mohseni (2015)
Supplier inventory management	Anand & Kodali (2008)
Work systems with high employee participation	Lucilla et al. (2016)
Postponement	Anand & Kodali (2008)
Job rotation and job development	Gurumurthy & Kodali (2009)
Flat organizational structure	Gurumurthy & Kodali (2009)
Modification of machinery layout	Gurumurthy & Kodali (2009)
Creating an official reward system	Gurumurthy & Kodali (2009)
Radio Frequency Identification (RFID) and barcode	Nath & Agrawal (2020)
Group Technology (GT)	Nath & Agrawal (2020)
Staff training and empowerment	Rocío, Cristina, Juan (2018), Takeda et al. (2021)
Staff payment based on performance	Dolan & Hacker (2005)
Concurrent Engineering (CE)	Gurumurthy & Kodali (2009)
Product modularity	Anand & Kodali (2008)
Idea generation and suggestion schemes	Gurumurthy & Kodali (2009)
Andon (use of warning lights)	Gurumurthy & Kodali (2009)
Multifunctional small machines	Gurumurthy & Kodali (2009)
Long-term forecast of customer demands	Tortorella , Miorando & Tlapa (2017), Nath & Agrawal (2020)

Lean Practice	Resource
Adapting to organizational culture	Nath & Agrawal (2020)
Delivery of materials directly to their place of use	Castro (2014), Mohseni (2015)
Standardization of components	Al-Refaie, Al-Tahat, & Lepkova, (2020)
Appropriate and standard packaging	Tortorella , Miorando & Tlapa (2017), Al-Refaie, Al-Tahat, & Lepkova, (2020)

2.2 Agile supply chain and its practices

The agile approach is a production strategy based on the introduction of new products into rapidly changing markets and is also the ability of an organization to respond to the continuous and unpredictable changes in the competitive environment (Ansari, Abedi & Khoshduz, 2016; Inman & Green, 2021). Therefore, the main goal of the agility approach is to provide an appropriate solution to help companies to deliver the right product at the right time to customers in turbulent and volatile markets in terms of diverse and varied demands in different volumes of the product (Olfat & Shahriarinia, 2014; Rahimi et al., 2019). Mostafa et al. (2016), considered supply chain agility as the ability to participate in rapid adaptation or response to market changes in meeting customers' needs and believes that the development of this capability requires significant planning and identifying the customer's changing need is one of the priorities. Nath & Agrawal (2020) argued that supply chain agility represents an effective integration of all components of the supply chain and emphasizes close and long-term relationships with consumers and suppliers. Sahu et al., (2018) addressed the agile supply chain essential for today's organization and stated that its management includes activities related to monopolistic strategies, which lead to the presentation of a product that consumers cannot find elsewhere. An agile supply chain, like a lean supply chain, is accomplished by a set of practices that should be applied to implement this paradigm. Table 2 presents a summary of previous studies on agile supply chain practices.

Table 2. The agile supply chain practices in previous studies

Agile Practice	Resource
The use of information technology in product design and development	Rahimi et al. (2019), Al-Refaie, Al-Tahat, & Lepkova, (2020)
The use of information technology in manufacturing	Rahimi et al. (2019), Al-Refaie, Al-Tahat, & Lepkova, (2020)
The use of information technology to coordinate and integrate procurement activities	Rahimi et al. (2019), Al-Refaie, Al-Tahat, & Lepkova, (2020)
The use of information technology to coordinate and integrate delivery activities	Sahu et al. (2018)
Developing mutual trust with suppliers	Rahimi et al. (2019), Nath and Agrawal (2020)
The flow of information and its sharing through the virtual network throughout the chain	Gorane, and Kant, (2016), (Sahu et al., 2018)
Ability to increase product customization levels	Sahu et al. (2018), Nath and Agrawal (2020)
Facilitate quick decision-making	Rahimi et al. (2019), Nath and Agrawal (2020)
Getting demand information rapidly	Sahu et al. (2018), Nath and Agrawal (2020)
Reducing product development cycle time	Azevedo et al.(2010), Rahimi et al. (2019)
Maintaining and improving customer relationships	Sahu et al. (2018), Rahimi et al. (2019)
Accelerating customer service improvement	Azevedo et al.(2010), Nath and Agrawal (2020)

Agile Practice	Resource
Accelerating the reduction of lead time and cycle time	Carvalho, Cruz-Machado (2011)
Accelerating the improvement of delivery reliability	Rahimi et al. (2019)
Supplier's ability to change size orders	Rahimi et al. (2019)
Supplier ability to change order time	Azevedo et al.(2010), Rahimi et al. (2019)
Ability to change production volume	Sahu et al. (2018), Rahimi et al. (2019)
Ability to generate surplus capacity (buffer)	Sahu et al. (2018), Al-Refaie, Al-Tahat, & Lepkova, (2020)
Ability to change delivery schedules	Nath and Agrawal (2020)
Multi-skilled manpower	Rahimi et al. (2019)
Ease of product assembly	Goldsby, Griffis & Roath. (2006)
Accuracy of data	Agarwal, Shankar, & Tiwari (2007)
Creating the infrastructure needed to encourage innovation	Rahimi et al. (2019)
Removing process barriers and organizational obstacles	Rahimi et al. (2019)
Minimizing resistance to change	Rahimi et al. (2019)
Increasing the frequency of introduction of new products	Nath and Agrawal (2020)
Participating in supplier activities to supply customer specification	Vinodh et al. (2013)
Maintaining surplus inventory to meet demand quickly	Carvalho, Cruz-Machado (2011)
Outsourcing	Rahimi et al. (2019)
Flat and flexible organizational structure	Rahimi et al. (2019)
Engaging suppliers in product development	Rahimi et al. (2019)
Ability to exchange personnel between departments	Rahimi et al. (2019)
Ability to change production combination	Sahu et al. (2018), Nath and Agrawal (2020)
Ability to reduce production operation time	Rahimi et al. (2019)
Accelerating meeting customer needs	Sahu et al. (2018), Rahimi et al. (2019)
Ability to produce small and large batches	Mohseni (2015)
Applying knowledge management	Rahimi et al. (2019), Nath & Agrawal (2020)

2.3 Supply chain performance measures

Improving supply chain performance can manifest itself in many aspects, such as inventory depletion, reduced lead time, production and delivery, or quality improvement. Grouping supply chain performance metrics into a broader range of competing priorities such as cost, quality, delivery time, flexibility, innovation, and service level can be a useful measurement method for supply chain performance (Kumar & Barua, 2021) Different priorities can be used as different dimensions of supply chain performance (Inman & Green, 2021). In the past few decades, researchers have identified a significant number of performance measures that can be used to evaluate supply chain performance. Table 3 summarizes the performance measures of the supply chain introduced in previous research.

Table 3. The measures of supply chain performance in previous studies

Performance measure	Resource
Product quality level	Shradha, Gawankar, Kamble (2016), Rocío, Cristina, Juan (2018)
Product cost level	Rocío, Cristina, Juan (2018), Zubairu et al. (2021)
Product delivery speed level	Lotfi & Saghari (2017), Rocío, Cristina, Juan (2018)
Product innovation level	Lotfi & Saghari (2017), Zubairu et al. (2021)
Product market share	Zubairu et al. (2021)
Image	Zubairu et al. (2021)
Asset management	Najmi & Maui (2010).
Reliability of product delivery	Najmi & Makui (2010), Zarei, Fakhrzad, Paghaleh (2011)
Chain flexibility level	Mohseni (2015), Shradha, Gawankar, Kamble Rakesh (2016)
Chain technical capability level	Chen, Lin, & Huang. (2006)
Inventory level (finished goods, raw materials, and WIP)	Zarei, Fakhrzad, Paghaleh (2011)
After-sales service level	Wang , Chang, & Wang (2009), Zubairu et al. (2021)
Supply chain integrity level	Carvalho, Cruz-Machado (2011), Zubairu et al. (2021)
Cooperation quality level in the supply chain	Shradha, Gawankar, Kamble (2016)

2.4 Military products supply chain

Iranian military product supply chain has three levels including suppliers, manufacturers, and end-users. Suppliers are either internal or external. Manufacturers are different defensive industries and their customers including all Iranian military and law enforcement forces. Figure 1 illustrates a schematic of the Iranian military products supply chain. Ground-based military products constitute 60% of the military products. Although today air-based and marine-based military products are globally recognized as strategic military products, in global military events, no success is achieved without the aid of ground-based military products which indicates the high importance of such military products.

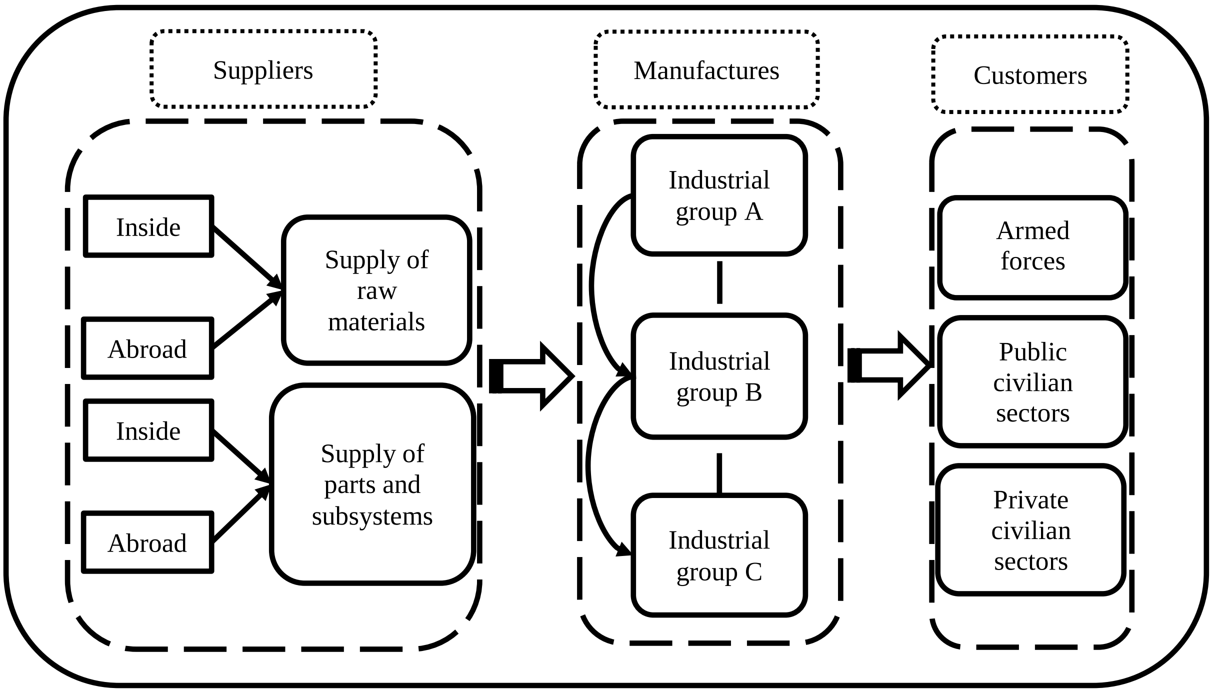

Fig 1. The supply chain of military products (source: the authors' review)

Studies indicate that scientific military research has been always pioneered in other fields and many provided products in trading markets have been the result of preliminary research in the military area including the Global Positioning System (GPS) and the Internet. Most likely, global military industries are pioneers in utilizing new supply chain approaches including lean and agility. However, the results from previous studies indicate that inaccessible information resources including reputable websites such Elsevier, Emerald, Springer, IEEE, scientific papers on military products supply chain lean and agility are not found. Lack of dissemination of military studies in this regard is likely due to their confidential nature or they are published in journals with restricted access to the public. Our study attempts to act as the first study on Iranian military products supply chain lean and agility and no study is so far conducted by such an approach in Iran.

3. Research methodology

Given the importance and necessity of the lean and agility of the supply chain of military industries, the main question of the research is what the leagile hybrid supply chain model of the military industry is. To answer this question, first, it is necessary to examine how a lean and agility approach is implemented, and what practices they involve? What are supply chain performance measures? What is the relationship between such practices? and What are the relationships between practices and supply chain performance measures? The research methodology is typically exploratory, mixed, and descriptive. In terms of its purpose, it is applied research based on identifying and searching for practices and the use of interpretive equations. This research was completed in three parts.

In the first step, through a thorough review of previous research (Tables 1, 2), the practices of lean and agile supply chain paradigms were identified. Then, these practices were clustered in the IFA matrix based on the two measures of their importance and feasibility, by the opinion of academic and industrial experts in the supply chain of military products. In this part, the objective sampling method is used along with completed 20 questioners by academic experts and industrial experts in the supply chain. In other words, 56 people were involved in completing these questionnaires. In total, from six industrial groups, three of the largest industries in each group were selected, and in each industry, three persons, including production, quality, and supply chain managers, participated in answering the questionnaire questions. Two university experts familiar with the supply chain of defense industries who have a history of carrying out improvement projects in the supply chain of these industries also answered the questionnaires in this section (6*3*3+2=56). The method of data analysis in this section was the clustering of practices in the form of an IFA matrix. Since the questionnaire of the first part is the result of using experts' opinions, the questionnaire enjoys needed validity.

In the second step, from previous research (Table 3), supply chain performance measures were identified and then based on the highest frequency and repetition in previous studies and the importance of them in the supply chain of military products based on opinions of 5 top managers, quality, cost, speed and innovation measures were considered as the most important measures for the performance of the military product supply chain.

In the third part, an objective sampling method is used and 10 defense industry supply chain experts, who had a deep understanding of the industry, supply chain, and lean and agile practices, gathered in an expert panel, and the pairwise comparison questionnaire was completed in three 2-hour sessions, after their discussion and consultation. For data analysis in this section, the fuzzy interpretive structural modeling techniques (FISM) were used and the relationships between important and feasible practices of the lean and agile military supply chain and their impact on key supply chain performance measures were modeled. Subsequently, practices and performance measures were clustered and analyzed by MICMAC (Matrix Impact Cross-Reference Multiplication Applied to Classification) technique based on their Driving and dependency power. The final results and model were evaluated and confirmed by two academic experts of the military products supply chain. In the present study, SPSS20 and MATLAB R2018b software packages, are used. Figure 2 presents the step-by-step process followed in the research through a basic flow chart.

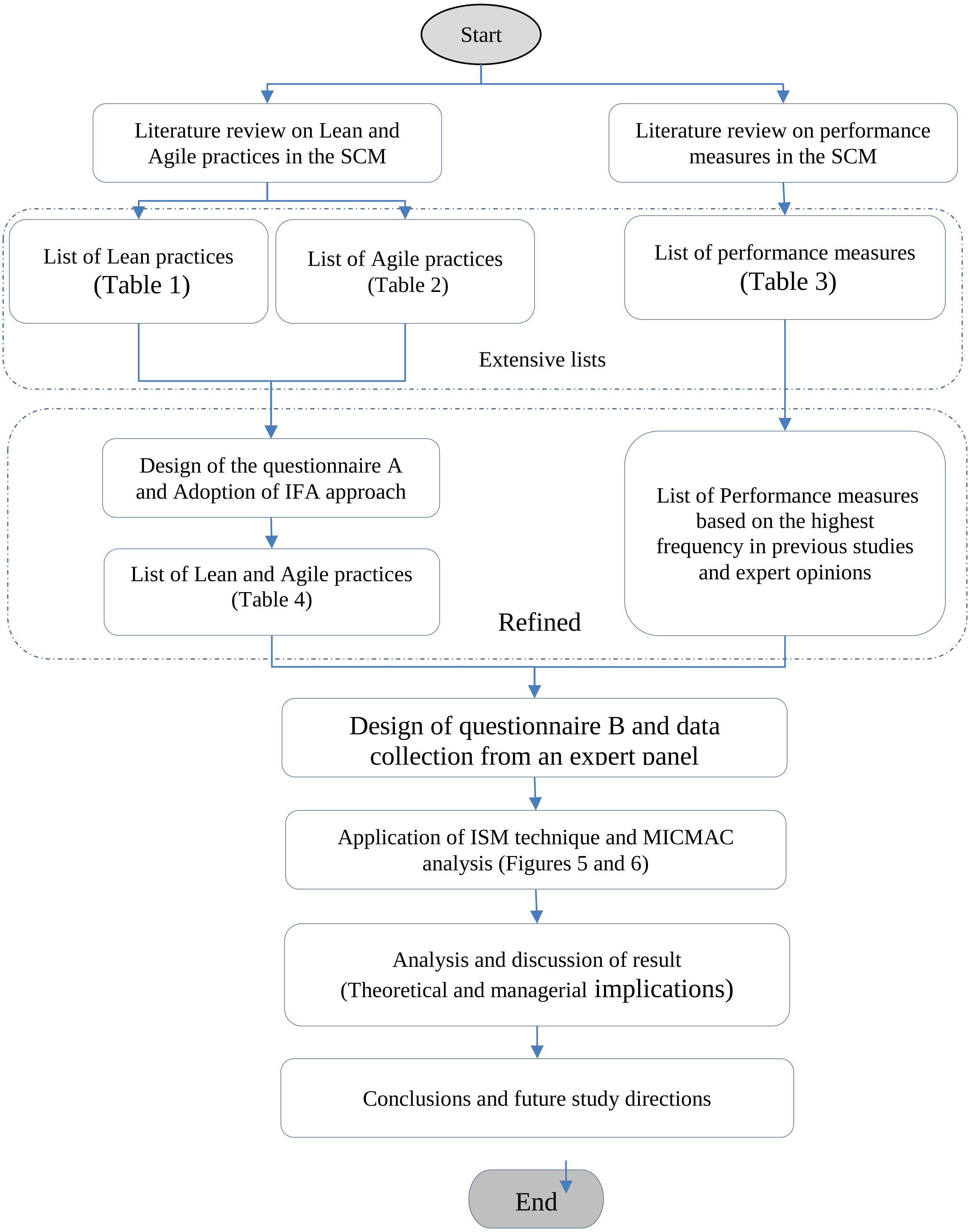

Fig 2. Research steps

4. Findings

4.1 Determining lean and agile paradigms practices of military products supply chain

In this section, based on practices taken from previous research, a two-part questionnaire consisting of 100 items, (63 lean practices and 37 agile practices in tables 1 and 2) each item referring to a practice of lean or agile supply chain, was prepared and provided to the experts (Questioner A). The main question was, in the experts' opinions, concerning each practice mentioned to the lean or agile supply chain, how much is important and feasible to implement in the military supply chain? To answer this question, a 5-point Likert scale (very low, low, medium, high, and very high) was used. Given that studied military industries are divided into six industrial groups, three of the largest industries of each group were selected and completed the questionnaires. Respondents to each questionnaire consisted of representatives from the supply, production and sales, and customer relationship (three persons). Two academics who were well versed in the military product supply chain also completed the questionnaires.

A total of 20 questionnaires were completed by 56 experts (6*3*3+2=56). The respondents to these questionnaires all have more than 15 years of useful work experience with the military product supply chain and most of them specialize in the fields of industrial meditation and industrial engineering.

Recently, Rocío, Cristina, Juan (2018) used the IFA technique to categorize lean, resilient, and green supply chain practices based on the two axes of importance and the extent of their use in the aerospace supply chain. Since the purpose of the present study is to present an applied model in the military industry supply chain, therefore, practices to implement paradigms should be introduced to the military industry, which in addition to being important in the military industry supply chain, should be well implemented. Therefore, in this study, the importance-feasibility matrix was used to categorize the practices of each paradigm to finally focus on the practices that will be placed in the Q1 quadrant. The data collected in this section were entered into Excel software and categorized in the Importance-feasibility Matrix format by Excel and SPSS software.

Figures 3 and 4 illustrate the importance-feasibility matrix for the military industry supply chain lean and agility, respectively. Their first quarter represents practices that are of great importance and properly applied in the lean and agility of the military industry supply chain. Therefore, they are identified as the lean and agile practices of the military products supply chain.

The values are shown on the vertical and horizontal axes of the quadrants (for example, 2.81 and 3.14), respectively, representing the meanings of importance and the feasibility of the measures in both Figures 3 and 4.

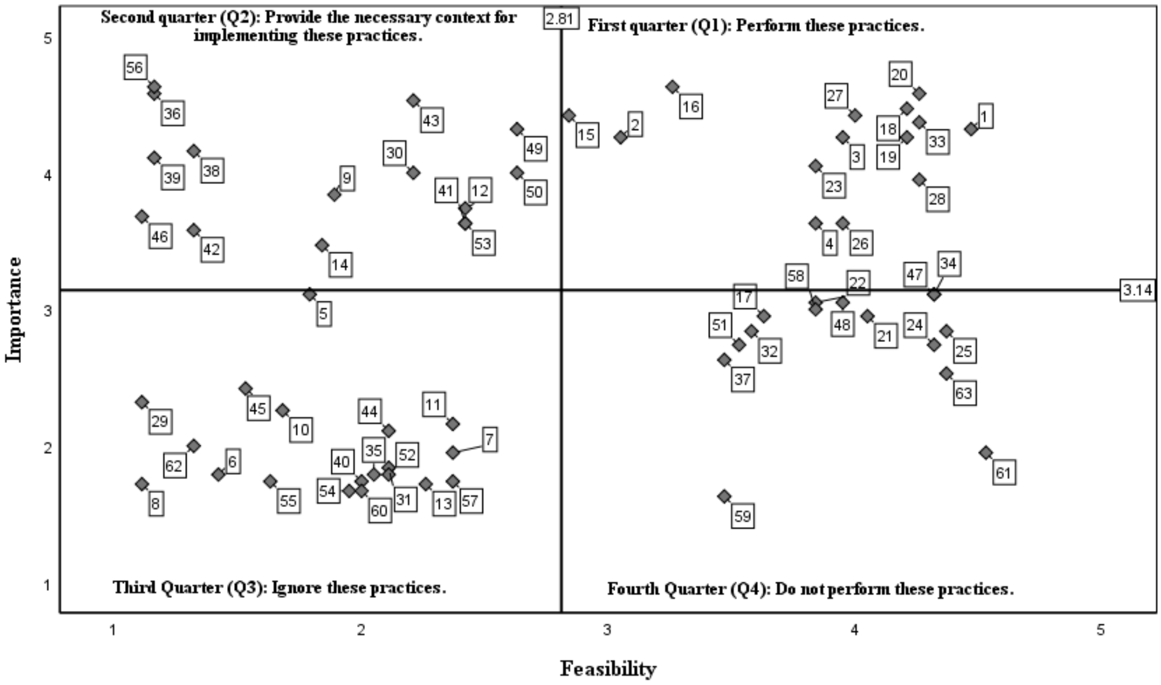

Fig 3. Importance-Feasibility Matrix of the lean supply chain practices of military products

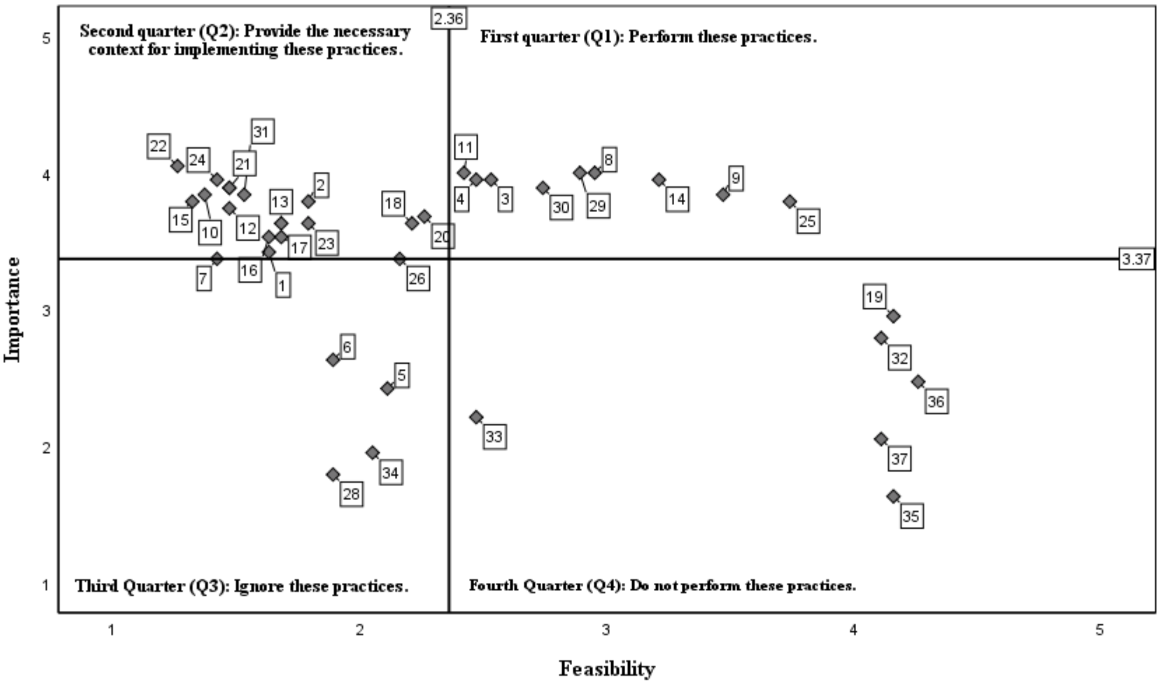

Fig 4. Importance-Feasibility Matrix of the agile supply chain practices of military products

Based on Figures 3 and 4, Table 4 shows the practices that are located in the first quarter of these figures. Since these practices are the most important and feasible practices for the lean and agile defense industry supply chain, they are prepared for use in the final model.

Table 4. The lean/agile practices of the supply chain of military products in the first quarter

Paradigm (Number of practices)	Code	Lean and agility practices in the military industries supply chain (Practices in the first quarter of importance - feasibility matrix)
Lean (14)	L1	Evaluating, monitoring, and ranking suppliers
	L2	Supplier Just in time delivery
	L3	interaction and long-term relationships with suppliers
	L4	Single source (reducing the number of suppliers)
	L5	Just in time Production
	L6	Total Quality Management (TQM)
	L7	Applying Quality control Circles (QCC)
	L8	Six Sigma
	L9	Total Productive Maintenance (TPM)
	L10	Reduced lead time and cycle time
	L11	Pull system or Kanban
	L12	Continuous improvement program and evaluation
	L13	Reduce inventory levels (raw materials, in-process goods, and manufactured goods)
	L14	Improving scheduling and production programing
Agile (9)	A1	Supplier's ability to change orders size
	A2	Supplier ability to change of order time
	A3	The use of information technology in product design and development activities
	A4	The use of information technology in product production activities
	A5	Reduce product development cycle time
	A6	Ability to changes in production volume
	A7	Maintain surplus inventory to meet demand quickly
	A8	Ability to change in production combination
	A9	Ability to reduce production operation time

4.2 Determining the supply chain performance measures of military industries

After a comprehensive review of the theoretical literature and previous research, 14 supply chain performance measures under Table 3 were identified. Considering that quality, cost, speed, and innovation measures have the highest frequency and repetition in previous studies (Table 3), and on the other hand, taking the views of senior managers of the defense industry, as well as the activities of authors in the defense industry and their familiarity with the performance of the supply chain of military products, for this reason, these measures (quality, innovation, speed, and cost) were considered as the most important measures for the performance of the military product supply chain.

4.3 The results of Fuzzy Interpretative Structural Modeling (FISM) of leagile supply chain practices

ISM has been defined as a process that aims to help man understand better what he believes and make a clearer diagnosis of what he does not know (Faris & Sage, 1975). This method first identifies the effective and basic factors of the research subject and then, based on the opinion of experts, identifies the relationships between these factors and displays them in the form of a graphic model. This method is qualitative which tries to calculate the mental understanding of experts on the relationships between the factors of the subject and in this sense, it is quantitative that based on a questionnaire and numerical analysis, which seeks to show the relationships between variables in a structural model. For this reason, it has been called a qualitative-quantitative method and an interpretive structure. This method is used to analyze the relationship between several variables or factors, which are defined for a problem (Kanan & Noorul, 2007).

The traditional and classical approach of interpretive structural modeling discusses only the relationship between elements (absence of relationship, existence of one-way relationship, and existence of reciprocity), which is achieved based on the two-value spectrum 0 and 1. But the intensity of the effect of one variable on another variable is not taken into account. In other words, it can be said that the classical approach does not fully reflect the real thought of individuals. Therefore, to fill this gap, an interpretive structural modeling approach has been introduced in the fuzzy environment, which also considers the intensity of the relationships between variables in a fuzzy spectrum (Pramod & Banwet 2013).

Fuzzy interpretive structural modeling is done in a series of steps. Since this technique is a well-known model in the fields of industrial management and engineering, the details of each step are avoided and we focus only on the final results and their analysis. After identifying the practices of lean and agile of the military products supply chain (Tables 1 and 2) as well as its performance measures (Table 3), as Table 4 shows, the two practices of inventory reduction (in the lean paradigm) and the surplus inventory to respond quickly to demand (in the agile paradigm) conflict with each other; this means that the level of inventory must be reduced to such an extent that, in addition to reducing the level of costs, the degree of chain agility does not fall below a certain level. These two practices, due to the conflict, cannot be presented in one model and therefore these two practices are not displayed in the final model. And the final model will be displayed based on 21 other practices. The model variables were determined as a total of 25 items (13 lean practices, 8 agile practices, and 4 performance measures: PM1 to PM4: quality, innovation, speed, and cost) which are considered as input variables of the FISM technique. Respondents to FISM questionnaire(questionnaire B) are industrial engineering and industrial management specialists with doctoral degrees and useful work experience at various levels of the military industry supply chain (over 15 years) who, in practice, are involved in the application of lean and supply chain agility practices and have a good practical understanding of these practices and the supply chain performance. Excel and MATLAB software were used to analyze the data in the modeling section. Table 5 shows the leveling output of MATLAB software for paradigms practices and supply chain performance measures.

Table 5. MATLAB software output for leveling paradigm practices and supply chain performance measures

Level	1	2	3	4	5	6	7	8	9
Practices/ measures	25	[22,24]	23	[10,19,20]	[2,5,11,13]	[14,15,18,21]	[6,7,8,9]	[16,17]	[1,3,4,12]

After determining the levels of the elements, a directional graph has been developed from the final availability matrix, removing the transferability. Figure 5 illustrated a diagram of an ISM of leagile hybrid paradigm practices and supply chain performance measures.

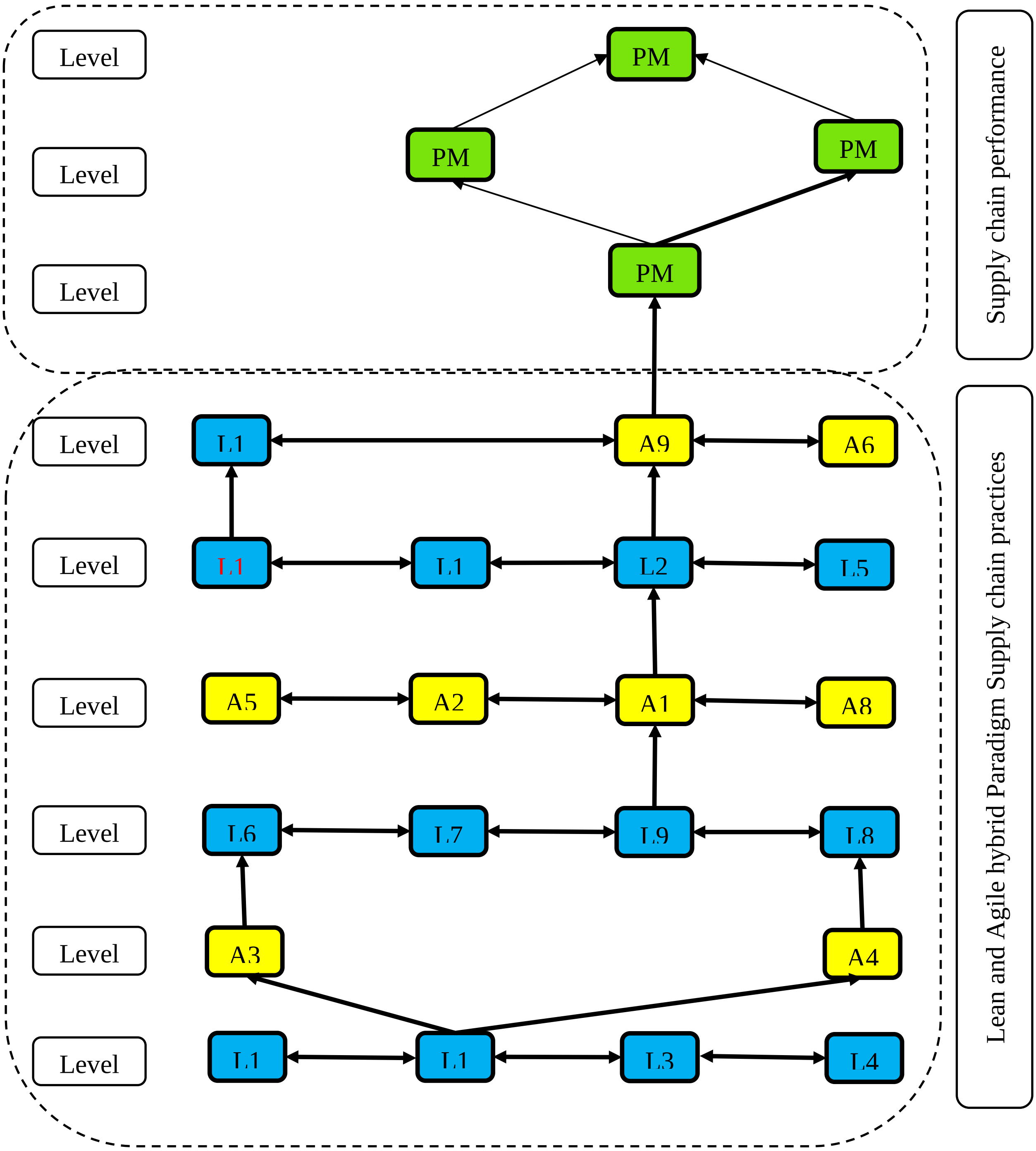

Fig 5. An ISM of leagile hybrid paradigm practices and supply chain performance measures

Figure 6 shows the interaction and prerequisite and post-requirement relationships between paradigm practices and how they affect supply chain performance. In other words, it expresses the priority of implementing these practices. As Figure 6 shows, paradigm practices at 6 levels must be implemented, level 9 practices are prerequisites for levels 8, and must be implemented before other levels practices. The relationship between two practices indicates that one practice can facilitate or assist in the implementation of another practice. Each practice has a set of prerequisites that in the final diagram, an arrow of all those prerequisites must be attached to that practice, but as the final diagram is clear and not tangled and recognizable, and also according to the rule of transferability, ignore the drawing of many surplus arrows. Although only one arrow can be shown between different levels of the diagram which means that higher-level practices are prerequisites for lower levels, symmetrical arrows between different levels of the diagram are drawn to the designer's taste and a more beautiful diagram display.

Figure 6 indicates the clustering of paradigm practices and performance measures into four general categories include autonomous variables, dependent variables, connective variables, independent variables.

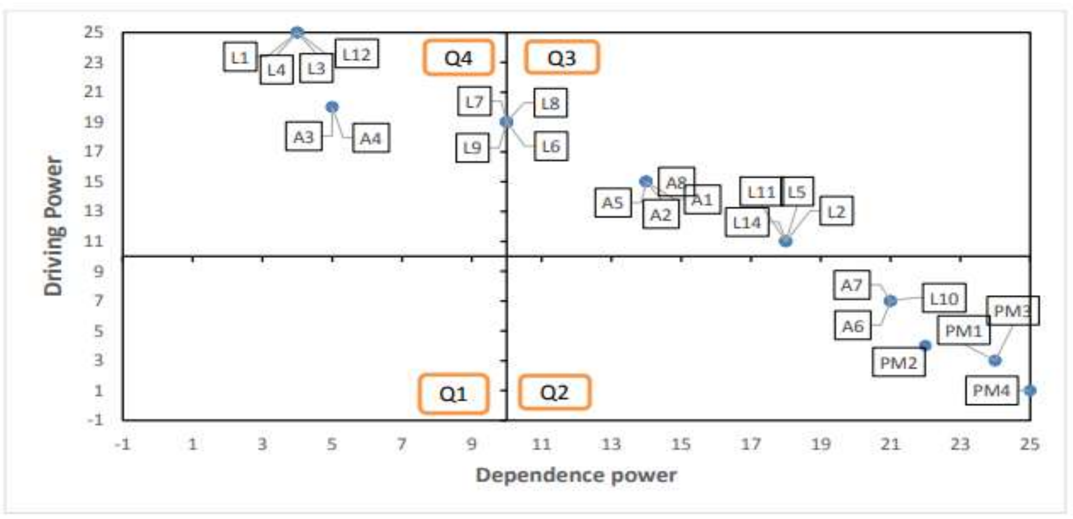

Fig 6. Clustering diagram of lean paradigm practices based on their degree of influence and dependence

5. Discussion

First of all, lean and agile practices applicable to the military product supply chain sector are identified. On the other hand, key performance measures of the military product supply chain were identified and interpretive structural modeling was used to determine the hierarchical relationships between the measures of the pure hybrid paradigm, and to identify the effect of these measures on improving the supply chain performance. Some practices identified in this study are currently used in the supply chain of the military industry, and it can be said that lean practices have been used more than agility. However, it is noteworthy that, because some practices are a prerequisite for subsequent practices and somehow facilitate their implementation, this issue has not been considered and as a result, there has not been a proper success in implementing the practices and, in a way, the implementation of these practices in practice is half-finished. Focusing on important and applicable practices of lean and agile paradigms, this research developed a hierarchy of their practices in the form of a model to help managers make better decisions to choose appropriate practices.

Figure 5 shows the interaction and prerequisite and post-requirement relationships between paradigm practices and how they affect supply chain performance. In other words, it expresses the priority of implementing these practices. As Figure 5 shows, paradigm practices at 6 levels must be implemented, level 9 practices are prerequisites for levels 8, and must be implemented before other levels practices. The relationship between two practices indicates that one practice can facilitate or assist in the implementation of another practice. Each practice has a set of prerequisites that in the final diagram, an arrow of all those prerequisites must be attached to that practice, but as the final diagram is clear and not tangled and recognizable, and also according to the rule of transferability, ignore the drawing of many surplus arrows. Although between different levels of the diagram can be shown with only one arrow, which means that higher-level practices are prerequisites for lower levels, symmetrical arrows between different levels of the diagram are drawn to the designer's taste and a more beautiful diagram display.

Figure 6 shows that lean and agile supply chain practices are clustered into four categories. Each of these clusters has specific definitions as described below:

Quarter IV (Q4: Driving variables): Evaluating, monitoring, and ranking suppliers (L1), interaction and long-term relationships with suppliers (L3), Single source (reducing the number of suppliers) (L4), Continuous improvement program and evaluation(L12), Application of information technology in product design and development activities(A3) and Application of information technology in product production activities(A4), Total Quality Management (L6), Applying Quality control Circles (L7), Six Sigma(L8), Total Productive Maintenance(L9), are in the fourth quarter and the category of independent elements. This means that it has high driving power and very little dependence. Therefore, these practices are known as prerequisite practices and facilitators, or in other words, contributors to other practices. In addition, the measures in the fourth quarter significantly improve the key performance parameters of the supply chain (quality, innovation, speed, and cost), and for this reason, in Figure 5, as measures basically, they have emerged.

Quarter III (Q3: Linkage variables): Supplier's ability to resize orders (A1), Supplier ability to change order time (A2), Reduce product development cycle time (A5), Ability to change the composition of production (A8), Supplier just in time delivery (L2), Just in time Production (L5), Pull system or Kanban (L11), Improving scheduling and production programming (L14), are in the third quarter as interconnected variables that have moderate influence and dependence. These practices are non-static, because any change in them can affect the system, and eventually system feedback can change these variables again. This means that these practices are considered as key and basic measures of the leagile hybrid paradigm and the leagile hybrid paradigm have a great impact on the application of these practices, which are very important in the final results. Therefore, since these measures are influenced by some previous measures and have a high impact on other measures, the success or failure rate in their application can have a major impact on the success or failure of the leagile hybrid paradigm in the supply chain. In addition, the practices of this category both affect the performance measure of the supply chain and as an intermediary, the effect of the practices in the fourth quarter on the performance measure of the chain.

Quarter II (Q2: Dependent variables): Reduced lead time and cycle time (L10), Ability to make changes in production volume (A6), Maintain surplus inventory to meet demand quickly (A7), have low penetration, but high dependence, and are in the second quarter as a dependent variable, which indicates that such practices are more effective. In other words, it would not be possible to carry out these measures without implementing other measures, and focusing on carrying out these practices without implementing other measures would not be fruitful. Although these practices themselves affect the key performance measure of the supply chain, those are influenced by other practices of the leagile paradigm, and other practices must be taken before this category of practices. The key performance criteria of the military industry chain, including quality (PM1), innovation (PM2), speed of delivery (PM3), and cost (PM4), are affected in the second quarter, indicating that these are the result of applying leagile hybrid paradigm practices and the most influential variables in the final model presented in Figure 5.

Quarter I (Q1: Autonomous variables): No practice is placed in the first quarter as an autonomous variable, indicating that all 21 practices of the leagile hybrid paradigm interact with each other to affect supply chain performance measures. And it can be said that among these 21 practices, no practice has no effect on other practices and leads to improved supply chain performance without interacting with other practices.

5.1 Theoretical implications

While this study has been conducted with the approach of proposing a practical model for the simultaneous use of lean and agile paradigms, its results can create knowledge in the theoretical subject of these paradigms which will be presented below.

Paradigms in a vacuum will not lead to results, but they should be used, and the application of these paradigms is in the form of defining practical measures for them. In different researches, different measures have been defined for each of the lean and agile paradigms and so far no research has been done to show these measures more fully and this issue has caused confusion in the implementation of these paradigms. In this study, we tried to count the practices of these two paradigms by reviewing the previous research relatively comprehensively. As a result, in this study, we introduced a total of 100 practices for lean paradigm (63 practices) and agile paradigm (37 practices).

But can all these 100 practices be used in the supply chain of all industries? The answer is no. In this study, by introducing IFA Matrix (Importance Feasibility Analysis), we help organizations to be able to divide these practices into four categories based on their ability to implement and the importance of their role in the lean and agile supply chain. In different supply chains, some practices are important but due to some limitations, they cannot be done. Therefore, before taking any practices to implement them, one should try to remove the obstacles in front of them. Practices that do not play an important role in the lean and agile supply chain should generally be ignored, although they are highly feasible. Finally, to lean and agile supply chain in practice; one must focus on practices that are both important and highly feasible. In this study, about 21 practices out of 100 practices are both important and feasible. Therefore, it should be noted that any practice expressed in articles and theories should not apply blindly.

The results of this study showed that lean and agile paradigms are not two independent paradigms. And their practices are formed in interaction with each other, and some of them create a platform to facilitate the use of other practices. In other words, lean and agile paradigms are intertwined, and the answer to the question of which one should be used before the other is meaningless.

Lean and agile paradigms interact with each other to have a better effect on improving supply chain performance. Therefore, efforts should be made to apply both of these paradigms together and with a combined approach. A theoretical point that can be deduced from the research results is that it is true that each of these paradigms is defined and applied to improve in a specific field, but they can also be effective in other functional parameters, for example, the lean paradigm, in addition, Its main function in reducing costs by eliminating waste, in this study was shown to affect the quality, innovation and speed of supply chain delivery and responsiveness.

Among the studies conducted to investigate the effect of new supply chain paradigms, including lean, agile, resilient, and green, on supply chain performance as well as the interaction between these paradigms, there are five significant studies that we compare the results of this study with them. It should be noted that because in this research, the same measures do not constitute their hierarchical model, so a complete comparison of their results with the hierarchical model of our research is impossible. Therefore, our focus in comparison between them is on the common practices that exist between our research model and theirs.

Rahimi et al. (2019) presented a hierarchical model for supply chain agility in military products, in which the use of information technology and workshop level management, including material planning and control of production operations, ability to change production volume and create surplus capacity, ability to reduce production time, minimization of time of launch of machines and equipment, minimize the production line preparation time and speed up the supply of new products, were among the most important categories. The results of the present study confirm the results of that research. The study by Rocío, Cristina, Juan (2018), examines the impact of lean and resilient paradigms on supply chain performance in the aerospace industry. Identifying lean, resilient paradigm practices in the industry, shows what the relationships are between these practices and how they affect supply chain performance. The model of this study is presented using interpretive structural modeling. This is the only study that shows lean practice in a completely different way from resilient paradigm practice. In other words, in this study, all the lean measures must be taken first, and doing them creates a suitable platform for chain resilience. While our research showed that there is an engaging interaction between lean and agile practices and in a way, they cannot be considered as two independent paradigms. A study by Rocío, Cristina, Juan (2018) examined the environmental benefits of lean, resilient, and green paradigms in the aerospace industry, and identified the relationship between lean, green, and resilient paradigms in the industry, showing the relationships between these practices. Supplier selection, evaluation, and monitoring, electronic supply chain, supplier participation in new product development, timely delivery, information exchange and communication with suppliers, lean training are the most important lean measures in this research. The results of this study, similar to our research, show that evaluating and monitoring suppliers is a basic practice and in the lean supply chain, is a priority practice. The study by Govindan, Khodaverdi, and Vafadarnikjoo (2015) examined the impact of lean, green, and resilient measures on supply chain performance metrics. This study includes 6 practices for the three paradigms of lean, resilient, and green. Timely production and total quality management are considered lean measures. The results of this study, which was carried out using interpretive structural modeling in the supply chain of the automotive industry, showed that just-in-time production is considered a basic practice and facilitates total quality management. In our study, the relationship between JIT and TQM was the opposite. In a way, our research experts believe that trying to implement TQM provides the basis for using JIT. Although the interaction of these two practices with each other seems to be two-sided, no study was found to show exactly what the relationships between these two practices are. Finally, the results of their research showed that the interaction between practices leads to a reduction in the operating costs of the chain, which was also confirmed by our research. Castro's (2014) study examined the effect of lean and green paradigms on the operational, economic, and environmental performance of the supply chain. In this research, reducing the size of the production batch and direct delivery to the place of use leads to increased quality, reduced cost, and ultimately customer satisfaction. Since in the supply chain of military products, production is based on order, the reduction of the product category was not one of the important measures of purification and direct delivery to the place of use within the production, and timely delivery was defined. And in our research, the results also showed that this measure will improve speed and reduce costs.

5.2 Managerial implications

The managerial implications that can be inferred from this research can be summarized in two questions. Firstly, why some important practices in the lean and agile military product supply chain cannot be implemented (Derived from Matrix IFA)? And secondly, why is the hierarchy of important and feasible practices of the lean and agile hybrid paradigm in Figure 5, and how do these practices improve the key performance parameters of the military product supply chain?

In answer to the first question, low-implementation capability practices can be classified into several categories that managers, in the first step, should try to remove the obstacles in front of them to implement them. These categories are included the inability of military industry suppliers, the small number of suppliers in specific areas required by the defense industry, technological limitations of manufacturers, limitations of specialized human resources, lack of incentive and equitable systems, organizational structure, and traditional hierarchy, and cultural issues.

But in answer to the second question, given that lean and agile paradigms are implemented in the form of their practices, managers must pay attention to the priority of implementing their practices. Given that the practices of paradigms interact with each other and can help implement each other or facilitate the implementation of other practices, the priority of implementing the practices of paradigms should be based on their prerequisites. The interpretive Structural Modeling (ISM) technique revealed hierarchical relationships between the practices of lean and agile hybrid paradigms. The managerial implications of the ISM model are described in the following.

The results of structural equation modeling showed that some practices help to apply other practices and, in some way, facilitate their application, so prerequisite practices should be used first, and then other practices should be considered for implementation. The interpretive structural model diagram of LA hybrid paradigm practices is prioritized at 6 levels (levels 4 to 9).

Level 9 practices are a prerequisite for other levels and are the first steps to be used. These practices include continuous improvement (L3), single-source sourcing (L4), evaluation, monitoring, and ranking of suppliers (L1); and interaction and building long-term relationships with suppliers (L12). Given that in recent years, suppliers have played a key role in the military industry supply chain and this role is expanding with the strategy of "small wise core and large capable network", the hierarchical model shows that in the application The lean and agile hybrid paradigm of the supply chain of the military industry, suppliers have a very key role, and without considering them and only focusing on the practice taken at the middle level of the chain, it is not possible to lean and agile the chain properly. Therefore, selecting suppliers and evaluating them in the right machine can help to improve the performance of the chain and provide a basis for interaction and long-term relationships with the supplier, which helps use many other lean and agile measures. On the other hand, by preparing a transparent agreement, any ambiguity in the contract is avoided, and by explicitly and fully stating all the terms and conditions of the contract, any misinterpretation between the supply and production levels is prevented and each chain partner doesn't interpret it in its favor. They do not increase the efficiency and effectiveness of their interaction and contribute to purification. On the other hand, the application of continuous improvement at the production level also understands and considers appropriate relationships with suppliers at the chain level. Continuous improvement is based on the philosophy that to make improvements in organizations, we should not necessarily look for explosive or sudden changes, but any kind of improvement or correction, provided it is continuous, will improve productivity in organizations. Applying this approach has been cited as a key step in leagility supply chains. Long-term, trust-based interaction with suppliers can lead to single-source sourcing and bring a positive relationship with the unit supplier, a common language with it, accuracy, low cost, and high quality.

Level 8 practices include the use of information technology in product design and development activities (A3) as well as in product manufacturing activities (A4). Application of IT in product design and development activities through the possibility of multi-dimensional design and its editing and simulation, the possibility of manufacturing and assembly with existing equipment and facilities, providing various designs using various raw materials, simulating the product production process, the possibility of modular product design, etc., can help to quickly perform activities, as well as their effectiveness and efficiency. Also, the use of IT in production activities through data exchange and improving their level of accuracy, coordination between different production departments, the use of different software in the production environment such as various production planning software, ERP (enterprise resource planning), Office automation software, warehousing software, etc., change management in programs and orders, preparing a list of parts and raw materials, as well as specifications of materials used in production in accordance with the inventory level, providing accurate, accurate and timely information (Information Management Systems (MIS)), Support for Manager Decisions (Decision Support Systems (DSS)), Use of Sensitizers, Artificial Troubleshooting Systems, Artificial Intelligence and Expert Systems, Inspection and Testing of Components, Robot Construction Increasing the level of automation in production, using flexible production systems (FMS) and computer-aided manufacturing (CAM), in process design and production control, etc. can improve speed, decision making, quality improvement, coordination and integration Today, information technology and computers, in addition to being integral to mechanical processes and technologies, Iodine (such as manufacturing machines such as CNCs) has been transformed, which helps to improve chain performance by increasing accuracy and producing products with less waste and cost, better quality and higher production speed. The hierarchy model of leagile practices shows the use of this technology in the supply chain, as a basic practice, facilitates the application of other measures.

Seventh-level practices are production level measures that focus on improving the quality level of the product. These measures include Six Sigma (L7), quality control loops (L6), total quality management (L5), and comprehensive productive maintenance (L8). Comprehensive productive maintenance, despite helping to facilitate the smooth flow of production through a timely performance of net activities, also leads to timely replacement of parts and their proper maintenance by improving the quality level of products. Measures at this level of the hierarchy indicate that performing quality activities is the basis of many other supply chain leagile practices.

Level 6 measures include the ability to change the order size by suppliers (A1), the ability to change the order time by suppliers (A2), reduce the product development cycle time (A5), the ability to change the production mix (A8). The ability of suppliers to reduce ordering time can provide parts and raw materials to manufacturers in a shorter time and help reduce product development cycle time. The ability to change the composition of production will be achieved when suppliers can change the order size and timing. All of this enhances innovation and speeds up the chain and reduces its cost.

The focus of the fifth-level practices is on improving time. Just in time supply (L2), just in time production (L5), Kanban system (L11), improvement of production scheduling and planning (L14), are among the practices of this level. The action of the timing of chain operations has somehow categorized these measures on one level. In the military industry supply chain, after applying practices aimed at improving the quality level of products, the use of time-consuming practices is introduced as lean and agile hybrid paradigm practices. Kanban system is in close interaction with JIT and timely supply and improvement in production scheduling and planning will lead to production and timely delivery to customers and enhance the speed of the supply chain.

The fourth level of the hierarchy of leagile paradigm consists of three practices: the ability to change production volume (A6), the ability to reduce production operation time (A9), the reduction of lead time, and product time cycle (L10). These measures are far influenced by other measures and in a way, it can be said that they are the result of applying other measures. In other words, these measures should be used as the final measures of the lean-agile hybrid paradigm.

In general, it can be stated that: First, higher-level measures in the hierarchical model of leagile hybrid paradigm measures are given higher priority (from ninth to fourth level, respectively). Second, the practices at each level can be applied simultaneously. Third, the hierarchy of leagile paradigm practices of the military industry supply chain is arranged in such a way that, are focused respectively, communication and interaction with suppliers, the use of information technology, improving the quality of the product and reducing operating time and finally achieving Ability to change the composition and volume of production, reduce lead time. And fourth, how the practices interact of these paradigms shows that it is not possible to say which of the lean or agile paradigms is superior to the other and should be used first; but the practices of the leagile hybrid paradigm should be implemented, based on the proposed interpretive structural hierarchical model. The interaction of 21 lean and agile practices in the form of 6 levels in the ISM model, leads to product and process innovation in the chain and chain activities are performed with higher speed and accuracy and by increasing the quality of final products and in Production, flow reduces chain costs and creates a significant improvement in the supply chain. In the final model, innovation (PM2) is considered as a basis for increasing production speed (PM3) and product quality (PM1) and ultimately leads to reducing the cost of the chain (PM4), at the first level of the model.

6. Conclusions

Due to the expansion of the supply chain of today's organizations, new supply chain paradigms, including lean and agile, have been proposed and used in many organizations to improve the performance of these vast chains. A lean paradigm is a cost-based approach that provides an improvement in supply chain performance, by reducing or eliminating all non-value-added activities at all stages of the product life cycle, from product design to final delivery to the customer. Agility paradigm, as well as is the ability of the company, both internally and externally with key suppliers and customers, to adapt quickly or respond to market changes and meet customer needs and is essential for today's organizations. How these paradigms interact to improve supply chain performance is still unclear and there is no exact answer in the scientific community. And managers are in a deep dilemma of simultaneously implementing these paradigms. In this study, we tried to examine the interaction of these two paradigms based on their practices. And produce practical knowledge for the simultaneous application of these paradigms. Since the military industry in Iran is a large and significant industry and their managers have tried to implement lean and agile paradigms in it, but the review of the authors of this article showed that the managers did not have a practical model and only did some practices based on their mental judgment, which could not significantly improve the performance of the chain. Therefore, considering the importance of improving the performance of the military industry supply chain, we decided to interact with lean and agile paradigms in the simultaneous application in the study of the military industry supply chain. Consequently, the integrated model of the two paradigms was developed and proposed to the scientific community based on their practices.

6.1 Research limitations and future study agenda

The operating body of military industries did not have a sufficient impression of lean and agile approaches, and the data gathering was difficult. To complete the questionnaires, we had to provide sufficient explanations to the respondents, which took a lot of time. The confidentiality of the military environment was one of the other limitations of the research.

This research has been conducted on the supply chain of land military products, although military industries include diverse air and sea products. Therefore, it is suggested that further research be carried out in other areas of the military industry. Structural equation modeling (SEM) can be used to confirm the statistical validity of the proposed model because structured interpretive modeling is based on expert judgments. Therefore, the use of SEM to confirm the interpretive structural model presented in this study is suggested for future research. Although the final model of this research was based on fuzzy set theories and was conducted in the form of fuzzy ISM, understanding the reasons for the preferences of experts in the pairwise comparison questionnaire will lead to deeper analysis. However, in this research, the analysis is presented from the perspective of the author and based on the case study. Therefore, the use of Fuzzy Total ISM (FTISM) is another topic for future study.

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