Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:54 Issue:09:2021
DOI: 10.17605/OSF.IO/62KSN

INTEGRATING LEAN, GREEN AND AGILE CONCEPTS IN SUPPLY CHAIN MANAGEMENT - A SYSTEMATIC LITERATURE REVIEW

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Abstract:
Over the past few years, organizations have been conducted to implement new patterns by introducing novel material and communication networks and developing more efficient product flows due to market pressures. Supply chains are viewed as a means to succeed in this field, as they may help to implement new management patterns. Three concepts, namely lean, green, and agile, deserve to be seriously addressed due to their significant importance in enhancing the supply chain performance. Nevertheless, conciliating the agile and lean principles for decreasing the environmental impacts is a comparatively new topic that is not clearly and structurally defined. The present paper aims to find new research routes and discover gaps in the literature through a systematic literature review with regard to lean, green and agile paradigms. This work is an attempt to summarize the state-of-art researches on the lean, green, and agile concepts in supply chain management and to try to find the way they are linked to each other.

Keywords: Supply chain management; Agile; Lean; Green; Systematic literature review.

1. Introduction

Lean manufacturing is a production system that was originally developed in Japan by Toyota where it was known as the Toyota Production System (Herron and Hicks, 2008). This manufacturing method is viewed as the most important paradigm in manufacturing (Forrester et al., 2010) as it helps companies throughout the world to enhance their competitive capacity and operational performance (Hines et al., 2004; Wickramasinghe, 2017). The lean concept seeks to deal with waste reduction and production resources in a more efficient manner.

It is widely acknowledged that today the majority of companies are forced to engage in both environmental performance and operational efficiency (Torielli et al., 2011; Garza- Reyes, 2015b) because they are all aware of the increasing concern of people around the world about the environmental impacts of the manufacturing processes as well as the new environmental regulations and ecological policies and requirements.

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Furthermore, the green paradigm has also emerged as a powerful operational method that attempts to reduce or prevent the damaging environmental impacts of the organization's products and services and also to enhance the environmental efficiency of its manufacturing operations. Therefore, one may say that the combination of lean and green paradigms could help companies to make sound decisions that would have positive impacts on the environment (Inman and Green, 2018; Vinodh et al., 2016; Verrier et al., 2014).

Agile paradigm in a supply chain makes it possible for colleagues to exchange data and information, to have rapid response with a sense of recognition. It also allows for the exploitation of unexpected changes in the market demands and in the business environment as well (Yang, 2014). It is worth noting that these three paradigms, i.e. lean, green and agile, emerged in the field of supply chain management (SCM) as the most adequate strategies in order to address the global competition and the fluctuating market conditions as well.

Considering the synergy between the three approaches, while concentrating on the reduction of waste and the rapid response to market demands, pushed the majority of companies to collectively apply the lean, green and agile practices (Dües et al., 2013; Prasad et al., 2016; Azevedo et al., 2016).

Over the past few years, some literature reviews on lean, green and agile manufacturing systems brought important insights in the field. For instance, Farias (2019) made an attempt to systematize the available knowledge about lean and green for the purpose of identifying the way these practices could be structured into a singular evaluation system for the purpose of assessing performance. Likewise, Garza-Reyes (2015b) carried out a similar study in which he tried to collect and analyze the existing contributions to lean, while paying particular attention to its application and its connection with environmental organizational aspects. Indeed, the author took into consideration emerging issues and suggested some possible routes for future research. It is worth citing for example the issue of generating a new research topic about the integration of lean and green with other performance enhancement paradigms.

It should be pointed out that the present paper aims to synthesize of the state-of-the-art of these new paradigms, i.e. lean, green, and agile, with the intention of providing guidance and counseling on the topic, by uncovering gaps and inconsistencies in the literature, and establishing new research directions. Based on the previous discussion, it was decided to address the following research questions:

- *What are the emerging issues in research on lean and agile and how can they be applied and linked to the environmental and organizational aspects?*

- *What are the main routes for further research on the lean-green-agile subject area?*

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The remainder of this paper is structured as follows. First, the introduction is presented in section 1. Next, the research methodology is discussed in section 2 by describing all the steps used to systematize the literature. Then, section 3 presents the findings with a general overview of the literature and its research streams; it also identifies the performance criteria of lean and green practices along with a conceptual assessment framework. The last section (section 4) provides the main conclusions of this research.

2. Research method

It is widely acknowledged that, in nearly all research fields, the systematic or structured literature review (SLR) has become an effective strategy because it follows a crystal clear, accurate, and explicit method in order to acquire an integrated overview of a particular research topic. A clear procedure was developed by the systematic literature review adopted in this paper, as recommended by Tranfield et al. (2003).

As a first step, a simple literature review was carried out in a non-structured way. Next, following this brief step, designated as step zero in Figure 1, the systematic literature review was then structured. Note that this introductory step allows identifying the main keywords and concepts related to the subject as well as the search period.

It is widely admitted that a systematic literature review (SLR) is based on a well-established and in-depth methodology to survey current research findings in a definite subject area (Brocke et al., 2009). In this context, Denyer et al. (2009) suggested that in order to maintain integrity and rigor, a sequence of five consecutive steps must be adopted to ensure transparency and rigor of the method, as shown in Table 1.

2.1. Selection of studies

The electronic databases (EDs) of numerous publishers were used to extract information and publications that are pertinent to the researcher's scope of review. The electronic databases included Emerald (emeraldinsight.com), Elsevier (sciencedirect.com), IEEE (ieeexplore.ieee.org), Taylor & Francis (tandfonline.com), Wiley (onlinelibrary.wiley.com), Springer (springerlink.com), Inderscience (inderscience.com), and Google Scholar (scholar.google.com).

The next step in this systematic literature review consisted in specifying the period of time required for its analysis and coverage. The time period necessary for this task is supposed to be sufficient to cover articles during the period from 1996 to 2018. Research about the integration of lean into the environmental concept started in late 1996 in the state of Florida (USA) where companies began to develop their proper environmental management systems in order to lessen risks and abide by the government regulations.

Indeed, academically peer-reviewed and full-text journals and book chapters, as well as conference papers, on the lean, green, and agile paradigms were explored using specific search strings. The combination '(lean) AND (green), (green) AND (agile), (lean) AND (environment*)' was used according to the key words given in Table 1. These terms were

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jointly used with supply chain in order to distinguish articles dealing with the coverage of these topics. These keywords were searched in the abstracts and titles. For all the queries, the term “supply chain” was used as an additional filter in the body of the text.

A diagram of the sequence of operations was used to arrange all the articles found in a database and to filter them based on particular criteria. Note that these criteria were essential in determining the quality of the results. The total number of articles found was actually 3512.

Afterwards, all the papers were sorted by their titles and abstracts to make sure that these papers comply with the study scope and to exclude the articles that did not discuss the lean, green, and agile concepts. Finally, only 270 articles, which discussed the two paradigms of lean and green, were identified. Moreover, the integration of all three systems of lean, green, and agile, was discussed. Then, all recovered articles were imported and stored in the Excel spreadsheet.

Table 1: Detailed systematic literature review

SLR Phase	Method	Tool
1.Question formulation	Identifying gaps from the highly cited journals	Forward review
2.Locating studies	Define the Electronic Databases	Elsevier, Springer, IEEE, Emerald, Taylor and Francis, Wiley, Inderscience, Google Scholar.
3.Study selection and evaluation	Define the search period	1996-2018
	Define the inclusion/exclusion criteria	Lean terms with green, environment- Lean terms with green and agile- Agile terms with green, environment: These terms were used in conjunction with supply chain Peer reviewed articles published in Journals or Proceedings of international conferences or “Book chapter”
	Define search strings	Lean Green supply chain; Lean Green Agile Supply Chain; Green Agile Supply Chain
4.Analysis and synthesis	Select a method to analyze qualitative data	Thematic synthesis
5.Reporting the findings	Analyze critically literature	-

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2.2. Study analysis

The synthesis of qualitative research may be achieved using various methods that involve thematic analysis/synthesis, qualitative meta-summary, qualitative meta-analysis, qualitative comparative analysis, and grounded theory. The most adequate approach is the thematic synthesis due to its efficiency in identifying essential recurring themes. Therefore, two main groups were formed as a preliminary classification in order to sort out the chosen articles. The first category included articles that discussed the lean and green concepts and the second one involved article related to the integration of lean, green and agile concepts. It should be noted that the green paradigm was employed in both categories due to its relevance and pertinence to this study. Note also that the number of articles in the first group was 52, while there were 24 articles in the second one.

In light of this classification, it was decided to realize a new categorization which helped to formulate a new stream for these two groups. Indeed, Figure 1 presents diverse research streams in the lean-green-agile intended for each field of research, such as the influence on organizational performance, the relationship with other approaches, the integrated implementation, and the compatibility between lean and green.

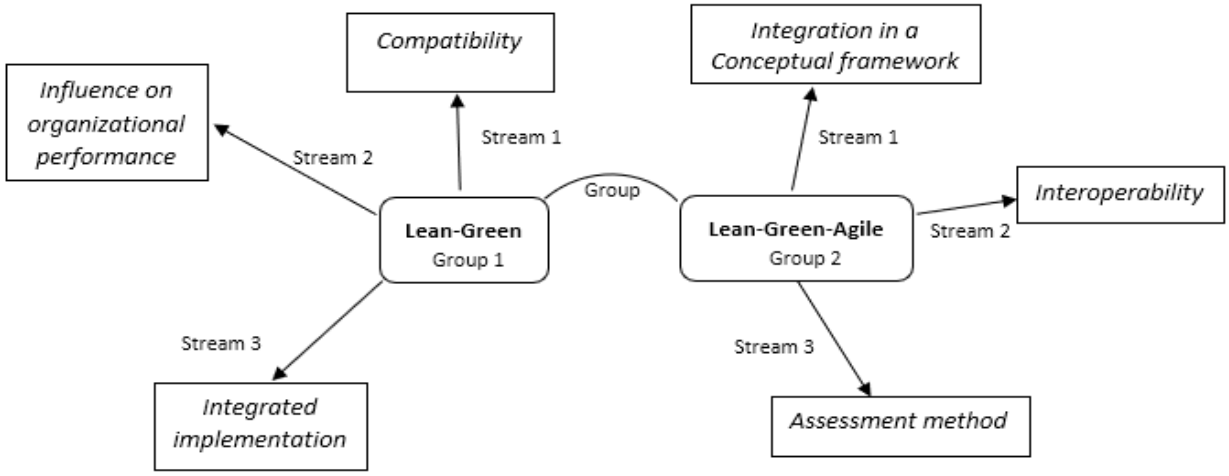

Figure 1: Concept map

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3. Results

This section provides a descriptive analysis based on the data selected from the previously screened papers. In addition, a qualitative analysis was carried out in order to explore the possibility of integrating lean and green with Agile.

3.1 General overview

Table 2 summarizes an excerpt of selected papers. Based on the finding's papers, one may say that the lean and green concepts started attracting particular attention within the research community in the year 2010.

A chronological summary of the papers published since1996. The majority of these papers are found within the period from 2011 to 2018. The largest number was published in 2015. These findings therefore indicate that the concepts of lean, green, and agile constitute interesting research themes, and are expected to be increasing in the coming few years. The results suggest that the most cited articles are in the University Press of Florida (1996) with 1117 citations, and in King and Lenox (2001) with 1008 citations. It is useful to know that Florida carried out the first research on lean and green paradigms.

Figure 2 sums up the distribution of papers in accordance with their related journals. As can be seen, the Journal of Cleaner Production prevails with 18 articles (25%) of the total number of lean-green-agile publications. It is followed by the International Journal of Production Research, the International Journal of Production Economics and the International Journal of Lean Six Sigma with 3 papers each. Figure 4 shows an article that was found in 30 journals. It should be noted that though researchers generally preferred journals, conferences were also employed in complementing publications about the lean-green-agile system (10% of conferences).

The literature reviews and case studies were prevalent and widely used. Nevertheless, surveys and models seemed to be increasingly utilized, particularly when dealing with a robust research topic.

The geographical distribution of journal *publication* was determined based on the country of the first and second authors as main contributors. Most publications were from Portugal (17 articles), the second highest number was from USA (11 articles) and the remaining papers (22%) were from developed countries, particularly from India, Brazil, China, Singapore and Turkey.

Figure 3 presents the distribution of industrial applications in each article. Industrial applications included sectors such as multi-sectoral automotive, metal, food and agri-food, textile, logistics and many others. The multi-sectoral section involved all publications dealing with several case studies. Note that the industrial applications could be applied in various sectors. Figure 3 indicates that the largest number of applications were from

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multiple sectors, with 28 articles, and from the automotive industry with 15 articles. The remaining articles originated from activities such as metal (Ng et al., 2015; Domingo and Aguado, 2015), food/agri-food (Venkat and Wakeland, 2006; Folinas et al., 2014), textile (Raj et al., 2017), logistics (Esmemr et al., 2010), aerospace (Ruiz-Benitez et al., 2017), construction (Banawi and Bilec, 2014), and electronics (Chiarini, 2014).

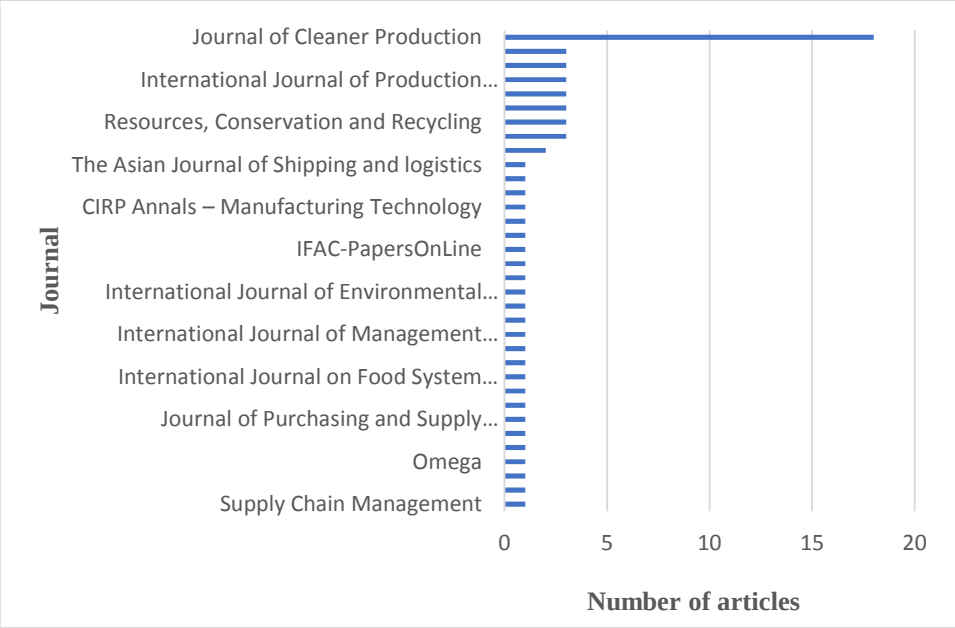

Figure 2: Number of publications in each journal

3.2 Concept map

Although the articles found in the literature review were related to the three concepts of lean, green, and agile, the preliminary classification indicated that they generally concentrated on different streams, in accordance with each group. These streams involved the compatibility between lean and green, their impact on performance, the integration of lean and green in a consolidated approach, etc. (Figure 1).

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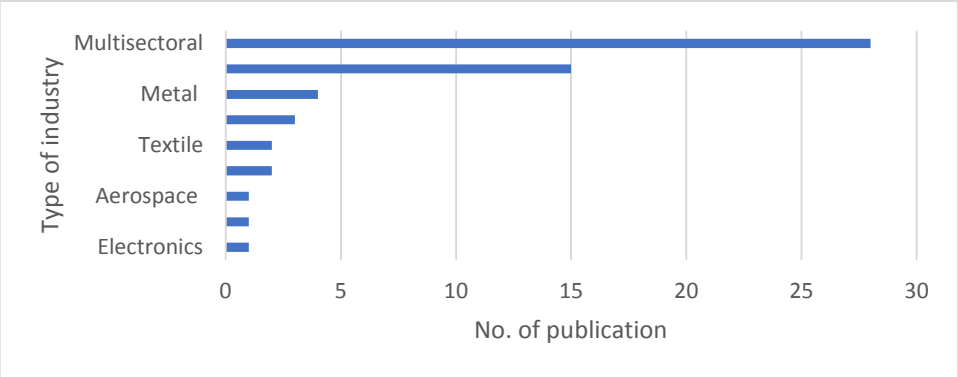

Figure 3: Number of articles by industrial applications

3.3 Research streams

3.3.1 Lean and Green paradigms

a Compatibility

Over the past few years, most companies have been forced to seek options by moving to green procedures in order to put together the actual established profitability, efficiency, customer satisfaction, quality, as well as responsiveness and performance measurements with green initiatives and objectives. The result of the integration of all these elements led to green and lean. Consequently, researchers were pushed to seek the potential merger of the lean and green approaches by exploring into their synergies and divergences.

A number of researchers suggested that in general lean and green may function together efficiently (Dües et al., 2013; Garza-Reyes et al., 2014; Garza-Reyes, 2015). It should be mentioned that various connections, such as waste reduction, lead time reduction, product design, use of different concepts and methodologies to deal with people, organizations, and relationships with the supply chain, exist between the lean and green paradigms (Larson and Greenwood, 2004; Mollenkopf et al., 2010; Garza-Reyes et al., 2014; Garza-Reyes, 2015; Dües et al., 2013; Wiengarten et al., 2013; Johansson and Sundin, 2014). In this context, Galeazzo et al. (2014) suggested that lean and green practices may be achieved either at a later time or at the same time, thus engendering sequential or mutual interdependencies.

Even though lean and green are not fully consistent, one may still assert that they cannot be combined in some areas. In this regard, Dües et al. (2013), Garza-Reyes et al. (2014), Garza-Reyes (2015), Johansson and Sundin (2014), and Mollenkopf et al. (2010) suggested that lean and green are different in some ways with respect to, for instance, waste definition, value structure, process structure, performance metrics, customer type, and tools/techniques used. Consequently, Kleindorfer et al. (2005) pointed out that lean

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and green practices are distinguishable, and therefore, they both have different effects on business performance.

b. Integration

While some authors consider that there is incompatibility between lean and green concepts (Section 2), others however insist on compatibility between them and propose integration methods as a consolidated approach. According to Pampanelli et al. (2014), integrating lean and green concepts into a well-constructed strategy is essential for the simultaneous implementation of these two concepts and the benefit of the cooperative effect between them. Likewise, Mollenkopf et al. (2010) suggested that in order to extract the synergies existing between the two concepts of lean and green, they must be integrated and implemented together. Table 2 shows an excerpt of articles that combine the two systems of lean and green. Numerous articles have adopted lean and green concepts, in order to maintain their competitivity in the industry and to develop their overall performance (Caldera et al., 2017; Chugani et al., 2017). These articles developed approaches to be applied either in the manufacturing industry (Diaz and Elsayed et al., 2013; Pampanelli et al., 2014) at the operations/processes level or in the supply chain manufacturing (Parveen et al., 2011). By integrating lean and green, significant cost savings across SC may be realized, as the unnecessary usage of processes or resources that generate waste are identified and eliminated (Beske & Seuring, 2014; Schaltegger & Burritt, 2014; Stindt & Sahamie, 2014). These articles showed a limited amount of research that developed models and frameworks to integrate the concepts of lean and green as a consolidated approach and for implementing them in a specific sector.

c. Impact on performance

Performance depends on various environmental, financial, operational dimensions and is directly related to sustainability and to the perception of the client (Yang et al., 2011). The effect of individual and concurrent lean and green practices on different composite dimensions of organizational performance has been enquired in a decisive study related to this topic. The different lean methods may enhance the sustainable business practice. These methods have positive impacts on enhancing the environmental performance.

The results obtained from a study previously conducted and summarized in Table 2, adopting lean and green practices, engendered positive impacts on different dimensions of performance. These observations are based on the conclusions of Dües et al. (2013) who indicated that companies that enforce the lean and green concepts can achieve a great deal of environmental and operational performance. As the conclusions from the studies are not sufficiently coherent and straightforward, the effect of lean and green on organizational performance continues to be viewed as a confined and uncertain issue.

In this respect, many investigators have established a number of approaches and models for the purpose of quantifying the contributions of these two systems to performance. For

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instance, Carvalho et al. (2010) suggested a theoretical pattern to assess the correlation between lean and green practices and supply chain performance. Furthermore, in addition to the investigations conducted on approaches that evaluate to what extent the lean and green paradigms can improve the supply chain performance, some authors developed other patterns and approaches for various objectives. For example, Verrier et al. (2014) benchmarked the lean and green practices. As for Cabral et al. (2012), they suggested that lean and green support decision-making in choosing the best suited practices along with key performance indicators. With regard to Duarte and Cruz-Machado (2014), they tried to suit an appropriate scorecard tool to evaluate the environmental performance.

The supply chain is of paramount importance when it comes to improving organizational competitiveness, productivity, and profitability. In this regard, most of the models and methods cited here have been employed in the supply chain (Carvalho et al., 2010; Cabral et al., 2012; Duarte and Cruz-Machado, 2011, 2015; Folinas et al., 2014; Espadinha-Cruz et al., 2011; Duarte and Cruz-Machado, 2014). However, only the method developed by Verrier et al. (2014) was tested in the manufacturing and logistics sectors. To the best of our knowledge, only a few strategies have been developed for assessing the lean and green practices, particularly in the industrial sectors.

3.3.2 Lean and green with another concept

Carvalho et al. (2011) indicated that lean and green practices are beneficial to supply chains as well as to operations and processes. They also added that adopting these two concepts allows minimizing costs and environmental risks. Nevertheless, other authors believed that agility is another concept that can be unified with lean and green paradigms to enhance the efficiency and sustainability of the supply chain and to improve operations and processes. Below are three sections that report about the existing literature that unifies lean and green with another concept.

a. Integration

Rosário Cabrita et al. (2016) examined the possibility of combining the lean, agile, resilient and green (LARG) paradigms with the Business Model Canvas (BMC). They found out that the available literature related to both areas of LARG and BMC shows a notable gap. Their papers addressed this knowledge gap and hence contributed to the study and development of a business model to be adjusted to the LARG concept. However, their proposal has not been implemented so far and therefore suggested to apply this business model in the form of a case study.

In the same perspective to develop a business model that integrates lean, green and agility, Figueira et al. (2012) deduced from the literature that new manufacturing models may be executed in today's companies in conjunction with human dimensions in view of preventing health risks to employees and deficits to organizations. Moreover, they established a theoretical foundation that integrates the execution of ergonomic and safety design

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standards throughout the different implementation stages of lean, agile, resilient and green paradigms. They asserted that when one or several of these four practices are executed, the effects on the human resources of the organization must be taken into consideration. He proposed to apply this theoretical model to a real case study.

As stated by Azevedo et al. (2011), a conceptual model is supposed to be used to examine the relationships between supply chain management (SCM) practices and supply chain (SC) performances and to help developing supply chains that are likely to become, at the same time, leaner, greener, more agile, and more resilient. It should note that the present article aims to present a performance measurement technique that helps decision makers to assess and control the results reached through the execution of these four concepts. The shortcoming of this theoretical framework lies in the fact that no validation was performed. Consequently, additional investigation about the impact of lean, agile, resilient and green practices on the performance of a manufacturing supply chain must be carried out. Furthermore, for the purpose of enhancing LARG performance, Cabral et al. (2012) established a structured model based on the analytic network process (ANP) to select the most adequate LARG supply chain management practices and *key performance indicators* (KPIs) to be executed by organizations in a supply chain (SC).

On the other hand, Cabral et al. (2011) considered an information pattern for a supply chain management (SCM) platform in order to confirm current integrated LARG paradigms. They suggested a subset of an information model, more specifically an integrated Class Diagram to support LARG paradigms in SCM and in some Use Case Diagrams.

b. Supply chain interoperability

Legner and Wende (2006) were first to introduce the concept of Business Interoperability. They defined it as "*the organizational and operational ability of an enterprise to cooperate with its business partners and to efficiently establish, conduct and develop IT-supported business with the objective to create value*".

It is necessary to build up a profound understanding of the advantages and drawbacks related to the lean, agile, resilient and green concepts to achieve an interoperable supply chain. Previous works conducted by Carvalho et al. (2011) examined the impact of LARG on the performance of a supply chain, while considering divergences and synergies.

Furthermore, the above-mentioned papers aimed at providing a range of supply chain management practices in which interoperability issues are involved. A number of researchers made an attempt to assess the interoperable lean – green - agility practices. In this context, Espadinha-Cruz et al. (2012) established a pattern along with a decision-making model using fuzzy sets to evaluate the interoperability in lean, agile, resilient and green supply chains. This model was aimed at assessing the situation needed to find out

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where there is no interoperability. Indeed, Espadinha-Cruz and his colleagues suggested utilizing the above decision-making model to other supply chain actors for the purpose of analyzing B2B views and exploring the possible ways they can directly estimate interoperability through the use of performance measures.

Furthermore, Espadinha-Cruz et al. (2013) indicated that two decision making models may be used to improve competitiveness and performance in supply chains (SCs) by evaluating interoperable supply chain management (SCM) procedures utilized in automotive industry and a method to develop cooperation through a structured model of Axiomatic Design. Moreover, in order to evaluate the LARG interoperable practices, Espadinha-Cruz et al. (2013) provided a conceptual class diagram to establish a connection with a case study they developed in 2012 in an automotive Supply Chain, that is between the focal firm and its suppliers.

c. Assessment method

A number of procedures have been proposed in the literature (Azevedo et al., 2013; Ferreira et al., 2012; Fazendeiro et al., 2015; Azevedo et al., 2016) in order to assess leanness, agility and greenness. In addition, the execution of LARG management practices was assessed using a fuzzy LARG index model. Afterwards, an illustrative case methodology followed (Azevedo et al., 2013; Ferreira et al., 2012). The same procedure was employed by Fazendeiro et al. (2015) as a facilitator to the proposed LARG assessment model. The suggested framework is also based on Enterprise 2.0 which is generally defined as a system of Web-based *technologies*. Furthermore, Azevedo et al. used the Delphi technique along with a linear aggregated method (2016) to estimate the degree of leanness, agility and greenness.

3.4 Discussion

All the studies reviewed in the preceding sections are presented and analyzed in what follows. The literature review indicates that only a few studies have suggested a well-organized structure that integrates the lean, green and agile concepts. However, to the best of our knowledge, no study or framework has tried to implement these three paradigms so far. For this reason, we found it necessary to fill this gap in the literature by designing a well-organized framework that aims to integrate the lean, green, and agile (LGA) practices. It is worth noting that the above-mentioned literature review discussed a fundamental matter that may be used to upgrade the conceptual framework which in turn makes the implementation of LGA easier. In this context, the first proposition made by Carvalho et al. (2016) consisted of examining the divergences and commitments connecting the lean, agile and green paradigms.

The same limitation considered in this work concerns the model relationships that were developed based on a narrative method deduced from the literature review; this represents

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only a limited perspective of supply chain dynamics. The second proposition lies in the fact that the interoperability between SC practices can help to implement these three concepts. These two propositions may help to have a better understanding of the tradeoffs linking the lean, green and agile concepts. In addition, before applying the LGA practices, it is highly recommended to design a method that helps to assess the degree of leanness, greenness and agility within the manufacturing companies.

3.5 Opportunities for future research

Various issues related to lean, green and agile concepts were discussed and analyzed in the previous sections. As expected, some research streams were extensively explored by researchers while others were poorly investigated and still need further research.

The present section provides some research questions that would certainly assist researchers in elucidating the lean, green and agile concepts. Formulating appropriate research questions can surely help and guide researchers to address the most relevant issues and avoid losing their time in unnecessary directions (Max, 1997; Bryman and Bell, 2011). Consequently, formulating good and well-thought research questions based on the discussions given in the previous sections would be the best scheme to find paths for future investigations on lean, green and agile paradigms. The potential research questions that could be considered for upcoming research are summarized in Table 3.

Table 3: Research questions for further investigation.

Groups	**Research questions**
Groupe 1: ***Lean and green paradigms***	1. How the synergies and divergencies between lean, green and agile change from one industry to another? 2. Is it possible to measure the compatibility between lean, green? 3. How the synergies and divergencies between lean and green change from operations/process level to supply chain level? 4.How to better environmental and operational performance based on lean and green practices? 5. What is the correlation between a high level of lean and green integration and a high organizational performance?

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Groupe 2: ***Lean and green with another concept***	1.Is it possible to develop a conceptual framework integrating lean-green-agile practices? 2. Can the integration of lean, green and agile practices achieve a high level of organizational performance? 3. How can lean, green and agile practices be implemented together in an organisation? 4. Is it possible to develop a method / model to implement these three paradigms? 5. How can every paradigm influence performance of an organization?

4. Conclusion

It is widely admitted today that environmental sustainability must be viewed as the most essential plan of action for organizations to be successful. Indeed, environmental sustainability must be given highest priority in order to accomplish sufficient efficiency and profitability. Effective implementation of lean, green and agile paradigms should be considered as a potential strategy for flourishing business.

A systematic literature review relating to lean, green and agile concepts was carried out in the present study to identify research directions on the topic and to contribute to determine the best strategies for future research. In addition, this paper aimed to provide insight on how lean and green systems can integrate with agility. In this context, 76 contributions were examined and classified in accordance with the integration between lean, green and agile paradigms. Three issues were found in the first group of lean and green: 1) Compatibility between lean and green, 2) Integration of lean and green, and 3) Impact of lean and green on performance. Similarly, three other issues were determined in the second group of lean, green and agile: 1) Integration of lean, green and agile, 2) Interoperability between these three paradigms, and 3) Assessment method.

The findings indicated that the lean, green and agile concepts still remain limited and unclear and require further investigation based on the research questions previously discussed.

Acknowledgement

The authors would like to thank the contribution of the anonymous reviewers and the editor for the helpful suggestions that greatly improved the original manuscript.

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:54 Issue:09:2021
DOI: 10.17605/OSF.IO/62KSN

Appendices

Table 2. Excerpt of selected papers

N	Author	Year	Title	Method	Database	Industrial area of application
1	Florida	1996	Lean and green: the move to environmentally conscious manufacturing	Survey	California Management Review	Multisectoral
2	King and Lenox	2001	Lean and green? An empirical examination of the relationship between lean production and environmental performance	Survey	Production and Operations Management	Multisectoral
3	Rothenberg et al.	2001	Lean, green, and the quest for superior environmental performance	Survey	Production and Operations Management	Automotive
4	Vais et al.	2006	“Lean and green” at a Romanian secondary tissue paper and board mill: putting theory into practice	Case study	Resources, Conservation and Recycling	Multisectoral
5	Venkat and Wakeland	2006	Is lean necessarily green?	Modeling and simulation	Proceedings of the 50th Annual	Food supply chain
6	Bergmiller and McCright	2009	Parallel models for lean and green operations.	Literature review	Proceedings of the 2009 Industrial Engineering Research Conference, Miami, FL.	Theoretical
7	Esmemr et al	2010	A Simulation for Optimum Terminal Truck Number in a Turkish Port Based on Lean and Green Concept.	Case study	The Asian Journal of Shipping and logistics	Shipping and logistics
8	Mollenkopf	2010	Green, lean, and	Literatur	Journal of Physical	Theoretical

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	et al		global supply chains	e review	Distribution & Logistics Management	
9	Yang et al.	2011	Impact of lean manufacturing and environmental management on business performance: an empirical study of manufacturing firms	Survey	International Journal of Production Economics	Multisectoral
10	Torielli et al	2011	Using lean methodologies for economically and environmentally sustainable foundries	Literatur e review	China Foundry	Theoretical
11	Cabral et al	2011 a	Modelling lean, agile, resilient, and green supply chain management	Modelin g and simulati on	Proceedings of the ITI 2011, 33rd International Conference on Information Technology Interfaces	Multisectoral
12	Cabral et al	2011 b	An information model in lean, agile, resilient and green supply chains	Modelin g and simulati on	2011 IEEE 3rd International Conference on Communication Software and Networks	Multisectoral
13	Cabral et al	2012	Decision-making models for interoperable lean, ag ile, resilient and green supply chains	Modelin g and simulati on	Proceedings of the International Symposium on the Analytic Hierarchy Process	Multisectoral
14	Carvalho et al.	2011	Lean, agile, resilient and green: divergencies and synergies	Literatur e review, Modelin g and simulati on	International Journal of Lean Six Sigma	Theoretical
15	Espadinha-	2011	A model for	Modelin	IEEE International	Automotive

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	Cruz et al		evaluating Lean, Agile, Resilient and Green practices interoperability in supply chains	g and simulati on	Conference on Industrial Engineering and Engineering Management	
	Parveen et al	2011	Integration of lean and green supply chain e impact on manufacturing firms in improving environmental efficiencies	Case study	IEEE International Conference on Green technology and environmental Conservation	Multisectoral
16	Azevedo et al	2012	Influence of green and lean upstream supply chain management practices on business sustainability	Case study	IEEE Transactions on Engineering Management	Automotive
17	Cabral et al	2012	A decision-making model for Lean, Agile, Resilient and Green supply chain management.	Case study	International Journal of Production Research	Automaker
18	Jasti et al	2012	Lean to green supply chain management: a case study	Case study	Journal of Environmental Research and Development	Steel
19	Duarte and Cruz-Machado	2013	Modelling lean and green: a review from business models	Literatur e review	International Journal of Lean Six Sigma Emeraldinsight	Theoretical
20	Dües et al.	2013	Green as the new lean: how to use lean practices as a catalyst to greening your supply chain	Literatur e review	Journal of Cleaner Production	Theoretical

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