Is leagile still relevant? A review and research opportunities

Is Leagile still relevant? A Review and Research Opportunities

Abstract

Leagile is an approach to managing production and supply chain excellence that is a hybrid of conventional Lean and Agile thinking and methods. This paper reviews the extant literature relating to Leagile and in the process identifies important opportunities for advancing research. Although several review works exist for lean operations (e.g. Jasti & Kodali, 2015), this paper seeks to be the first to specifically review Leagile research. Following review of recent, literature reviews (Ho et al, 2015; Jasti & Kodali, 2015), a seven-step process was developed to undertake this research. A total of 225 articles were reviewed, resulting in 53 articles where Leagile was a central theme. Findings include and reveal that Leagile is recognised as important for business excellence (Aykuz, 2014) but under-investigated; papers in high quality publications have declined to date; 73% of research articles used qualitative research methods. Research that involves practical studies comparing the paradigms lean, agile and leagile, tends to better understand the difficulties and better implementation practices of the theme. The service, SME and health sectors are particularly fitting for further work given their competitive, progressive and relatively unexplored nature.

Keywords:

Leagile, Quality Excellence, Lean, Agile, Review

1. Introduction

Katayama & Bennett (1999) noted that dramatic changes in the business environment caused by market instability, technological development and globalisation are affecting manufacturing companies, this is still the case today. Companies no longer compete between companies, instead it is their supply chain arrangements that determines their successes or failures (Christopher & Towill, 2001), and companies must match their operations with customer needs and in order to accomplish this goal, managers must learn to recognise the most adequate strategies (Hallgren & Olhager, 2009; Lemieux *et al*, 2015). The concept of lean manufacturing that is synonymous with the Toyota Production System, has clearly been a key driver in this ongoing change (Krishnamurthy & Yauch, 2007). The lean strategy advocates optimisation of process flow and encourages the full use of workers' capabilities. The principles focus on the reduction of cost by assuming that the company should have only the essential quantity of production supplies along with building up a system that will offer an opportunity for workers to develop their full abilities (Sugimori *et al.*, 1977). An ability to quickly reconfigure aspects of one's operations later became an important competitive factor. Here, 'Agility' in manufacturing systems is flexibility (Christopher & Towill, 2001) and enables organisations to grow in a competitive market of unexpected changes and give a rapid response to fluctuating markets driven by customer-based evaluation of services and products (Yusuf *et al.,* 1999).

A hybrid approach that some companies have adopted is the combination of both lean and agile strategies, a total supply chain perspective commonly referred to as 'leagile' (Naylor *et al.*, 1999). The main difference between the two approaches in terms of customer value is that lean targets Muda (wastes) and uninterrupted flow that is central to sales prices, whereas agility focuses on flexibility and speed which are central to customer service (Aitken *et al*., 2002). Despite the differences, the connection between the two strategies can be extremely beneficial for organisations, particularly in terms of total quality excellence (Akyuz, 2014). Lean allows companies to target much smoother demand and reduced variety leading to cost reductions while agility enables focus on a highly variable demand, product variety, and the capability of delivering to an unpredictable marketplace (Mason-Jones *et al*., 2000b).

According to Naim & Gosling (2011), there is a need to research a generic definition of Leagile, its characteristics and attributes. Although recent reviews have looked at Lean (Jasti & Kodali, 2015), Leagile supply chain risk (Ahmed & Huma, 2018), Lean performance (Negrao et at, 2017) and Lean healthcare (Costa & Filho, 2016), to date, a Leagile review has not directly been addressed. This paper therefore provides a full and systematic review of Leagile. This paper seeks to understand the current state of research into Leagile systems and provide insights as to future research directions.

To explore these research questions in depth, the paper is set out as follows: introduction followed by a background on lean, agile and leagile approaches is presented. Section three details the research methodology adopted, and section four presents the results of extant literature on the key themes. Section five presents discussion, conclusions and directions for future research.

2. Background

2.1 Lean

The term lean manufacturing was first mentioned in the book 'The Machine That Changed the World', (Womack *et al*, 1990) when the authors reported findings from their study of the Toyota

Production System. The lean concept has a clear focus on the reduction and elimination of waste (Ohno, 1988). Ohno, a former vice-president of Toyota implemented changes and created the basic just-in-time framework in the company, so it could compete following World War II. Lamming (1996) has since expanded the use of this term from manufacturing firms to supply chain management and to encompass other industries.

The lean methodology puts emphasis on zero waste or 'Muda' in Japanese. Ohno identified seven categories of waste (overproduction, waiting, transportation or conveyance, over processing or incorrect processing, excess inventory, unnecessary movements and defects) and suggested ways to avoid them. According to Womack & Jones (1996), lean thinking supports organisations in "specifying value, line up value creating actions in the best sequence, conduct these activities without interruption whenever someone requests them, and perform them more and more effectively". Lean advocates that companies use more efficient human effort, equipment, time and space while offering the client what they want and what the customer considers as value.

One of the most important aspects of lean thinking is the definition of value, determined by the client's perception and how much he is willing to pay for it. Thereafter, everything that does not add value in the buyer's' point of view is considered as waste (Bicheno & Holweg, 2004). Considering these features, it is possible to assume that the application of lean is best utilized in markets where demand is relatively stable and predictable, with a low variety and high volume (Christopher, 2000).

2.2 Agile

Agile manufacturing, a conceptual approach for more flexible manufacturing and supply chain operations. This flexible and high-quality way to produce goods includes both manufacturer and customer. The concept of agile manufacturing involves the ability to deal with changes by the application of partners' capabilities to supply customised products. It calls for the synthesis of numerous technologies within an integrated system (Jin-Hai *et al*., 2003). Agility can also be defined as the skill of businesses to grow in a competitive market of incessant and unanticipated change and being able to respond quickly to fast changing markets driven by customer-based evaluation of products and services (Yusuf *et al.*, 1999).

Agile manufacturing is a broad, strategic, market driven approach that involves taking a balanced consideration of organisation, people and technology in a more integrative way. It is not only driven by technology, although it plays an important role. The objective of agile manufacturing is to create an environment that exercises human skills, judgment, creativity and knowledge and employs the best use of modern computer-based technologies (Kidd, 1994).

2.3 Leagile

The combined strategy of lean manufacturing upstream and agile response downstream is commonly referred to as leagile. According to Naylor *et al*. (1999): "Agility means using market knowledge and a virtual corporation to exploit profitable opportunities in a volatile market place" and "leanness means developing a value stream to eliminate all waste, including time, and to ensure a level schedule"

As noted, lean promotes smooth demand, reduced variety, and decreasing costs, while the agile part enables highly variable demand, product variety, and the capability of delivering to an unpredictable marketplace (Mason-Jones *et al.*, 2000b). This combination therefore allows companies

to manufacture products in a generic format for as long as possible and then just assemble them once an order or request has been received from the final consumer (Chan *et al.*, 2009).

Christopher & Towill (2001) present three approaches for combining lean and agile to form leagile strategies: these being the decoupling point approach, Pareto approach, and separation of 'base' and 'surge' demands. The latter approach separates the base demand, managed with lean procedures, from surge demand, managed with an agile strategy. Here, Pareto analysis is often used and separates products by volume, shows where the top 20 per cent of products are more predictable and could be managed with lean, whilst the remaining 80 per cent being less predictable, could be managed with an agile strategy. In the former approach, a decoupling point aims to use the lean paradigm up to a certain point within the supply chain, and then to employ an agility strategy in the remaining downstream segment. These strategies can be combined dependent upon the exact context and market requirements.

The profit source in each approach is different. Agile takes advantage of the volatility of the marketplace, while lean benefits from the reduction and elimination of non-value adding activities. The distinction can be analysed in terms of market qualifiers and market winners. Quality and lead-time are prerequisites to compete in the market for both methods, however, service level in agile will be the one to win the customer order, and the cost will be the definitive factor in the lean supply (Mason-Jones *et al.*, 2000a). The main goal of this strategy is to place the decoupling point as near as possible to the end user, so the lead time can be minimized (Chan *et al.*, 2009), Table 1 summarises the distinguishing attributes for lean, agile and leagile.

Take in

Table 1: Lean, agile and leagile attributes (Agarwal *et al.*, 2006)

From Table 1, a combination of lean and agile features strategies generates leagile attributes. Lean precedes agile both geographically and temporally. Regarding material flow, the supply chain starts with leanness and then changes to agility. This same idea is used when it comes to formulating a company strategy, start applying lean thinking and then adapt to agile by removing limitations and constraints (Mason-Jones *et al.*, 2000b).

3. Research methodology

The primary objective of this article is to review the published scientific literature on the subject leagile systems, within the *operations management* research field. Therefore, it is descriptive in relation to the purpose of research (Yin, 2003; Robson, 2002). The research conducted in this paper is via literature review, simultaneously organising existing primary publications and explicitly exposing the means used and the results obtained (Pai *et al*., 2004). The literature review provides support for the identification of a research topic, constructing the theoretical knowledge, promoting the analysis and the interpretation of the results (Rowley & Slack, 2004). A mixed method approach is undertaken meaning the combination of qualitative and quantitative approaches, since it required both subjective and objective treatment (Creswell, 2003).

Following review of recent, previous literature review articles (Ho et al, 2015; Jasti & Kodali, 2015), a seven-step process was developed to undertake this research. The review process steps are as follows: (i) database selection, (ii) keywords' selection, (iii) search for documents, (iv) removal of repetitive articles, (v) first elimination of texts, (vi) second elimination of texts, and (vii) review of selected texts.

3.1 Search protocol

Any articles published up to the end of 2017 were reviewed. The research was conducted as follows: (i)The first action was to select a set of academic databases: Emerald Insight, Scopus, Web of Science, Science Direct and the Loughborough University Library database were used. (ii) The keywords for the search were defined and both the terms 'leagile' and 'leagility' were used in the search with each of the databases. (iii) The searches were conducted in ways to achieve capture of all relevant peer-reviewed publications. Keywords used were sought in the title, abstract and keywords. Publication in any year was allowed. Table 2 below shows the outcome of the initial search.

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Table 2: Raw outcome of the initial search

These filtering criteria yielded a total of 225 publications. (iv) Following the initial collection of documents, it was necessary to remove any recurring articles. This process was conducted in two stages: firstly, the removal of repetitive texts under each search term, resulting in 78 leagile and 34 leagility articles; then secondly, the exclusion in between the terms, resulting in 88 papers. (v) The selected texts were analysed for relevance in the study, i.e., articles that investigate the theme or apply its concepts, resulting in a final number of 53 studies. (vi) Each article was fully reviewed, classified and tabulated as part of the results.

The construction of the database took into consideration the research question of the article that sought to understand how leagile / leagility has been addressed in scientific studies. The study was divided into two parts, publication related, and contents related. The first classification, publication related, contains the following subtopics: availability, methodology, year and journals. This first part analyses the relevant literature on leagile and demonstrates its usage and coverage to date. The second classification is content focused and explores the development of the theme and uses the following subtopics: concepts, leagile vs leagility, terms, theme, small and medium-sized enterprises and sector. This second part attempts to explore the leagile theme itself from various works and viewpoints

4. Results

This literature review aims to compile information regarding a specific subject field in a manner that identify and organize the state of the art (Rowley & Slack, 2004).

4.1 Publication related

This section addresses all the articles published related to leagile/leagility, it analyses the availability, the methodology used in each paper, the years that they were published and the journals in which they are available.

4.1.1 Availability

Table 3 separates the articles that specifically discuss leagile or leagility. The division was made by separating the papers that were considered relevant for the study and those that were irrelevant.

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Table 3: Relevant articles

The papers were separated into two categories: Relevant and Irrelevant. The Relevant (51 articles) are the ones that have pertinent information and discussion on leagile whether exploring the subject, conducting a case study or a literature review. Beyond that, they present important information about methodology, approach, purpose of research and unit of analysis. Alternatively, the Irrelevant articles (37 papers) are classified as such due to two reasons: if researchers merely cite leagile, use leagile as a superficial example or references an article about the subject but the paper itself does not study the subject, or they do not provide in-depth information about the variables that are important to leagile.

With the aim of classifying the papers, Table 4 was organised following the categorisation format used by Bhamra *et al*. (2011). It presents the classification of all the papers, 53 in total, considered relevant to the study. The articles were classified according to their methodology, theoretical approach, purpose of research and unit of analysis.

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Table 4: Methodology, approach, purpose and unit of analysis in leagile literature

The information in Table 4 above is summarized in Table 5 below.

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Table 5: Summary of Methodology, approach, purpose and unit of analysis in leagile literature (% of 53 articles)

Table 5 identifies the percentage number of articles contributing to the major areas of research methods, approach, purpose and unit of analysis. The totals do not add up to 100% for each major area as each individual article may contribute one or more of them.

Case study is a research strategy that can be used to provide description, test or generate theory, focusing in the dynamics of examples (Eisenhardt, 1989), and appears in 57% of the studies. Theory building helps understand how a phenomenon occurs and to construct its concepts and interrelationships (Corley & Gioia, 2011), is observed in 55% of the studies. Model and framework development, is where a model is used to represent or explain a specific mechanism and framework is used to display any empirical relationships between various features under study, occur in 45% of the papers. Survey, that is the systematic collection of data, in the form of face interviews, telephone interviews or mail questionnaires (Mathiyazhagan & Nandan, 2010), only arose in 8% of the articles.

Considering the approaches employed by researchers, the vast majority, 70% of the articles, utilised a qualitative approach. This approach focuses on the process and its meaning, so seeking to establish significance to the object under study. Only 8% of the articles used a quantitative approach, which guarantees data accuracy through the numerical and statistical analysis, largely avoiding distortions. Other researchers, i.e., 23% of the reviewed papers, use a mixed methods approach, which uses a combination of features from both qualitative and quantitative approaches (Creswell, 2003).

Regarding the research purpose categorisation, exploratory research, which is defined as the initial research that aims to provide greater familiarity with the problem in order to make it explicit or to build hypotheses, was represented in 57% of the leagile literature. Descriptive categorises a research that provides deeper information about a subject, aiming to describe characteristics and establish relationships between variables, it was seen in 47% of the articles. Explanatory research attempts to explain the reasons of a phenomena, in other words it aims to understand the cause and effect of an event (Yin, 2003), and occurs in only 9% of the texts.

The unit of analysis is the classification of the extension utilized by each author during the research. It describes how comprehensive or specific the studies were. The large majority of the articles have focused attention to supply chains (70%), which is expected as this is where agility has considerable operational effectiveness. In Firm level investigations, (Company) constituted 15% of the articles reviewed. A focus on only the departmental level, made up 8% of all studies. Finally, product type category represented 4% of reviewed articles.

4.1.2 Year

The seminal paper by Naylor *et al* (1999) can be said to have begun the momentum of interest in leagile. This study (Naylor *et al,* 1999) focused on measuring the performance of leagile supply chains and developed ideas that still influence the study of this concept. Figure 1 shows the quantity and frequency of leagile articles published since Naylor *et al's* (1999) work first appeared.

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Figure 1: Distribution of Articles since 1999

From figure 1, the year that had the most publications on leagile was 2011 with seven articles, followed by 2006 and 2009 with six articles each. The years when there were fewest publications are 1999, 2002 and 2004 with only one article each. The study also shows that, within our defined research boundaries, no relevant papers at all were published in the years, 2003, 2005 or 2016.

4.1.3 Journals

Operations management journals with two or more publications with leagile as the focus of study are shown in Table 6 below.

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Table 6: Journals with two or more core Leagile articles

Following data ~~collection the~~collection the most targeted journals for leagile related output comprise: International Journal of Production Economics, International Journal of Production Research and Supply Chain Management: An International Journal. The number of papers published that are presented in Table 6 represents 43% of the total relevant articles found in this study.

4.2 Contents and concepts

This section reviews leagile/leagility content within articles. The concept itself, how each author explains it, the use of the words leagile and leagility, the terms that are used to define the concept, the theme that each paper addresses, the exploitation of small and medium enterprises and the sectors analysed.

4.2.1 Definitions

Table 7 compiles the key definitions stated in the articles.

Take in

Table 7: Definitions of leagile

Although, the majority of authors that developed an article in which leagile was the focus had cited Naylor *et al.* (1999) several authors combined concepts from different researchers and for this reason they are not acknowledged in Table 7 above: - Herer *et al*. (2002); Bruce *et al.* (2004); Bruce & Daly (2006); Krishnamurthy & Yauch, (2007); Hilletofth, (2009); Bruce & Daly (2011); Soni & Kodali (2012); Vinodh & Aravindraj (2013); Birhanu *et al*. (2014); Gunawardhana *et al.* (2014); Purvis *et al.* (2014).

4.2.2 Leagile, leagility and terminology

The selected articles were reviewed in order to understand how the terms 'leagile' and leagility' had been ~~used,~~used. These findings are shown in Table 8 below where most of the papers (57%) use both word terms, often interchangeably.

Take in

Table 8: Leagile vs leagility

A few papers made use of both words leagile and leagility, such as Childerhouse & Towill (2000); Bruce *et al.* (2004); Agarwal *et al.* (2006); Nishat *et al.* (2006); Ambe & Badenhorst-Weiss (2010); Banihashemi (2011); Bruce & Daly (2011); Drake *et al.* (2013); Lemieux *et al.* (2015); and Olsson & Aronsson (2015). Finally, most researchers (55%) used leagility as a noun and leagile as an adjective, for example when referring to leagile supply chain, leagile technique, among others.

A variety of synonyms have been used with leagile/leagility. The most significant (by number of citations as reported by Google Scholar, April 2018) papers were as shown in Table 9. Articles were reviewed to see in which context, leagile was used. The results are noted in Table 10.

Take in

Table 9: Article vs terms

Take in

Table 10: Leagile context

4.2.3 Themes

Amongst all reviewed articles, the most common catagory appeared to be was *supply chain* and its divisions. Supply chain involves physical and non-physical functions (market-mediation function). The physical function covers the conversion of raw materials into parts, components and finished goods and the transport from one point of the supply chain to the next. The market mediation aims to ensure that the variety of products reaching the marketplace matches what consumers want to buy (Fisher, 1997). Thus, a supply chain involves the manufacturer, the suppliers, transportation, warehouses, retailers and customers and all activities involved to fulfil one customer demand (Galankashi *et al.*, 2013).

Within the *supply chain* category, other subdivisions also emerge, such as supply chain management, supply chain strategies, supply networks as well as a combination of supply and demand chains. Supply chain management can be defined as "the integration of key business processes from end user through original suppliers that provides products, services, and information that adds value for customers and other stakeholders" (Lambert *et al.*, 1998). Supply chain strategy helps an organization to use a specific

strategy to determine the benefit of the operation, distribution, services and all its activities (Galankashi *et al.*, 2013). The strategy determines how the supply chain should operate efficiently to compete (Karunaratne *et al.*, 2012). There are two articles about supply networks that can be defined as "sets of supply chains, describing the flow of goods and services from original sources to end customers" (Harland, 1996). Additionally, Müller *et al's* (2009) investigation into supply and demand chains provides the definition as: "A demand chain is a supply chain that emphasizes market mediation to a greater degree than its role of ensuring efficient physical supply of the product". There are 34 articles (66%). that explore the Supply Chain.

There are two articles for each of the following themes: Comparison of lean/agile (Christopher & Towill, 2000; Olsson & Aronsson, 2015), and Services (Rahimnia & Moghadasian, 2010; Rahimnia *et al.,* 2009). These articles compare both methodologies investigate their characteristics, their differences and their capability to consolidate leagile. The services focused area has two subdivisions, mass services and professional services in which leagility is applied. Mass services operations focus on products while professional services focus on process (Rahimnia & Moghadasian, 2010).

The study and application of Leagile concepts into multiple areas has been continuing since the concepts inception, as exemplified by the following studies: Reverse Logistics Process (Banomyong *et al.*, 2008), Application of leagility (Krishnamurthy & Yauch, 2007), Construction (Demir *et al.*, 2012), Decoupling Point (Liu *et al.*, 2009), Mass customisation (Stump & Badurdeen, 2012), – early Concept (Van Hoek, 2000), Operational Strategy (Guimarães & de Carvalho, 2012), Performance optimisation (Chan *et al.,* 2009), Product Development (Lemieux *et al.*, 2015), Production System (Court *et al.*, 2006), Purchasing portfolio model (Drake *et al.*, 2013), Remove Non Value Activities (Chen *et al.*, 2015), Value Networks (Gunawardhana *et al.,* 2014).

4.2.4 Small and medium-size enterprises

The small and medium-size enterprises (SME) have a significant impact in the economy and comprise a big part of industry. In the European Union, 78% of all companies are SMEs and they are responsible for 58 cents in each euro of value added of equivalent net contribution that comes from the companies to the economy (Ec.europa.eu, 2015).

Even though SMEs should work hard to keep up and compete in market, they are less likely to implement methodologies such as lean manufacturing that are used by the bigger companies. And reflecting that reality, there are only a few researches about implementation of those kind of techniques when SMEs are involved (Bakas *et al.*, 2011).

Considering these points, an effort was made to find out how many scientific leagile focused publications address the issue of SMEs. Among all the articles found about leagile/leagility, only 5 dealt with SMEs, equivalent to 9% of the total. These papers being: Nishat e*t al.*, 2006; Krishnamurthy & Yauch, 2007; Huang & Li, 2010; Galankashi *et al.*, 2013; and Ramana *et al.,* 2013.

4.2.5 Industry Sectors

Industry sectors investigated by researchers are listed in Table 11 below. The Apparel and Textile Industry has been the sector where most of the attention has been focused. This sector is generally known to be one of the major sectors in both industrialised and developing countries contributing significantly to employment and revenue (Bruce et al, 2004). The sector is also known to operate in a rather volatile environment with short product life cycles and high product variety hence

adoption of lean and agile strategies are viewed important for the company's success and continuation These conditions probably lend reasons as to why this sector has been popular in studies.

Take in

Table 11: Industry Sectors

5. Discussion and conclusions

Although leagile is a subject that has been studied since the late 1990s, it has not been as intensely investigated as the Lean concept itself, in their work, Jasti & Kodali (2015) discovered 546 articles on lean alone. With reference to Table 3, relevant articles, almost half of the total number of papers were irrelevant to this investigation on leagile, where articles only dealt with leagile in superficial or elementary terms. As leagile is viewed as critical in enhancing excellence in total quality management and manufacturing and supply chain performance, it is somewhat surprising that more focus has not been brought to bear to this field, as an advancement to standard lean theory and operations alone.

Although there is continuing interest in Leagile as a study, publications of good quality and research that may progress the field are observed to be in a decline. There are a few recent articles to be found that have a core Leagile focus, and unfortunatley, these are collectively very poor and not published in strong management journals. Instead, they have been published in provincial conferences and low quality, obscure publications.With regard to the rate of article output, it is noticeable that there is a clear decline in the work on leagile. The importance of the leagile topic can also be recognised by the fact that 32% of articles have been published in strong, international journals of high impact (see table 6) such as International Journal of Operations and Production Management, International Journal of Production Economics, International Journal of Production Research, Production Planning & Control and Supply Chain Management: An International Journal.

In the categories 'unit of analysis', 'theme' and 'term', it was verified that all articles discuss supply chain and it is predominant in the three topics. In the unit of analysis, 69% of the articles discuss about supply chain, 66% of papers have this subject as the theme and 34% of articles refer to leagile as a kind of supply chain. This is because the most important thing for a company is to satisfy customer needs and configuring the supply chain in the right way is a good start to achieve this requirement. With the integration of lean and agile methodologies, it is possible to facilitate the transport of materials, money, resources and information, improving the supply chain depending on the type of product and meeting market demand. These characteristics demonstrate that different researchers agreed and there is a consensus on these issues in the leagile literature.

It was also found that most researchers used leagile and leagility, but sometimes interchangeably. In conclusion, most authors used leagile as an adjective, in order to qualify something, such as leagile supply chain, and leagility was mainly used as a noun.

With regards to small and medium-size enterprises, the current number of publications is substantially low, with only 10% of the total. From a research perspective this is quite insufficient

since SMEs have a great impact in the economy. Research on SMEs ~~therefore, requires~~therefore, requires special attention in order to be able to compete with bigger companies and also with other SMEs since they do not have many barriers to get in the market.

5.1 Research methodologies

Regarding the methodological approach, 73% of research articles have used a qualitative approach which although providing rich and deep understanding, may also give rise to some subjective weakness through specifics of application. The counter argument to this is that through the use of quantitative methods, numerically more objective, these publications have tended to exhibit a shortage of explanatory research. It was found that 36% of all articles made use of a case study methodology, with only half focusing on a specific industry sector. Fundamentally, the research methods must of course reflect the research enquiry objectives and we discover that the majority of research studies have focused on supply chains, using cases to explore and describe in order to build theory. We can now reflect on whether complimentary research methods would add to our understanding of the leagile phenomenon. For example, studies research using quantitative approaches that look at the growing service, retail or healthcare sectors would be valuable additions to the field.

5.2 Research purpose

This study has used definitions of research purpose taken from Robson (2002) where, 'Exploratory' seeks to determine what is happening, 'Descriptive' seeks to describe/profile situations and where 'Explanatory' seeks to show how variables are related. This research finds that only 8% of the relevant articles could be classified as having conducted explanatory research. Having recognised this outcome, even works such as Chan *et al* (2015) that engage with explanatory schemes, the leagile content can become lost in the application of research tools, in this case, algorithm/simulation. Our findings strongly indicate that there is a lack of research pursuing (and therefore a research gap) in using explanatory research and so posing opportunities for researchers interested in pursuing a 'path less travelled' and of advancing academic and practitioner value.

5.3 Leagile performance

Based on the literature review findings, leagile strategies have long been recognised by various industry sectors as useful, particularly so in manufacturing. This recognition and recent increase of research in the area, particularly service sectors such as healthcare, suggests that the adoption of leagile practices and initiatives significantly influence business performance. The traditional approach would be to look at case studies in specific industries to explore how leagile strategies are adopted and evolves depending on changing market situations and to determine whether there is a difference in the way leagile strategy works in different industry settings and contexts. This approach provides deeper insights and enables learning especially for SMEs that are considering adoption of leagile strategies. A good example of this is the study conducted by Kisperska-Moron and De Haan (2011) on fast moving consumer goods sector in Poland where they observed varying degrees of lean and agile applications as market changes occured. Many industries today both mature and upcoming are also required by the various regulatory bodies in which they operate in to carry out more transparent and stringent reporting consequently, enabling researchers to capture objective information to complement existing methods for a more comprehensive understanding. Improvements in reporting can enable

researchers to ascertain leagile related performance for companies. The study by Malmbrandt and Åhlström (2013) for instance offers useful instruments for capturing performance measures on lean production and adoption for companies.

5.4 Sectoral focus

Based on ~~the~~ this review, the adoption of leagile strategies and work done to date seems to be mainly isolated to manufacturing (specifically, apparel and electronics). This makes sense as lean applications were born out of manufacturing (i.e., origins in the Toyota Production System) and gradually adopted in a beyond automotive by firms in other industries More in-depth studies of firms nested in this sector could offer a greater understanding of why adoption is apparently easier and feasible in manufacturing. Research in the service sector has been limited and with an increasing interest in healthcare, there is an opportunity for researchers to explore this sector along with others given that today, many firms consider themselves as providing a bundle of benefits. This will give some insights into how leagile strategies can be promising in shaping business performance and successes. While the concept of leagile may be universally understood, there are differences in measures adopted and cost benefits in various industries hence requires more studies to be done. Different degrees of lean and agile implementations in service supply chains and contexts are also suggested. For instance, Arlbjørn *et al* (2011) studied lean implementation in Danish municipalities using a mixture of surveys and case studies. Through their findings they offered a model that illustrated conditions where lean is seen as appropriate depending on the type of service provided. There is potential for application of lean for organisations operating in the public sector. Their study acknowledges lean philosophy and advocates the need for in-depth research in these sectors.

5.5 Further research

Although the characteristics of a leagile supply chain strategy is known, it is necessary that more practical studies be made by comparing the paradigms lean, agile and leagile, to better understand the difficulties and good implementation practices of the theme. In addition to tests with the three different ~~paradigms, the~~paradigms, the application of the leagile hybrid approaches (decoupling point, Pareto curve, surge and base demands) should be considered. Since each one should be used for different situations, there is scope for more studies about their characteristics and possibilities.

For researchers, further study should be undertaken in a wide variety of industries sizes and types, therefore extending and increasing the comprehension of leagile in different sectors. The leagile subject should be studied specially in services, exploring more mass and professional services and also other areas within these categories. Firms operating within the public sector should not be ignored. The health sector is a particularly fitting sector which has seen recent developments in improvements along the lines of lean and agile. Given the competitive and progressive nature of this industry and mandatory requirements by the state and health bodies, there is a wealth of information that is publicly available for researchers.

Furthermore, given that there is general agreement and consensus on the ‘leagile’ concept, future researchers can take a more rigorous approach by identifying suitable proxy measures on leanness, agility, leagile terms and collecting more objective data for the purposes of empirical testing. This approach will give more latitude in understanding how leagile is implemented and practiced in

service and manufacturing organisations and highlight the factors that may promote stronger performance. Despite the richness gained from case studies, a mixed method could be more insightful.

Small and medium-size enterprises have a significant share of the market and are important actors in the economy. This subject should be more explored because the current number of papers is relatively low with only 10%. In this regard, studies should be done aiming to develop a route map to implement leagility in SMEs and also to establish good practices for those companies. Other interesting lines of research would be the comparisons between the implementation of leagile in SME and large companies and the difficulties each of them faces as well as the differences in perception, pressures and incentives for the adoption of leagile activities. In summary, there are numerous opportunities for future research that this study has found, and the most immediate include:

- Comparison of the lean-related paradigms
- Research of leagile in the service sector
- Research of leagile application in healthcare
- Understanding of practical leagile measures and cost benefits
- Focus on leagile with the SME sector
- Possible application of quantitative methods and approaches to leagile systems understanding

We anticipate that our recommendations will provide direction to future researchers to undertake more rigorous work in this area. Regarding limitations, this study has been selective with the papers that we have included as relevant for the purposes of analysis and therefore disregarded works such as conference papers, doctoral dissertations, textbooks and book chapters. Based on the relevant articles, we were able to categorise and identify the themes that have emerged over the time period and offered suggestions based on analysis. Future studies can make more impactful research by exploring individual themes in less researched industries along the methodologies suggested. In particular, how leagile practices could be further developed or influenced by technologies such as Industry 4.0 and vulnerabilities and risks as associated with the broad theme of resilience and security.

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