Understanding the relationships between information technology and lean and agile supply chain strategies: a systematic literature review

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Abstract

This study analyzes the relationships studied in the literature between Information Technologies (IT) and two supply chain strategies that have similar mechanisms of action: Lean Supply Chain (LSC) and Agile Supply Chain (ASC). The purpose is to identify and understand the role that IT plays in the two strategies depending on the way that it is conceptualized, and whether this is transferred to performance. The Systematic Literature Review is the methodology used to locate articles, select and analyze their content. In general terms, research to date shows a positive association between IT and these two supply chain strategies and that this association improves business results. However, the study shows that research into LSC and ASC has used different conceptualizations of IT and, in some cases, these conceptualizations can have different effects on the study's outcomes. This paper proposes directions for future research and theoretical development are suggested.

Keywords Information technologies · Lean supply chain · Agile supply chain · Systematic literature review

1 Introduction

There is a broad consensus in the literature that supports the statement that for a company to be competitive at the current time, it should not only focus on internal aspects, but also manage its supply chain (SC) efficiently and effectively. As a result, the principles of Lean management and Agile manufacturing have been incorporated into supply chain management (SCM) in

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recent decades. This has given rise to the Lean Supply Chain strategy (LSC) (Lamming, 1996) and the Agile Supply Chain strategy (ASC) (Christopher, 2000). LSC strategy focuses on the elimination of waste and non-value added activities across the supply chain and is associated with level scheduling in an environment of low uncertainty, while ASC strategy focuses on the ability to meet market requirements and requires capacity to be set aside to handle volatile demand (Christopher, 2000; Qrunfleh & Tarafdar, 2014).

However, supply chains are becoming more complex and managing such complexity to provide effective responsiveness increasingly requires adequate and intelligent information processing (Kharub et al., 2019; Qrunfleh & Tarafdar, 2014). In this sense, Information Technology (IT) is a tool that plays a major role in the digitalization and/or development of information management processes at the SC level in the pursuit of responsiveness-related competitive advantages (Calatayud et al., 2019; Zhang et al., 2011). Therefore, since LSC and ASC are strategies related to SC's responsiveness capability, providing, respectively, leanness or agility (Qrunfleh & Tarafdar, 2013) to it, both SC strategies can be supported by IT. Indeed, new developments in IT solutions that can be applied to SC and changes in demand that require very flexible responses have driven up business management interest in the IT-flexibility relationship and inspired researchers to analyze the existing relationship between IT and Lean practices at the SC level (Moyano-Fuentes et al., 2012; Pagliosa et al., 2021). At the same time, IT is considered to be an important enabler that contributes to the achievement of competitive advantages with the ASC strategy (Christopher, 2000; DeGroote & Marx, 2013; Mandal, 2018) and a variety of studies have investigated the role that it plays in driving up agility (Dubey et al., 2019a; Humdan et al., 2020; Sharma et al., 2017).

In this sense, several studies find a positive association between IT and both of these SC strategies (Qrunfleh et al., 2012; Swafford et al., 2008). However, the previous findings suggest that these relationships are expressed in a variety of ways, often in combination with other influential variables; some studies yield contradictory findings when analyzing different types of IT (Ding et al., 2012; Samdantsoodol et al., 2017).

Prior literature reviews exist that have investigated the relationship between IT, SCM, and performance (Zhang et al., 2011), the role of IT in sustainable SCM (Thöni & Tjoa, 2017), and the role of Industry 4.0 technologies classified according to the Life Cycle of Technology in the specific context of the LSC (Núñez-Merino et al., 2020). On the other hand, it would be necessary to analyze separately the impact that IT has on lean and agile supply chains because both strategies can be applied taking into account the decoupling point. Thus, the supply chain would be lean before the decoupling point and agile before the decoupling point (Mason-Jones et al., 2000; Naylor et al., 1999). With this idea in mind, this study investigates separately the relationships between IT and each of these supply chain strategies. The purpose is to understand how the way that IT is conceptualized affects its role in Lean and Agile strategies and whether there is a consequential effect on performance. Our study specifically seeks to identify consensus and opinions, improve conceptual clarity, and encourage the practical exploitation of synergies between the domains. For this, a Systematic Literature Review (SLR) is carried out (Denyer & Tranfield, 2009). The SLR method allows to locate, select, evaluate, and synthesize information on a particular subject (Denyer & Tranfield, 2009). These steps are carried out following protocols that can be verified and replicated by other researchers (Denyer & Tranfield, 2009; Thomé et al., 2016). Furthermore, SLR is argued to be more rigorous and transparent and, consequently, more robust than other unstructured literature reviews (Tranfield et al., 2003). Moreover, SLR is a versatile approach adopted in recent studies on different research topics published in high-quality scientific journals, for example purchasing and supply chain management (Chiksand et al., 2012) and the lean field (Danese et al., 2018). In this sense, SLR is considered to be an appropriate method for this

study as it helps to identify and select the existing and relevant body of knowledge on IT and LSC/ASC, thus providing a comprehensive overview of the literature by answering research questions and indicating future research directions.

The review focuses on survey-based research, following the line of earlier works (Rungtusanatham et al., 2003; Zhang et al., 2011). The survey-based research aims to test theoretical models and the goal is explanatory, looking for correlation and/or causality relationships between variables, whereas qualitative methodology is preferably used for exploratory or descriptive purposes. Therefore, putting the focus on survey-based research will allow us to contrast those relationships previously studied in the literature.

An overview of the different relationships studied and of the empirical support that these relationships receive would be very useful for both theory and practice. For theory, it would inform about the relationships that receive the greatest consensus and identify the contradictions found. This would, in turn, enable the identification of the gaps and the research lines that should be pursued in the near future. At the managerial level, the findings would allow managers to understand IT's role in both of the SC strategies and the variables that should be managed to achieve greater responsiveness in the chain through flexibility and/or agility.

The paper proceeds as follows: after this introduction, the second section presents the background. The third section presents the methodology used. In the fourth section, the results of our research are presented. Lastly, the implications and conclusions are presented in the fifth section.

2 Background

2.1 Key issues, conceptualization

2.1.1 Lean supply chain (LSC) and agile supply chain (ASC)

The LSC concept refers to a set of organizations that work together to reduce waste by efficiently pulling, increasing flexibility, decreasing cost, and improving the quality of supply chain activities from the final customer's point-of-view (Lamming, 1996; Moyano-Fuentes et al., 2019, 2021). At the strategic level, LSC focuses on the application and management of Lean principles and practices across the supply chain (Lamming, 1996; Moyano-Fuentes et al., 2021). In this sense, an LSC must be based on close relationships, information needs to be transparent throughout the supply chain, and performance must be monitored (Mor et al., 2019; Paul et al., 2019; Sangwa & Sangwan, 2018). A fundamental requirement for this is greater coordination and management of physical, information, and financial flows between the various agents involved (Novais et al., 2020). LSC is connected with the responsiveness of the supply chain (Qrunfleh & Tarafdar, 2013).

On the other hand, ASC can be defined as a set of organizations that focuses on the supply chain's ability to understand and rapidly respond to market changes (Christopher, 2000; Tarafdar & Qrunfleh, 2017). The literature suggests that an ASC has some specific characteristics, including being market sensitive and having a high level of shared information and connectivity between partners (Dubey et al., 2020; Gligor & Holcomb, 2012). ASC strategy employs make-to-order provisions, not committing to products until demand becomes known, and using rapid replenishment and postponed fulfillment (Goldsby et al., 2006; Lalmazloumian et al., 2016). ASC focuses on the ability to meet market requirements and requires capacity to be set aside to handle volatile demand (Christopher, 2000; Qrunfleh

& Tarafdar, 2014) by increasing service level and shortening lead times (Stewart & Ivanov, 2019). Furthermore, the use of IT is generally indicated as an enabler for the deployment of this strategy and for supply chain agility to be achieved (Gligor & Holcomb, 2012). Supply chain agility is the term used for the ability derived from the ASC strategy (Sharma et al., 2017).

Furthermore, some literature, points out that the LSC strategy is appropriate when demand is reasonably predictable and stable and product variety is low (Christopher, 2000; Qi et al., 2011), while the ASC strategy is often adopted when there is a high degree of demand and supply uncertainties (Lee, 2002). Despite their differences, LSC and ASC strategies share a common objective, to meet demand at the lowest total cost (Goldsby et al., 2006), and act in a similar way, developing long-term lines of action to achieve flexibility and/or agility objectives in supply chains (Moyano-Fuentes et al., 2019). Another strategy, the resilient supply chain, designs action plans to recover from major disturbances at specific moments in time (major disturbances may or may not occur) and its action mechanism is different from that of LSC and ASC (Ivanov, 2020; Ponomarov & Holcomb, 2009). The similarities of the LSC and ASC action mechanisms has fostered an interest in studying the two strategies simultaneously (Ghobakhloo & Azar, 2018a; Moyano-Fuentes et al., 2019; Qrunfleh & Tarafdar, 2013). Indeed, the concept of “leagile”, which takes the view as the combination of both paradigms, has been promulgated (e.g., Bruce et al., 2004; Mason-Jones et al., 2000; Naylor et al., 1999). Mason-Jones et al. (2000) argue that there are decoupling points within particular SCs that require a Lean approach at one point and an Agile approach at another. The supply chain should be, therefore, lean upstream and agile downstream from the decoupling point in the supply chain (Li et al., 2020; Mason-Jones et al., 2000; Naylor et al., 1999).

2.1.2 Information technology (IT)

IT at the company level is defined as a set of tools that enable the transformation of data into useful information and manage it to meet certain business objectives (Boaden & Lockett, 1991). Thus, IT is applied to various business processes, including processes associated with the Supply Chain (Calatayud et al., 2019). In the IT literature, this broad set of tools (including information systems, communication technologies, and digital technologies) has been conceptualized in different ways. First, IT is interpreted from a static perspective in the literature as a resource that companies can use to achieve their objectives (Powell & Dent-Micallef, 1997). Ways to identify these resources as static elements include a) considering them as an investment in IT, such as IT infrastructure for example (IT investment), and b) considering the extent of the use of IT resources (IT use) (Devaraj & Kohli, 2003; Kamble et al., 2020). Second, IT has been conceptualized from a dynamic perspective that focuses on the capabilities developed in companies by operationalizing the resources that IT incorporates (IT capability) (Bharadwaj, 2000; Liu et al., 2013). Therefore, according to the previous literature (Bharadwaj, 2000; Zhang et al., 2011), these three conceptualizations can be interpreted as three consecutive stages of IT employment. In the first stage (IT investment), IT adoption is incipient and has no direct impact on performance. In the second stage (IT use), companies can perceive greater benefits from IT. In the third stage (IT capability), companies develop capabilities and IT has a greater impact on the achievement of strategic objectives (Zhang et al., 2011). In this sense, drawing on the resource-based view (RBV) of the firm, substantial evidence has been found that when IT is considered an isolated resource (IT investment or IT use), it does not, by itself, constitute a competitive advantage as it can easily be mimicked by competitors (Barney, 1991; Powell & Dent-Micallef, 1997; Yu et al.,

2017). It is when IT resources are used in conjunction with other company resources and capabilities such as human and management resources, that firms develop capabilities that can be generators of sustainable competitive advantage (Dubey et al., 2019a; Yu et al., 2017).

2.2 IT-LSC and IT-ASC relationships

There is some convincing empirical evidence in the literature as to the relationships between IT and Lean and Agile supply chain strategies (Mittal et al., 2017; Qrunfleh et al., 2012; Swafford et al., 2008). The results of some surveys show that IT can support the implementation of LSC practices such as Just in Time delivery, Kanban, and pull systems (e.g., Kamble et al., 2020; Khanchanapong et al., 2014). In the same line, surveys on the relationship between IT and ASC also found empirical support for IT's role in underpinning the accomplishment of agile goals. In this sense, some findings suggest that IT can support, for example, the detection of changes in the environment and the continuous collection of information from suppliers and customers (Dubey et al., 2019a; Tarafdar & Qrunfleh, 2017). Previous findings suggest that IT-LSC/ASC relationships are expressed in a variety of ways (Samdantsoodol et al., 2017; Sharma et al., 2017). Moreover, according to findings in the literature, the relationships between IT and LSC/ASC could be direct, indirect, or complementary. First, the relationship is direct when IT has a direct impact on Lean or Agile supply chains, i.e., these supply chain strategies directly benefit from the application of IT (Boyd et al., 2012; Sangari & Razmi, 2015). An indirect relationship means that the IT effects on Lean or Agile supply chains are mediated by other variables (Boyd et al., 2012). Finally, the relationship is complementary when the interaction (moderation or joint effect) between IT and LSC or ASC practices results in better (or worse) outcomes, for example, by compensating for (or strengthening) each other's weaknesses (Boyd et al., 2012; Tarafdar & Qrunfleh, 2017).

Quantitative methods of analysis of information captured through surveys are used to measure the relationships between variables (Rungtusanatham et al., 2003). Survey studies provide theoretical knowledge on how variables are related that is highly generalizable (Karlsson, 2010). However, in general, surveys also have some limitations (Karlsson, 2010). For example, it should be noted that the effectiveness of the method depends on several aspects such as the use of clearly defined concepts (Shah & Goldstein, 2006). More specifically, some concerns can be highlighted about survey-based research on the IT-LSC/ASC relationship. First, initial scrutiny has found that a long list can be drawn up of seemingly different IT measurements. This concern is similar to the previous findings on the IT-SCM relationship that found different conceptualizations of IT (Zhang et al., 2011). On the other hand, it is not a major concern for LSC/ASC measurements (Gligor & Holcomb, 2012; Moyano-Fuentes et al., 2019). Second, some studies yield contradictory findings, often IT are measured in combination with other influential variables, without any apparent consensus on these influential variables (Chiarini & Vagnoni, 2017; Samdantsoodol et al., 2017).

The above concerns have motivated us to dig deeper into the results on the IT-LSC/ASC relationships found in the literature and to offer some directions to improve theory development in this area.

3 Methodology

The methodology used in this work consists of a Systematic Literature Review (SLR) (Denyer & Tranfield, 2009). The review process has been carried out following the five steps proposed

by Denyer and Tranfield (2009): (i) Formulation of the research question(s); (ii) Identification of studies; (iii) Selection and evaluation of studies; (iv) Analysis and synthesis, and (v) Reporting of results and discussion. In the following, we indicate how these five steps have been carried out in the specific framework of this work.

3.1 Formulation of the research question(s)

The first step in an SLR consists of defining the research questions. These must reflect the study's scope and purpose. The study objective is located at the intersection area between the IT concept and both the LSC and ASC concepts. The definitions of the key concepts should be clearly specified (Seuring et al., 2021), therefore, Fig. 1 shows the key concepts and the area in which the identified papers are located.

In relation to these key concepts and since this research aims to clarify the relationships between IT and two supply chain strategies (LSC and ASC) by identifying agreements and disagreements on the research fields, the following question has been defined as a general research question to guide the present study:

RQ (basic research issue): What role does Information Technology play in Lean and Agile supply chain strategies?

In this sense, the first step is to locate the literature on IT-LSC and IT-ASC (RQ1). For this, it is essential to perform the search in relevant scientific databases and define quality criteria to select the studies to be considered in the review. Second, given that different types of relationships—direct, indirect, and complementary—between the key concepts are reported in the literature, it is important to map the developments in the field to understand their integration and its effect on performance (RQ2). Third, according to the previous literature, IT can be conceptualized in different ways, so it would be explanatory to determine how different IT conceptualizations (e.g., IT investment and IT capability) affect the two supply chain strategies (RQ3). Finally, to fulfill the SLR's purpose of encouraging and facilitating subsequent research, the fourth step is to identify unexplored areas and raise questions for future investigation (RQ4).

Therefore, this study addresses the following four specific research questions:

Fig. 1 Key concepts and research objective of the SLR. *Source:* Prepared by authors

RQ1: What is the existing survey-based literature on the relationships between IT and the Lean and Agile supply chain strategies and what are their key aspects?

RQ2: What relationships have been observed in the literature between IT and the Lean and Agile supply chain strategies and how have these relationships transferred to performance?

RQ3: What effect does the way that Information Technology is conceptualized have on Lean and Agile supply chain strategies?

RQ4: What gaps and challenges exist for future research in the area of this study?

3.2 Identification of studies

In the present case, the most relevant scientific databases in the area have been used for locating the studies, including *Web of Science* (WOS), *Scopus*, and *EBSCOhost*. Two search strings were created to identify the literature in these databases. The first was formed of keywords related to IT and LSC and the second of words related to IT and ASC. An analysis of previous reviews (Núñez-Merino et al., 2020; Pagliosa et al., 2021) and a brainstorming session by the study's authors were performed to define the keywords used. Three sets of keywords were defined for each search, representing IT, Lean, and supply chain in the first case, and IT, Agile, and supply chain in the second. Simple operators were used to combine the keywords and generate the search strings, including truncated characters (e.g., *, “exact phrase”) and Boolean operators (e.g., AND, OR). It was also necessary to adapt the search string to each of the databases, as their syntaxes differ. The keywords used are given in Table 1. It was determined that the defined sets of keywords should appear in the following fields: title, abstract or article keywords, depending on the possibilities offered by the different databases.

Table 1 Keywords and search strings

Keywords	
(A) LSC	(lean OR leanness OR jit OR just-in-time OR “toyota production system”) AND (“supply chain*” OR logistic*)
(B) ASC	(agile OR agility) AND (“supply chain*” OR logistic*)
(C) IT	(“information system*” OR “information technolog*” OR “information and communication* technolog*” OR “digital technolog*” OR ict OR “technological innovation” OR “internet of things” OR iot OR cloud OR web OR e-business OR e-commerce OR “enterprise resource planning” OR erp OR “material* requirement* planning” OR mrp OR “electronic data interchange” OR edi OR “radio-frequency identification” OR rfid OR “business intelligence” OR software OR “artificial intelligence” OR “big data” OR “industry* 4.0” OR e-procurement OR “cyber physical system*” OR blockchain OR “augmented reality” OR “virtual reality” OR “additive manufacturing” OR robotic* OR “3D print*” OR cybersecurity OR “industrial simulation” OR “warehouse management system” OR “transportation management system”)
Search strings	
Search 1: (A) AND (C)	Search 2: (B) AND (C)

3.3 (iii) Selection and evaluation of studies

Inclusion and exclusion criteria were determined for the selection and evaluation of the works. The first inclusion criterion applied was the publication period of the works. This was limited to 1996–December 2019 for works on IT and LSC and 1999–December 2019 for works on IT and ASC. The starting year for the two searches corresponds to the first publications on the strategies, Lamming (1996) for LSC and Mason-Jones and Towill (1999) and Naylor et al. (1999) for ASC. Apart from this, only works written in English were considered in article, early access article or review format and published in research areas related to the study subject area. Duplicates of articles that were retrieved in the search results for the different databases were also excluded. The reference database used for the results was WOS and all duplicate studies in subsequent searches were removed.

To ensure the quality of the selected studies, the next step was to discard any articles published in journals not indexed in JCR and/or SJR. An analysis was then done of the selected articles' titles, abstracts, and keywords to ensure that they complied with the research questions. Following this, the works were read through in full and those not related to the research issue (false positives) were removed. Other works were discarded that considered Lean or Agile solely from an internal focus, i.e., without considering the SC. The last inclusion criterion was the methodology used in the article. This review has been restricted to survey-based research. The reason for this is that it enables a homogeneous comparison of articles. Also, the purpose of quantitative methodology is to test theoretical models and the goal is explanatory, whereas qualitative methodology is preferably used for exploratory or descriptive purposes. This same criterion has previously been used in other works related to SCM (Rungtusanatham et al., 2003; Zhang et al., 2011). Lastly, both forward and backward searches were performed to guarantee the inclusion of new articles with the snowball effect (Okoli & Schabram, 2011; Thomé et al., 2016). Three new articles were added during this stage.

The search yielded a total selection of 59 papers, 13 of which address the IT-LSC relationship, 39 articles that analyze the IT-ASC relationship, and 7 that analyze both IT-LSC and IT-ASC relationships.

3.4 (iv) Analysis and synthesis

For the content analysis evaluation, information was extracted from every study included in the review and stored. Selected papers were categorized in Mendeley, which is a useful tool for information coding, by tagging each article based on its key concepts, creating notes, and highlighting relevant information. At the same time, a database was created in Excel to code the content of the articles. For this, information was collected on the supply chain strategy adopted (LSC or/and ASC), the purposes, the theories adopted, the main contributions, the variables adopted in each study and their roles (e.g., independent, dependent, mediator, moderator), and the relationships between the key concepts. More specifically, the relationships between IT and both SC strategies have been determined after evaluating the selected articles through an iterative process of identification and revision. As a result, this process identified nine types of relationships between the study's key concepts (see Table 2).

Furthermore, considering the relationships studied and according to the types of interaction between IT and LSC or ASC, respectively, the studies were classified into three approaches: (i) IT-LSC/IT-ASC direct relationship; (ii) IT-LSC/IT-ASC indirect relationship, and (iii) IT-LSC/IT-ASC complementary relationship. Subsequently, following the background of this article, we distinguish whether IT is conceptualized as a resource (IT investment or IT use)

Table 2 Summary of relationships

Relationships	
A:	Direct relationship between IT and LSC or ASC
B:	Relationship between IT and another factor in the presence of LSC or ASC
C:	Relationship between another factor and LSC or ASC in the presence of IT
D:	IT as a moderator between LSC or ASC and performance
E:	LSC or ASC as a moderator between IT and performance
F:	Direct relationship between LSC or ASC and performance in the presence of IT
G:	Direct relationship between IT and performance in the presence of LSC or ASC
H:	IT as a moderator between another factor and LSC or ASC
I:	Joint effect of IT and LSC or ASC on performance

or capability (IT capability). Finally, according to the IT's level of analysis, we determine whether it is measured as an aggregate (generic concept) or a specific kind of technology.

These pre-defined coding schemes, which are based on the theoretical background and the clear definition of constructs allow the involvement of the different researchers in this process, help to avoid common biases in the SLR process (Durach et al., 2017), and shed light on the data analysis process and how theory is employed (Seuring et al., 2021). Therefore, as recommended by good practice in content analysis (Seuring & Gold, 2012), a two-step categorization process has been followed. First, the basic categorization framework has been established based on existing theory, and second, some of the categories have subsequently been refined during the coding process. Furthermore, discussions among the research team have allowed to reach a consensus and consolidate the results, which in turn improves the internal validity of the findings (Seuring & Gold, 2012).

3.5 (v) Reporting of results and discussion

The results of this step are presented in the following section. Figure 2 illustrates the methodological procedure followed in this study and described in a flow diagram in this section. The diagram shows the flow of information through the different SLR phases and gives the number of records identified, included and excluded and the reasons for their exclusion, as recommended by best practice for conducting an SLR in operations management (Thomé et al., 2016), in SCM (Durach et al., 2017), and in Information Systems research (Okoli & Schabram, 2011).

Fig. 2 Summary of the Systematic Literature Review. *Source:* Prepared by authors

4 Results

4.1 Descriptive analysis

First, the selected body of literature was classified by the addressed supply chain strategy, LSC, or ASC (see Table 3). Note that 7 papers address both SC strategies. The results of these 7 articles will be considered taking into account the role of IT in each of the strategies independently.

The set of selected documents was published over 19 years, between 2001 and 2019. In the specific case of the literature on IT-ASC, over 70% of the papers are from the last 5 years,

Table 3 Papers by SC strategy

Scope	Papers
IT-LSC	Ahmad and Schroeder (2001); Bayraktar et al. (2009); Bayraktar et al. (2010); Ghobakhloo and Hong (2014); Ghobakhloo et al. (2018); Hong et al. (2010); Kamble et al. (2020)*; Karakadilar and Hicks (2015); Khanchanapong et al. (2014); Kou et al. (2018); So and Sun (2010); So and Sun (2011); Zelbst et al. (2014)
IT-ASC	Almahamid and Hourani (2015); Al-Nimer (2019); Bargshady et al. (2016); Bi et al. (2013); Brusset (2016); Chen (2019); DeGroote and Marx (2013); Dehgani and Navimipour (2019); Ding et al. (2012); Dubey et al. (2019a); García-Alcaraz et al. (2017); García-Alcaraz et al. (2019); Hwang and Rho (2016); Kabra and Ramesh (2016); Kumar et al. (2017); Liu et al. (2013); Liu et al. (2018); Mandal (2018); Mandal (2019a); Mandal (2019b); Motadel et al. (2011); Oh et al. (2019); Panichayakorn and Jermittiparsert (2019); Paulraj and Chen (2007); Pool et al. (2018); Rahimi et al. (2019); Samdantsoodol et al. (2017); Samizadeh et al. (2019); Sangari and Razmi (2015); Schniederjans et al. (2016); Sheel and Nath (2019); Swafford et al. (2008); Tarafdar and Qrunfleh (2017); Vagnoni and Khoddami (2016); Vickery et al. (2010); Wamba and Akter (2019); Wamba et al. (2020)*; Yang (2014); Yusuf et al. (2004)
IT-LSC/ASC	Chiarini and Vagnoni (2017); Ghobakhloo and Azar (2018a); Ghobakhloo and Azar (2018b); Gorane and Kant (2017); Qrunfleh and Tarafdar (2014); Qrunfleh et al. (2012); Shahin et al. (2016)

*In-press version published in 2019

whereas in the literature on IT-LSC, 45% of the papers were published in the last 5 years. Interestingly, since 2015, IT-ASC has been explored more than IT-LSC, especially in 2019. Explanations for this may be that emergent IT such as Cloud Computing and Big Data and the development of Industry 4.0 could be having a greater influence on ASC strategy.

Figure 3 is a graph of the number of studies published per year and the cumulative frequency of the two major research topics considered.

Fig. 3 Distribution of papers by year and cumulative frequency. *Source:* Prepared by authors

Fig. 4 Summary of the relationships in the IT-LSC literature. *Source:* Prepared by authors

4.2 Overview of relationships in the IT-LSC survey-based research

Nine types of relationships were identified in the analysis of the 20 selected articles. Articles may have analyzed one or more relationships. Figure 4 represents the distribution of papers according to the type of relationship. The thickness of the line is proportional to the number of papers that address each relationship with the number also given in parentheses. Table 4 also shows the distribution of the papers over these different relationships and whether these relationships are positive, negative, or non-significant.

In short (see Table 4), considering the positive and significant relationships, on the one hand, the main results show that IT had a direct effect on LSC in 45% of the 20 papers and that LSC had a direct effect on performance in 60% of the 20 papers. On the other hand, some relationships were less explored, for example, the moderating role of IT was addressed in only 10% of the papers.

4.3 Overview of relationships in the IT-ASC survey-based research

Seven types of relationships were found in this literature. Following the same criteria as in Fig. 4 and Table 4, Fig. 5, and Table 5 respectively show the distribution of papers according to each relationship.

Considering the positive relationships (see Table 5), the main results indicate that IT had a direct effect on ASC in almost 70% of the 46 papers and that ASC had a direct effect on performance in 56% of the 46 papers. Some relationships require a deeper understanding, such as the moderating role of IT, which was studied in 11% of the papers.

Table 4 Relationships in the IT-LSC survey-based research

Literature on IT-LSC	Relationships								
Author	A	B	C	D	E	F	G	H	I
Ahmad and Schroeder (2001)									+
Bayraktar et al. (2009)									+
Bayraktar et al. (2010)									+
Chiarini and Vagnoni (2017)	–								
Ghobakhloo and Azar (2018a)	+					+			
Ghobakhloo and Azar (2018b)	+					+	○		
Ghobakhloo and Hong (2014)	+					+			
Ghobakhloo et al. (2018)	+								
Gorane and Kant (2017)		+	+			+			
Hong et al. (2010)*						+			+ / ○
Kamble et al. (2020)	+					+	+		
Karakadilar and Hicks (2015)					○	+	+		
Khanchanapong et al. (2014)						+	+		+
Kou et al. (2018)	+					+			
Qrunfleh and Tarafdar (2014)				+		+			
Qrunfleh et al. (2012)			+					+	
Shahin et al. (2016)	+					+	+		
So and Sun (2010)	+								
So and Sun (2011)		+	+						
Zelbst et al. (2014)*	+ / ○	+	+			+			
Total	10	03	04	01	01	12	05	01	05

(+) Positive; (–) Negative; (○) Non-significant

*Articles that have analyzed more than one type of technology and have found different results depending on the technology type

4.4 IT-LSC approaches

The following analyzes each of the three approaches (direct, indirect and, complementary relationship) in detail.

- (i) *IT-LSC direct relationship* The direct impact of IT on LSC was analyzed in 10 studies. Of these, some studies (Ghobakhloo et al., 2018; Ghobakhloo & Azar, 2018a, 2018b; Ghobakhloo & Hong, 2014; Kamble et al., 2020; So & Sun, 2010) concluded that IT specifically contributes to improving the implementation of Lean Management practices. IT use can also directly and positively affect the improvement of Just-In-Time (JIT) practices (Zelbst et al., 2014) and the launch of products from a Lean perspective (Kou et al., 2018). However, IT does not significantly enhance Total Quality Management (TQM) practices (Zelbst et al., 2014) and a negative relationship between IT and LSC was found in one case (Chiarini & Vagnoni, 2017). In this case, the paper's results indicate that Enterprise Resource Planning (ERP) does not provide the flexibility required to adopt LSC practices (Chiarini & Vagnoni, 2017). Further, as Lean practices help supply chains decrease non-value-added activities to reduce production costs, it is associated

Fig. 5 Summary of the relationships in the IT-ASC literature. *Source:* Prepared by authors

with improvements in firm or supply chain performance (Ghobakhloo & Azar, 2018b; Ghobakhloo & Hong, 2014; Kou et al., 2018; Zelbst et al., 2014).

This approach was tested using three different models (see Fig. 6).

- (ii) *IT-LSC indirect relationship.* The review has found that only 3 papers have considered the IT-LSC indirect relationship. This approach assumes that the relationship between IT and LSC is mediated by other factors, so the impact of IT on LSC is not direct. There is no consensus among researchers on mediating factors. These factors are different in each of the document: the relative advantage of Lean (So & Sun, 2011), information-sharing (Zelbst et al., 2014), and SC integration (Gorane & Kant, 2017). This approach was tested using two models (see Fig. 7).
- (iii) *IT-LSC complementary relationship.* This approach assumes that firms can gain additional improvements when IT and LSC practices are used in conjunction, i.e., focusing exclusively on IT or LSC does not provide the best results. This approach is tested with four models in 8 papers (see Fig. 8). The first model (3A) considers an IT-LSC joint relationship that has been an object of interest in the literature (5 papers), whereas the other models (3B, 3C, and 3D) focus on the moderating effects of IT or LSC, which have been tested to an extremely limited extent (3 papers).

4.5 IT-ASC approaches

Each of the three approaches are analyzed in detail below.

- (i) *IT-ASC direct relationship.* This approach assumes that IT and ASC strategy are directly related (36 papers). The majority of the papers with this approach ($n = 30$) found that IT use has a positive direct effect on ASC (e.g., Mandal, 2018; Wamba & Akter, 2019). These findings indicate that IT has a direct effect on ASC as it increases the ability to

Table 5 Relationships in the IT-ASC survey-based research

Literature on IT-ASC Author	Relationships								
	A	B	C	D	E	F	G	H	I
Almahamid and Hourani (2015)*	○/ +	+	+						
Al-Nimer (2019)	+					+	+		
Bargshady et al. (2016)	+								
Bi et al. (2013)		+	+						
Brusset (2016)*	○/ +								
Chen (2019)	+					+			
Chiarini and Vagnoni (2017)	-								
DeGroote and Marx (2013)	+					+			
Dehgani and Navimipour (2019)	+								
Ding et al. (2012)			+					-	
Dubey et al. (2019a)	+					+	+		
García-Alcaraz et al. (2017)	+					+	+		
García-Alcaraz et al. (2019)	+					+	+		
Ghobakhloo and Azar (2018a)	+					+			
Ghobakhloo and Azar (2018b)	+					+	○		
Gorane and Kant (2017)		+	+						
Hwang and Rho (2016)	+					+			
Kabra and Ramesh (2016)	+					+	+		
Kumar et al. (2017)	+					+	+		
Liu et al. (2013)	○	+	+			+			
Liu et al. (2018)	+								
Mandal (2018)	+								
Mandal (2019a)	+								
Mandal (2019b)	+								
Motadel et al. (2011)	+								
Oh et al. (2019)				-		+			

Table 5 (continued)

Literature on IT-ASC	Relationships								
	A	B	C	D	E	F	G	H	I
Panichayakorn and Jermstittiparsert (2019)	+					+	+		
Paulraj and Chen (2007)		+	+						
Pool et al. (2018)	+								
Qrunfleh and Tarafdar (2014)				+		+			
Qrunfleh et al. (2012)			+					○	
Rahimi et al. (2019)	+								
Samdantsoodol et al. (2017)	–	+	+			+			
Samizadeh et al. (2019)	+					+	○		
Sangari and Razmi (2015)	+					+			
Schniederjans et al. (2016)		+	+						
Shahin et al. (2016)	+					+	+		
Shell and Nath (2019)	+					+			
Swafford et al. (2008)		+	+			+			
Tarafdar and Qrunfleh (2017)				+		+			
Vagnoni and Khoddami (2016)	+					+	○		
Vickery et al. (2010)	○					+	○		
Wamba and Akter (2019)	+					+	+		
Wamba et al. (2020)	+					+	+		
Yang (2014)	+					○			
Yusuf et al. (2004)	+								
Total	36	08	10	03	0	27	14	02	0

(+) Positive; (–) Negative; (○) Non-significant

* Articles that have analyzed more than one type of technology and have found different results depending on the technology type

Fig. 6 IT-LSC direct relationship (n = 10): Models. *Source:* Prepared by authors

Model 2A (1 paper)

Model 2B (2 papers)

Fig. 7 IT-LSC indirect relationship ($n = 3$): Models. Source: Prepared by authors

Model 3A (5 papers)

Model 3B (1 paper)

Model 3C (1 paper)

Model 3D (1 paper)

Fig. 8 IT-LSC complementary relationship ($n = 8$): Models. Source: Prepared by authors

rapidly detect market changes by facilitating the obtention of information in real-time and supporting the exchange of information between chain partners. IT use also increases the ability to respond to these market changes through agile joint decision-making. In this sense, some studies assume that IT impacts on ASC, which in turn results in greater customer satisfaction and increased company revenue and, consequently, better firm or supply chain performance, i.e., they indicate the existence of a mediating effect of ASC between IT and performance (e.g., DeGroote & Marx, 2013; Sheel & Nath, 2019). It has also been found that in some specific cases the direct relationship between IT and

Fig. 9 IT-ASC direct relationship ($n = 36$): Models. *Source:* Prepared by authors

ASC depends on the purpose of IT use or the specific type of IT (Almahamid & Hourani, 2015; Brusset, 2016).

The IT-ASC direct relationship has been tested using three models (see Fig. 9).

- (ii) *IT-ASC indirect relationship.* This approach implies the existence of a mediating factor in the effect of IT on ASC. The mediating factors used were: collaboration between commercial partners (Almahamid & Hourani, 2015; Schniederjans et al., 2016), SC integration (Gorane & Kant, 2017; Paulraj & Chen, 2007), SC capability (a complex variable that includes SC integration, information, and SC coordination) (Bi et al., 2013), virtual enterprises (Samdantsoodol et al., 2017), absorptive capacity (Liu et al., 2013), and SC flexibility (Swafford et al., 2008). In general, these factors are related to coordination processes across the SC. Therefore, in some cases, to achieve agility, IT first must be complemented with some other supply chain processes in order to later impact ASC and boost firm performance (Liu et al., 2013; Samdantsoodol et al., 2017; Swafford et al., 2008). In other words, if there are any issues with the supply chain, IT does not turn it into an ASC but requires that any problems be solved first. This approach has received less attention in the literature and was tested in 8 studies, with two models (see Fig. 10).
- (iii) *IT-ASC complementary relationship.* This approach assumes that firms can achieve better outcomes when IT and ASC practices are used in conjunction. This approach has been tested in fewer papers ($n = 5$) and the results are positive in only two of these. Two models with moderating relationships were identified (see Fig. 11). In this sense, the results of this approach demonstrate the existence of a lack of agreement on the moderating role of IT.

4.6 How IT affects lean and agile supply chain

Table 6 summarizes the approaches to the relationship between IT and each of the SC strategies and considers how IT is conceptualized and measured in the selected papers. Additionally, Table 6 indicates whether the papers are supported by consolidated theories.

IT-LSC As Table 6 shows, most papers (14) conceptualize IT as a resource (IT use), four papers conceptualize IT as a capability, and two papers consider IT as both a possible resource (an IT investment) and a possible IT capability. Table 6 also shows that half of the papers measure IT in aggregate terms (as a generic concept), and the other half, as a specific type of technology (e-business technologies, Radio Frequency Identification—RFID, Advanced Manufacturing Technologies—AMT, ERP). Further, only ten papers are grounded in consolidated theories. The most-used theory is RBV (Barney, 1991), which is widely used in the literature to study the “IT productivity paradox”.

Fig. 10 IT-ASC indirect relationship ($n = 8$): Models. *Source:* Prepared by authors

Fig. 11 IT-ASC complementary relationship ($n = 5$): Models. *Source:* Prepared by authors

Our analysis of how the way that IT is conceptualized and measured can affect LSC found that when IT is conceived as a resource, it can positively impact LSC, regardless of whether a general or specific technology approach is adopted. This impact mainly occurs directly but the complementary relationship between IT and LSC and its positive effects on performance have also been confirmed in some studies. However, only the results of the impact of ERP use on LSC (2 papers) show conflicting results (negative or non-significant). Further, when IT is considered as a capability, we have found mostly direct effects (either as an aggregate or as a specific type of IT). The IT efficiency capability, i.e., the support that IT gives for the efficient coordination of inventory and production between partners, is an important feature for achieving LSC strategy goals. However, similar results are found in most papers, despite the IT in question having different characteristics.

IT-ASC According to the evidence in Table 6, most papers (26) conceptualize IT as a capability, nineteen papers conceptualize IT as a resource (IT use), and one paper recognizes IT as both a possible resource (an IT investment) and a possible capability. Table 6 also shows that twenty-eight papers measure IT as an aggregate (as a general concept), and the others (18), as a specific type of technology (e-business technologies, RFID, AMT, ERP, Cloud Computing, Big Data, Business Intelligence, Blockchain). Further, twenty-six papers are grounded in consolidated theories. The most used theories are RBV (14 papers) and its extension, Dynamic Capabilities (Teece, 2007) (12 papers).

Table 6 IT-LSC/IT-ASC approaches, IT features, and theories

Strategy	Papers	Approach	Conceptualization	Measurement		Theory
				Aggregate	Specific IT	
LSC	Ahmad and Schroeder (2001)	C	RE.U		E-BUS	
LSC	Bayraktar et al. (2009)	C	RE.U	AGGRE		
LSC	Bayraktar et al. (2010)	C	RE.U	AGGRE		
LSC*	Chiarini and Vagnoni (2017)	D-	RE.U		ERP	
LSC	Ghobakhloo and Azar (2018a)	D	RE.U		AMT	
LSC*	Ghobakhloo and Azar (2018b)	D	RE.I/CAP	AGGRE		RBV/ Tcomp
LSC	Ghobakhloo and Hong (2014)	D	RE.I/CAP		AMT	RBV
LSC	Ghobakhloo et al. (2018)	D	CAP	AGGRE		RBV
LSC*	Gorane and Kant (2017)	I	RE.U	AGGRE		
LSC	Hong et al. (2010)	C/C ⁰	RE.U		E-BUS/ERP	ValueCT
LSC	Kamble et al. (2020)	D	RE.U	AGGRE		
LSC	Karakadilar and Hicks (2015)	C	RE.U	AGGRE		
LSC	Khanchanapong et al. (2014)	C	RE.U		AMT	RBV
LSC	Kou et al. (2018)	D	CAP	AGGRE		RBV
LSC*	Qrunfleh and Tarafdar (2014)	C	CAP	AGGRE		IPT
LSC*	Qrunfleh et al. (2012)	C	CAP	AGGRE		CT
LSC*	Shahin et al. (2016)	D	RE.U		RFID	
LSC	So and Sun (2010)	D	RE.U		E-BUS	
LSC	So and Sun (2011)	I	RE.U		E-BUS	IDT

Table 6 (continued)

Strategy	Papers	Approach	Conceptualization	Measurement		Theory
				Aggregate	Specific IT	
LSC	Zelbst et al. (2014)	D/ I	RE.U		RFID	ST
ASC	Almahamid and Hourani (2015)	D, I	RE.U		ERP/E-BUS	
ASC	Al-Nimer (2019)	D	RE.U		ERP	
ASC	Bargshady et al. (2016)	D	CAP	AGGRE		
ASC	Bi et al. (2013)	I	CAP	AGGRE		RBV
ASC	Brusset (2016)	D	CAP	AGGRE		RBV/ DC
ASC	Chen (2019)	D	CAP	AGGRE		RBV/ DC
ASC*	Chiarini and Vagnoni (2017)	D-	RE.U		ERP	
ASC	DeGroote and Marx (2013)	D	RE.U	AGGRE		
ASC	Dehgani and Navimipour (2019)	D	CAP	AGGRE		
ASC	Ding et al. (2012)	C-	CAP	AGGRE		RBV
ASC	Dubey et al. (2019a)	D	CAP +		BIG D	DC/ CT
ASC	García-Alcaraz et al. (2017)	D	RE.U	AGGRE		
ASC	García-Alcaraz et al. (2019)	D	CAP	AGGRE		
ASC*	Ghobakhloo and Azar (2018a)	D	RE.U		AMT	
ASC*	Ghobakhloo and Azar (2018b)	D	RE.I/CAP	AGGRE		RBV/ Tcomp
ASC*	Gorane and Kant (2017)	I	RE.U	AGGRE		
ASC	Hwang and Rho (2016)	D	CAP		RFID	RBV/ SCT
ASC	Kabra and Ramesh (2016)	D	RE.U	AGGRE		
ASC	Kumar et al. (2017)	D	RE.U	AGGRE		
ASC	Liu et al. (2013)	I	CAP	AGGRE		DC

Table 6 (continued)

Strategy	Papers	Approach	Conceptualization	Measurement		Theory
				Aggregate	Specific IT	
ASC	Liu et al. (2018)	D	CAP		CLOUD	
ASC	Mandal (2018)	D	CAP		BIG D	RBV/ DC
ASC	Mandal (2019a)	D	CAP	AGGRE		DC
ASC	Mandal (2019b)	D	CAP		BIG D	RBV/ DC
ASC	Motadel et al. (2011)	D	CAP	AGGRE		
ASC	Oh et al. (2019)	C-	RE.U		E-BUS	
ASC	Panichayakorn and Jermisittiparsert (2019)	D	RE.U	AGGRE		RBV
ASC	Paulraj and Chen (2007)	I	RE.U	AGGRE		
ASC	Pool et al. (2018)	D	RE.U		BI	TOE
ASC*	Qrunfleh and Tarafdar (2014)	C	CAP	AGGRE		IPT
ASC*	Qrunfleh et al. (2012)	C ⁰	CAP	AGGRE		CT
ASC	Rahimi et al. (2019)	D	RE.U	AGGRE		
ASC	Samdantsoodol et al. (2017)	D-, I	RE.U	AGGRE		RBV
ASC	Samizadeh et al. (2019)	D	CAP	AGGRE		
ASC	Sangari and Razmi (2015)	D	CAP		BI	RBV/ DC
ASC	Schniederjans et al. (2016)	I	RE.U		CLOUD	SCT/ TAM
ASC*	Shahin et al. (2016)	D	RE.U		RFID	
ASC	Sheel and Nath (2019)	D	CAP		BLOCK	RBV/ DC
ASC	Swafford et al. (2008)	I	CAP	AGGRE		RBV
ASC	Tarafdar and Qrunfleh (2017)	C	CAP	AGGRE		Tcomp/ IPT
ASC	Vagnoni and Khoddami (2016)	D	CAP	AGGRE		DC
ASC	Vickery et al. (2010)	D ⁰	RE.U	AGGRE		Tcomp
ASC	Wamba and Akter (2019)	D	CAP +		BIG D	RBV / DC

Table 6 (continued)

Strategy	Papers	Approach	Conceptualization	Measurement		Theory
				Aggregate	Specific IT	
ASC	Wamba et al. (2020)	D	CAP +		BIG D	DC
ASC	Yang (2014)	D	CAP	AGGRE		IPT/ TCE
ASC	Yusuf et al. (2004)	D	RE.U		E-BUS	

Strategy: LSC, Lean supply chain; ASC, Agile supply chain; (*) Papers that address both strategies; *Approach:* D, Direct; I, Indirect; C, Complementary; (−) Negative; (°) Non-significant; *Conceptualization:* RE.I, Resource—IT investment; RE.U, Resource—IT use; CAP, Capability; CAP⁺, Higher-order capability; *Measurement:* AGGRE, Aggregated terms; E-BUS, E-Business technologies; ERP, Enterprise resource planning; AMT, Advanced manufacturing technologies; RFID, Radio frequency identification; BI, Business intelligence; BLOCK, Blockchain; CLOUD, Cloud computing; BIG D, Big data; *Theory:* RBV, Resource-based view; Tcomp, Theory of complementarity; ValueCT, Value co-creation theory; IPT, Information processing theory; CT, Contingency theory; IDT, Innovation diffusion theory; ST, Systems theory; DC, Dynamic capabilities; SCT, Social capital theory; TOE, Technology-organization-environment; TAM, Technology adoption model; TCE, Transaction cost economics

Three main observations can be highlighted considering these data. First, most of the papers that measure IT as a capability have found a direct IT-ASC relationship. These results are mainly confirmed when IT capability is measured as an aggregate and as a Big Data Analytics (BDA) capability. In this regard, papers grounded in Dynamic Capabilities consider SCA to be a higher-order capability derived from other lower-order capabilities, such as IT capability. The most-investigated features of IT capability are IT integration and IT flexibility. Only in the case of BDA capability is it assumed (in 3 papers) to be a higher-order capability. In this sense, this specific IT capability directly affects both ASC and firm performance. One illustrative example is Netflix's BDA capability, which enables the company to quickly analyze mass user data to identify customer behavior and predict trends and, thus, nurture customer satisfaction and improve sales (Wamba et al., 2020).

Second, most of the papers that measure IT use are not based on existing theories. However, they also mainly found a positive and direct relationship between IT and ASC, while a few studies that used aggregated terms or specific technologies found an indirect relationship.

Finally, the minority of the papers (6) found negative or non-significant results for IT's effect on ASC. Four of these studies conceptualize IT as a resource (IT use). Two ideas can be drawn from these studies: On the one hand, negative or non-significant effects are found by measuring the use of one specific type of IT when this technology is unable to meet the supply chain's needs for agility (Chiarini & Vagnoni, 2017; Oh et al., 2019). On the other hand, some results state that IT must be combined with other firm or SC capabilities (i.e., the creation of a virtual enterprise, absorptive capacity, and SC integration) (Samdantsoodol et al., 2017; Vickery et al., 2010). In this sense, the theory of complementarity (Milgrom & Roberts, 1995) helps to explain that it is not IT alone that leads to enhanced ASC but IT's interaction with complementary capabilities.

4.7 Gaps and challenges for future research

In the previous subsections, survey-based research related to IT and the two supply chain strategies has been analyzed and synthesized to identify what is being studied in these research

areas. A framework for future research has been developed based on the findings of the study. We summarize the main topics as follows:

- (a) *Use of consolidated theoretical perspectives* There is a lack of use of existing theories, mainly in the IT-LSC literature but also in IT-ASC studies. The use of theoretical lenses can provide a better understanding of the underlying complexity of the relationship between constructs. Thus, future studies should incorporate the theoretical perspectives already used in other papers in this review, including RBV, Dynamic Capabilities, and the Theory of Complementarity. Researchers could also adopt other theories used in Operations Management studies. In this regard, Institutional Theory (DiMaggio & Powell, 1983) and Resource Orchestration Theory (Sirmon et al., 2011) might offer a useful framework to understand how SC can build and configure resources and capabilities (such as IT aligned with the supply strategy) to obtain a competitive advantage. According to Institutional Theory, organizations facing the same environmental conditions can be influenced to adopt the same structures and ways of working (DiMaggio & Powell, 1983). Therefore, institutional pressures can drive companies to adopt specific technologies or develop certain capabilities in their supply chains (Dubey et al., 2019b). This is an important issue to consider in global supply chains, where companies from different countries may experience distinct pressures, which in turn can have an effect on their supply chain strategy deployment.

Resource Orchestration Theory (ROT) is an extension of the resource-based view that overcomes its limitations (Sirmon et al., 2011). ROT considers that the development of competitive advantage depends on the ability of managers to generate synergistic effects through the deployment of resources and capabilities (Sirmon et al., 2011). So, it can be extrapolated to the SC level (Rojo et al., 2020), and could be used to understand how managers can orchestrate, i.e., identify, bundle and leverage, different IT supply chain resources and capabilities to achieve better results in Lean and Agile contexts.

- (b) *IT features and their impacts on LSC/ASC*: The reviewed literature conceptualizes IT as a resource and as a capability. We understand that both views are important for understanding the underlying processes of IT's impact. However, the research results reveal the need to reinforce research and explore new ideas in some areas.

IT as a resource: The role of emerging technologies (Industry 4.0 technologies and digital technologies), can be meaningfully measured as IT use since they are IT in a nascent process of adoption, and many SCs have not developed specific capabilities related to their adoption. In this view, Institutional Theory could be used for the study of the institutional pressures that can lead to IT adoption. Besides, measuring IT as a specific technology may provide insights into how and which technologies are suitable for supporting LSC/ASC practices. In this sense, the role of some (specific) emerging technologies of Industry 4.0 stands out in the ASC research, but not in the LSC research. Therefore, as there is a need for Digital Technologies in modern manufacturing systems, the role of emerging IT (e.g., Internet of Things, Cloud Computing, Big Data, Blockchain, Artificial Intelligence, 3D printing) in extending Lean practices across the SC, could be explored.

Another avenue for future research might be to compare the functions of specific technologies. In this sense, some studies have differentiated between ERP and e-business technologies (Almahamid & Hourani, 2015; Hong et al., 2010). It would, therefore, be interesting to compare and analyze how different types of IT can affect LSC and/or ASC strategy, as this would provide knowledge of the context or situation in which IT is more effective for one strategy or the other. On the other hand, it is also true that technologies

are rarely implemented alone. Thus, the joint role of these different types of IT should also be considered. A further avenue for future research could be to compare the roles of individual technologies and combined technologies linked to Industry 4.0 in the LSC context (as other previous studies, e.g., Núñez-Merino et al. (2020), indicate) and in the ASC context.

IT as capability: According to a few studies, IT efficiency capability is an important feature for LSC. However, the role of IT capabilities was less developed in the LSC context than in the ASC context and some questions remain unanswered. Thus, it may be useful to understand how other IT capabilities such as IT flexibility and BDA capability can support Lean practices. Moreover, due to the disruptive changes related to Industry 4.0 that SCs are facing, future studies on LSC/ASC should consider the digital supply chain capability (Queiroz et al., 2021). This could offer a holistic view of the way that the digitalization of SC processes interacts with each of the SC strategies.

Further, if they are grounded in the aforementioned theories, futures studies could examine how to build these IT capabilities and how to orchestrate SC resources.

- (c) *IT indirect effects on LSC/ASC* As demonstrated by some of the studies in this review, the effects of IT on LSC/ASC can be perceived via indirect effects, i.e., by the mediation of other variables such as SC integration, SC flexibility, and SC absorptive capacity. This means that there are multiple processes in SC that must be properly configured to achieve the results sought with each of the SC strategies and, ultimately, to achieve better performance (Maqueira et al., 2021). Therefore, the complexity of supply chain processes means that other capabilities can help to explain the IT-LSC/ASC relationships. In this regard, futures studies should analyze the role of SC ambidexterity, i.e., the ability to integrate and reconfigure both the firm's and the suppliers' resources through the simultaneous exploration of new opportunities and the exploitation of existing competencies (Rojo et al., 2020). Previous studies have recently demonstrated that IT capabilities facilitate exploration and exploitation processes at the supply chain level (Rojo et al., 2020). Further, some studies suggest that Lean implementation requires a certain level of ambidexterity (Secchi & Camuffo, 2016) and that SC ambidexterity can increase the detection of changes in the environment and speed up reactions to (Rojo et al., 2020), both critical skills for an agile supply chain. In this view, using ROT lenses, future studies could analyze (a) the potential of IT capabilities to enable SCs to orchestrate their resources (IT → SC ambidexterity), and (b) the ability to translate SC ambidexterity into enhanced LSC/ASC (SC ambidexterity → LSC/ASC). These efforts could help to understand the IT indirect effects and might also explain the contradictory results found in previous studies.
- (d) *IT-enabled LSC/ASC and performance* It seems clear that LSC and ASC have positive effects on business performance (see Tables 4 and 5, relationship F). However, most of the studies have adopted financial and operational focuses and have overlooked environmental and social aspects (Kamble et al. 2020 is an exception). Therefore, there is a lack of theoretical understanding of how IT-enabled LSC/ASC impact sustainable business performance. Previous studies have demonstrated that lean practices are related to employee welfare (Baliga et al., 2019) and positively impact sustainable sourcing and production practices; however, the same practices negatively impact sustainable logistics operations (Jakhar et al., 2018). Further, some scholars indicate that agile practices rely on a capacity surplus to improve the supply chain's ability to respond to changes in customer's needs and this could negatively affect sustainability performance (Ciccullo

et al., 2018). In this sense, further studies should be conducted to confirm these impacts and, if applicable, analyze whether IT could reduce these trade-offs and how. Moreover, as Lean and Agile can be considered complementary strategies (Christopher, 2000; Goldsby et al., 2006), further understanding of the role of IT in the two strategies will provide important insights. Future studies could comparatively analyze the relationship between IT and LSC/ASC, their joint or synergistic effect with IT support, and how their joint implementation can affect performance. This would allow us to deduce where IT both meets the goals targeted with the SC strategy and improves company-level performance.

5 Conclusions and implications

The purpose of this paper was to understand how the way that IT is conceptualized affects its role in Lean and Agile SC strategies and whether there is a consequential effect on performance. This has resulted in directions being given to improve theory development in the area. For this, a Systematic Literature Review has been carried out that has enabled the identification and analysis of 59 survey-based articles on the addressed topics.

First, the findings of the study highlight the fact that the survey-based research literature on IT-ASC is more developed in terms of quantity than that on IT-LSC. One possible explanation could be that the Lean literature mostly focuses on internal aspects rather than on customer and supplier integration issues (Marodin et al., 2017). Another explanation could be that the research appears to regard IT more as a mechanism that provides agility than leanness or that reduces inefficiencies along the SC. Hence, it seems that researchers have overlooked the fact that IT could also be helpful in LSC contexts as it provides flexibility, automation, and a more efficient decision-making process in the SC.

Second, the study shows that some relationships have been repeatedly tested in the literature, while others have been explored to a very limited extent or not at all. In general, the combination of IT use and the implementation of LSC or ASC can have a positive effect on business performance. However, it can be inferred that there is no general agreement as to the way that IT and LSC interact, i.e., interaction can be mainly through direct and complementary relationships, or how different features of IT can impact LSC. As a considerable number of the studies conceptualize IT as a resource (often as an aggregate) without any consolidated theoretical foundations, limited specific deductions can be drawn. Overall, this review has found more support for the positive effects of IT on LSC than not. At the same time, these results demonstrate that the relationship between IT and Lean can be more complex than a direct effect and that the outcomes can be achieved under different conditions.

On the other hand, this study has identified that the direct effect of IT on ASC is the most prominent approach in this context. When IT is conceptualized as a capability, IT integration, IT flexibility, and Big Data Analytics capabilities stand out. These results give indications of important IT features that supply chains need to have to achieve ASC goals. However, the literature on IT-ASC presents some limitations, including contradictory results, the lack of the use of consolidated theories to underpin them when IT is conceptualized as a resource, and a narrow focus on performance. Conflicting results are especially found when IT is measured as a resource (IT use). Besides, the direct effects of IT are slightly stronger when IT is considered as a capability. This seems to suggest that as a resource, IT by itself has less impact on ASC than IT capabilities, as has been shown to be the case with the IT effect on performance or competitive advantage (Powell & Dent-Micallef, 1997; Yu et al., 2017).

Therefore, concerning the three stages of IT use, we found that IT investment is not a common conceptualization and has only been used in a few studies to understand the effect of IT investments on IT capability-building. In this sense, the reviewed literature is in line with the previous research on IT strategic literature, which considers that IT investments alone are unable to transfer to performance. Furthermore, the conceptualization of IT as a capability is more widely adopted in the ASC studies than in the LSC studies. This finding shows that the research on IT-ASC has adopted a more dynamic view of supply chain processes than that on IT-LSC. This is also reflected in the theoretical choices of each research domain. While the literature on IT-ASC has used RBV and the theory of Dynamic Capabilities, the research on IT-LSC has used RBV in only a few studies and in a large number of papers the relationship has not been supported by any theory.

Based upon existing work and the gaps detected, we have developed a framework with four main points to provide directions for future research. Thus, to make futures studies more meaningful, this review encourages researchers to use theories adopted in the field of strategic management (Institutional Theory and ROT). These theories can help to understand important issues for progressing toward a greater digital supply chain capability aligned with the objectives of Lean/Agile supply chain strategies and sustainable performance goals. For this, researchers could investigate the use of emerging technologies, the way that supply chains are able to build IT capabilities, and the role of other SC capabilities such as SC ambidexterity. Furthermore, future studies could explore the alignment between IT internal and suppliers capabilities and LSC and ASC strategies to create a synergy effect, which could be different depending on the decoupling point. These future avenues of investigation could help understand how to configure the SC in the most appropriate way and which technologies and capabilities might be more suitable depending on the goals targeted.

As a practical contribution, this review offers a summary of the current body of knowledge that can be used by managers to support decision-making on the use of IT in LSC and ASC strategies. The study also indicates that a direct impact of IT on performance is less frequent but, if it is appropriately accompanied by LSC or ASC strategies, together they can boost performance. In this sense, some evidence shows that the use of a group of technologies and, more specifically, the use of e-business technologies, RFID, and AMT gives the supply chain flexibility by fulfilling LM objectives. At the same time, there is no doubt about the crucial role of IT in improving ASC implementation. More specifically, capabilities such as BDA, IT integration, and IT flexibility seem to have a direct effect on agility, while the use of other types of mature IT can do so indirectly or require the support of other SC capabilities. So, managers should invest in improving IT capabilities and developing other SC capabilities.

Lastly, it must be stated that the present SLR is not without its limitations. The inclusion and exclusion criteria used have influenced the results that have been obtained. Furthermore, SLR is criticized for the subjectivity of its search keyword selection. Notwithstanding this, the involvement of several researchers and the consensus that they arrived at in the choice of search keywords reduces the bias associated with the subjectivity of a single researcher (Thomé et al., 2016). Another limitation is the exclusive selection of quantitative empirical articles, which restricts the perception of the phenomenon using other methodological approaches. However, while qualitative techniques are recognized as effective for exploring or describing little-known phenomena, theoretical models are preferably explained with quantitative techniques (Zhang et al., 2011).

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Declarations

Conflict of interest No potential conflict of interest was reported by the authors.

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