Supply chain agility and performance: evidence from a meta-analysis

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Abstract

Purpose – The link between supply chain agility (SCA) and performance has been tested in previous research with different samples and results. The present paper quantitatively analyses and summarises the impact of SCA on performance found in previous empirical papers and determines the influence of several identified moderators.
Design/methodology/approach – Using a meta-analysis approach based on a systematic literature review, a total of 63 empirical papers comprising a sample of 14,469 firms were meta-analysed to consider substantive (type of performance and SCA operationalisation) and extrinsic (economic region and industry) moderators.
Findings – Results confirm a significantly large, positive correlation between SCA and performance. None of the analysed moderators has enabled the identification of any significant differences between the SCA and performance correlations by subgroup. However, high heterogeneity in total variance, both in the full sample and the subgroups by moderator, demands further rigorously reported empirical research on this topic with clearly conceptualised variables and frameworks and the use of validated scales.
Research limitations/implications – Several research gaps and best practice recommendations have been indicated to improve future empirical research on this topic.
Practical implications – Practitioners in different economic regions and industries will find consistent evidence of improvements in performance through SCA.
Originality/value – No meta-analysis has been found in previous research to estimate the value of the correlation between SCA and performance and the influence of moderating variables.

Keywords Supply chain agility, Performance, Competitive advantage, Meta-analysis, Systematic literature review, Correlations
Paper type Research paper

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1. Introduction

In today's constantly changing environment exacerbated by the pandemic and natural disasters, supply chain agility (SCA) has been identified as a key element for survival and competitiveness (Do *et al.*, 2021). SCA is a dynamic capability that enables a superior position to be gained by responding in a timely and effective way to market volatility and other uncertainties, and supply chain (SC) disruptions (Gligor and Holcomb, 2012a). It is essential for inventory reduction and allows firms to respond to end demand more quickly, adapt to market variations more efficiently and integrate with customers and suppliers more effectively (Mason *et al.*, 2002). Following Lee (2004), an agile SC addresses short-term changes in demand or supply rapidly and deals with external disruptions nimbly. Furthermore, in conjunction with SC adaptability and alignment, SCA forms part of the Triple-A SC (Lee, 2004), which allows firms to achieve sustainable competitive advantage (CA). SCA directly impacts a firm's ability to produce and deliver innovative products to its customers in a timely and cost-effective way (Swafford *et al.*, 2006). Companies must watch their environment closely in order to react rapidly and adapt to changing customer needs, supply environments and SC disruptions (Blome *et al.*, 2013). It is crucial for firms to be agile and their entire SCs must be agile to reap the benefits of agility in today's hyper-competitive environment (Alfalla-Luque *et al.*, 2018). The contention that SCA influences performance lies in the notion that a firm's ability to dynamically and effectively match its resources to market changes should also aid its efforts to maintain a competitive position (Blome *et al.*, 2013). As Al Humdan *et al.* (2020) state, the relevance of SCA continues to grow and it appears that it has still not reached its peak.

Previous studies confirm the wide diversity and heterogeneity of the SCA framework (Swafford *et al.*, 2006; Chen, 2019; Eckstein *et al.*, 2015; Marin-Garcia *et al.*, 2018a, b; Aslam *et al.*, 2018). This circumstance inspires conducting a meta-analysis for reasons such as the diverse conceptualisations and operationalisations of the variables (Akın Ateş *et al.*, 2022), the heterogeneous context (Ataseven and Nair, 2017) and the fragmented conceptualisation and conflicting effects of the topic (Iftikhar *et al.*, 2021). Some of these aspects have been deeply analysed in previous SCA literature reviews (Table 1) that focus on issues such as (1) SCA conceptualisation and dimensions (Al Humdan *et al.*, 2020; Fayezi *et al.*, 2017; Gligor and Holcomb, 2012a; Gligor *et al.*, 2019; Li *et al.*, 2008; Patel and Sambasivan, 2021; Sharma *et al.*, 2017, 2020); (2) SCA conceptual approaches and theoretical frameworks (Ciccullo *et al.*, 2018; Du *et al.*, 2021; Li *et al.*, 2008; Patel and Sambasivan, 2021); (3) SCA enablers and outcomes (Al Humdan *et al.*, 2020; Gligor and Holcomb, 2012a; Feizabadi *et al.*, 2019; Shashi *et al.*, 2020) and (4) SCA research bibliometric analysis (AlKahtani *et al.*, 2019; Patel and Sambasivan, 2021; Sharma *et al.*, 2020; Shashi *et al.*, 2020). However, none of these reviews develops a meta-analysis that summarises the empirical research on the SCA–performance link, quantifies the impact on this relationship and determines and analyses the influence of a range of moderating factors. Consequently, the present meta-analysis complements previous conceptual literature reviews and broadens their scope. A comparison of the main objectives and main findings of the previous SCA literature reviews with the present meta-analysis in Table 1 underlines the contributions of this research.

Focusing on the SCA–performance relationship, there is still a scarcity of both conceptual and empirical studies that examine SCA's impact on several performance measures (Attia, 2015; Chan *et al.*, 2017; Mandal, 2018). Very few explain the influence of SCA on the different aspects of performance such as financial and non-financial outcomes. This is important to know as SC managers need to be aware of the impact that the application of practices to foster SCA might have. Consequently, the current state of the art of the SCA–performance relationship also justifies a meta-analysis that would quantitatively summarise the previous empirical research on this topic. The reasons that could be argued for the present meta-analysis are in line with previous arguments developed on other topics that have called for the limited understanding of the topic to be addressed (Sihag and Rijsdijk, 2019; Mackelprang and Nair, 2010), advanced theory development to be consolidated (Ataseven and Nair, 2017),

Table 1. Main characteristics of previous SCA literature reviews and present research

Paper	Objective	No. of papers analysed	Study data	Information sources/keywords	Main findings
Al Humdan *et al.* (2020)	To compare and contrast the existing SCA definitions in order to develop a comprehensive definition To extract and analyse the enablers of SCA and to explore the performance implications of SCA To explore the performance implications of SCA to understand the scope of the benefits accruing to firms that pursue SCA	56	1999–2018	*Databases:* Web of Science and ABI INFORM/Global *Keywords:* "supply chain agility", "agile supply chain", "supply chain leagility", "leagile supply chain"	Development of a new definition of SCA Identification of the enablers of SCA from both proactive and reactive perspectives Discussion of performance implications of SCA
AlKahtani *et al.* (2019)	To establish an empirical study of published literature reviews (from 2000 to 2017) on the assessment of agile supply chains	66	2000–2017	*Databases:* Scopus and Web of Science *Keywords:* "supply chain" and agil* are used in combination with "assess*" or evaluat*	Descriptive analysis and content analysis Identification of gaps and issues in the field of SC assessment
Ciccullo *et al.* (2018)	To develop a systematic literature review addressing the integration of the lean, agile and sustainable supply chain management paradigm	73	1999–2017	*Databases:* Scopus and Google Scholar *Keywords:* "lean", "agile", "responsive", "resilient", "flexible" in combination with "sustainability", "sustainable", "environmental", "green" and "social", "supply chain" was used as a further filter in the body of the text in all the queries	Six types of integration between lean and sustainable and agile and sustainable supply chain paradigms and a set of practices to achieve each type of integration Possible reasons why the same practices can support different integration types Future research directions
Du *et al.* (2021)	To examine the current state of the art of SCA and identify potential research gaps	35 (20 for content analysis)	−2020	*Databases:* Springer, IEEE, Elsevier, Taylor, ACM and Emerald *Keywords:* "supply chain, SC and agility"	Factors affecting SCA Approaches to SCA discussed/employed Critical classifications in SCA Summary of research gaps and future research agendas in previous research

(*continued*)

Table 1.

Paper	Objective	No. of papers analysed	Study data	Information sources/keywords	Main findings
Fayezi *et al.* (2017)	To review the literature to provide an explanation of how the concepts of agility and flexibility are defined, used and developed in SCs	83	−2015	*Databases:* Emerald, ScienceDirect and ABI/Inform Global Proquest *Keywords:* "agility", "flexibility", "organizational agility/flexibility", "supply chain agility/flexibility" and "supply chain responsiveness"	Identification and categorisation of SC agility and flexibility in terms of conceptual, contextual and methodological gaps Illustration of the importance of relationship management as a foundation for developing agile and flexible capabilities in SCs Provides an overview of the different research methods employed by researchers involved in SC agility and flexibility
Feizabadi *et al.* (2019)	To synthesise existing research across the Triple-A SC capabilities (agility, adaptability and alignment) to offer a comprehensive framework of Triple-A antecedents and consequences	120 (for the three As)	2005–2016	*Journals*: Journal of Business Logistics, Journal of Operations Management, Journal of Supply Chain Management and the International Journal of Physical Distribution and Logistics Management *Keywords*: agil*, adaptab*, align* and "supply chain"	A comprehensive framework of antecedents and consequences of Triple-A SCs that allows both scholars and practitioners to benchmark and prioritise Triple-A capabilities
Gligor and Holcomb (2012a)	To explore the role of logistics capabilities in achieving supply chain agility	31	1991–2010	*Database:* EBSCO *Keywords*: "manufacturing", "firm", "organization", "agility" and "agile"	Conceptualisation and enablers of manufacturing, organisational and SC agility Characteristics of an agile SC that can be directly or indirectly linked to logistics capabilities

(*continued*)

Table 1.

Paper	Objective	No. of papers analysed	Study data	Information sources/keywords	Main findings
Gligor *et al.* (2019)	To clarify the concepts of agility and resilience by integrating the different bodies of knowledge	100 agility-related articles 100 resilience-related articles	−2019	*Databases:* EBSCO, ProQuest, Science Direct, Emerald and Google Scholar *Keywords:* "agile" OR "agility" AND variations on "sport", "manufacturing", "information systems", "organization" and "supply chain", "resilience" OR "resilient" OR "resiliency" AND variations on "sport" "manufacturing", "information systems", "organization" and "supply chain"	Six major dimensions to capture the concept of SC agility and six major dimensions of SC resilience Common and distinguishing characteristics of agile and resilient SCs
Li *et al.* (2008)	To provide a theoretical model of SC agility and use it to develop a research framework for investigating linkages between SC agility and firm competitiveness	16	1990–2007	*Database*: ISI Web of Knowledge *Keyword*: "agility"	A review of SCA definitions and a proposal for a general definition An analysis of SCA dimensions Conceptual work-design model for SCA at three levels (strategic, operational and episodic design)
Patel and Sambasivan (2021)	To examine previous SCA papers to determine research insights, existing gaps and future research directions	126	1999–2020	*Databases:* Science Direct, Elsevier, Wiley Online Library, Emerald, Inderscience, Springer and Taylor and Francis *Keywords:* "agility", "SCA", "agile manufacturing", "agility index", "agility assessment", "agility maximisation", "agile supply chain barriers", "agile supply chain enablers" and "leagility"	A review of SCA definitions and a proposal Identification of prominent SCA dimensions and approaches Literature categorisation related to modelling the enablers, agility assessment, agility implementation, leagility and agility maximisation Proposed comprehensive framework for SCA

(*continued*)

Table 1.

Paper	Objective	No. of papers analysed	Study data	Information sources/keywords	Main findings
Sharma *et al.* (2017)	To gain knowledge of the current state of research on SCA, specifically to have conceptual clarity and synthesise future research avenues	118	1999–2016	*Databases:* Emerald, Wiley, Science Direct, Taylor and Francis and Informs *Keywords:* "Supply Chain" AND Agil*	A review of SCA definitions and a comprehensive definition of SCA Classification and analysis of SCA papers from a strategic view and a capability view and their performance impact Proposed unified framework for SCA
Sharma *et al.* (2020)	To integrate lean, agile, resilient, green and sustainable paradigms in the SC domain	160	1999–2019	*Databases:* Scopus with Science Direct and Emerald Insight *Keywords:* "Lean", "agile", "resilient", "green", "supply", "performance", "sustainable" and "supply chain"	Analysis of lean, agile, resilient, green and sustainable paradigms in previous research Analysis of literature based on the research type, geographical location, tools/techniques used, industry/sector of application and focus
Shashi *et al.* (2020)	To offer a systematic review of SCA and describe the main aspects that have addressed technology within SCA with the identification of research gaps	90	1999–2017	*Databases:* Scopus and Web of Science *Keywords:* "agil*" and "supply chain"	A descriptive and analytical analysis of how technology has been addressed in SCA A nomological network of SCA research A proposed research agenda
Siddhartha. and Sachan (2016)	To analyse and synthesise models and frameworks to introduce SCA in an organisation and develop a detailed agenda to help guide future research	44	−2012	*Databases:* Business Source Complete and ProQuest *Keywords:* "agile supply chain" and "responsive supply chain"	A review of SCA definitions and characteristics An analysis of models and frameworks to implement SCA in industry

(*continued*)

Table 1.

Paper	Objective	No. of papers analysed	Study data	Information sources/keywords	Main findings
Present paper	To critically analyse and quantitatively synthesise the results of the previous empirical research on the SCA–performance relationship using an SLR and a meta-analysis	65	−2022	*Databases:* Scopus and Web of Science *Keywords:* suppl* and chain* and (agil* or Triple-A or "Triple A")	Identification of the empirical papers focused on the SCA–performance relationship Analysis of the main characteristics of the empirical research on the topic (papers by year, journals, co-citations, etc.) Determines and groups the performance measures Analysis of SCA scales and dimensions Determines the value of the SCA–performance correlation Identifies moderation variables and quantifies moderator effects Confirms significant positive relationship between SCA and performance in an aggregate sample and in moderators Empirical analysis of the effect of moderators in the SCA–performance relationship Guidelines for the development and reporting of further studies on the topic Provides managers with quantification of effect between SCA and performance

the relationships between variables of interest in unexplored or ambiguous aspects to be explained (Iftikhar *et al.*, 2021), and the extant literature, which does not provide a holistic perspective of the topic, to be improved (Akın Ateş *et al.*, 2022). When no consensus or homogeneity is achieved on a topic, previous results could confuse managers. Therefore, clarification is needed (Sihag and Rijsdijk, 2019).

In this line, several prior studies on the SCA–performance relationship that use different performance measures and samples conclude a positive relationship (e.g. Alam *et al.*, 2019; Chan *et al.*, 2017; Gligor *et al.*, 2013). However, other studies also exist that do not confirm this relationship or do so only partially (e.g. Altay *et al.*, 2018; Gligor *et al.*, 2015; Gligor, 2016; Um, 2017; Muafi and Sulistio, 2022). This shows that there is a lack of consensus in previous results, which is commonly argued as a reason for developing a meta-analysis (e.g. Akın Ateş *et al.*, 2022; Ataseven and Nair, 2017; Sihag and Rijsdijk, 2019; Lee and Madhavan, 2010, Nair, 2006; Cao *et al.*, 2011; Mackelprang and Nair, 2010) and can also justify the present study. Meta-analysis is a powerful method for conducting systematic syntheses of the empirical literature as it helps resolve conflictive findings and enables the potential sources of these conflicts to be evaluated through moderator analyses (Abreu-Ledón *et al.*, 2018).

The inconsistent results found in the previous studies could be caused by the influence of moderating variables. Different performance measures and SCA scales have been used in the prior literature and no previous research has analysed the possible effect of these variables on the relationship or summarised the results of different samples. Additionally, the moderating effects of other factors such as the economic region and industry must be analysed and quantified. Thus, the present meta-analysis offers new knowledge on the variables that explain any possible differences in performance. In addition, it allows to determine the values of the correlations in the total sample and by moderator variable, thus advancing knowledge of the unexplored issue that is the intensity of the impact.

Consequently, to summarise, a broad range of reasons justify the development of a meta-analysis in the SCA–performance relationship context. Firstly, concerning the state of the art of the topic, a generalised understanding of the SCA–performance relationship is required that would help to consolidate and advance theory development. Secondly, the lack of consensus in a heterogeneous context warrants a study of any moderator variables that might explain the differences detected, based on elements such as the performance measure considered, the SCA scale used and the industry and economic region. Thirdly, it is necessary to take stock of the results obtained in previous empirical studies and generate some answers for researchers and SC managers. Finally, no previous meta-analysis on this topic can be found, which is yet another reason often argued for one to be developed (Chahal *et al.*, 2020; Iftikhar *et al.*, 2021; Yu *et al.*, 2015).

The present paper clarifies the divergences or controversies around the SCA–performance link and provides some new evidence by critically analysing and quantitatively synthesising the results of past research. It responds to the following research questions: What impact does SCA have on performance? What influence do substantive and extrinsic moderators have on the SCA–performance relationship? This research differs from the previous literature reviews in terms of its aim, approach, sample, methodology and contribution. It is not focused on the conceptualisation of SCA or the development of theoretical models with antecedents and consequences as these are topics that have been widely addressed in previous literature reviews. We focus on empirical papers that analyse the SCA–performance relationship and develop a meta-analysis. As can be seen in Table 1, the present study exposes a range of issues and contributes to previous literature reviews by (1) identifying and classifying peer-reviewed empirical papers focused on the SCA–performance link; (2) analysing the main characteristics of empirical research on the topic; (3) determining and grouping the different performance measures analysed in the previous research; (4) analysing the SCA scales and dimensions in the previous research; (5) identifying moderating variables; (6) quantifying the value of the SCA–performance correlations (high, medium and low) in the total sample and by moderator

subgroup; (7) determining whether the correlations are significantly different by moderator subgroup; (8) providing guidelines for developing and reporting further studies on the topic and (9) developing implications for managers.

The remainder of the article is organised as follows. Firstly, the theoretical background and hypotheses are established. Next, the methodology and the results of the meta-analysis are presented, including a detailed analysis, findings and discussion. Finally, some conclusions, research gaps and best practice recommendations are presented.

2. Theoretical background

2.1 SCA and performance

The origins of agility as a business concept can be traced back to agile and flexible manufacturing systems focused on achieving short lead times and a greater capacity to react to changes in product variety and volume (Scholten *et al.*, 2010). However, agility has spread to organisational contexts and, subsequently, to the SC as a whole. It has been studied as an extensive and multidimensional concept that combines many disciplines and its base has been fragmented into various domains (Li *et al.*, 2008). Consequently, SCA is a relatively new construct (Gligor *et al.*, 2013) that responds to the need for SCs to quickly react to dynamic and volatile markets, which implies the ability to interpret and address real demand (Lee, 2004). SCA is considered to be a dynamic capability that demands complex resources and whose implementation might be hard, complicated and expensive to replicate and, therefore, generates a CA and superior performance (Machuca *et al.*, 2021). It can be defined as the "ability to rapidly detect and respond to unexpected short-term changes in supply and demand in order to generate or preserve CA, thus allowing companies to remain fully aware of variations in customer preferences and requirements and offer them the right product at the right time and price (Alfalla-Luque *et al.*, 2018, p. 50).

Although the benefits of agility have been widely recognised across a variety of domains, limited research has been developed in the SC context (Gligor *et al.*, 2013). Some previous studies (Table 1) offer formal SCA definitions (e.g. Li *et al.*, 2008; Marin-Garcia *et al.*, 2018a, b; Swafford *et al.*, 2006) and a detailed analysis of agility from different scopes (Sharma *et al.*, 2017; Al Humdan *et al.*, 2020; Li *et al.*, 2008; Yusuf *et al.*, 2014; Gligor and Holcomb, 2012a). Several systematic literature reviews (SLRs) summarise some particular features of SCA research (e.g. Charles *et al.*, 2010; Gligor *et al.*, 2013, 2019; Gligor and Holcomb, 2012a; Al Humdan *et al.*, 2020; Li *et al.*, 2008; Sharma *et al.*, 2017, 2020; Siddhartha and Sachan, 2016). They confirm the SCA framework's diversity and heterogeneity (Swafford *et al.*, 2006; Chen, 2019; Eckstein *et al.*, 2015; Marin-Garcia *et al.*, 2018a, b; Aslam *et al.*, 2018). It has been very unusual for articles to use the same SCA definitions, scales and dimensions (Gligor *et al.*, 2013; Marin-Garcia *et al.*, 2018a, b). For example, Al Humdan *et al.* (2020), the fact that they have found as many as 25 definitions of SCA indicates that, although awareness of the existence of SCA is growing rapidly, as a concept, it is far from being fully consolidated. Table 1 summarises the main findings of previous SLRs that have carried out detailed analyses of SCA definitions and theoretical frameworks. But this is not our aim. This paper complements previous research findings by focusing on the empirical studies on the SCA–performance relationship, which is considered to still be in its infancy (Wu *et al.*, 2017).

SCA is a dynamic capability able to positively influence performance in an ever-changing business context (Blome *et al.*, 2013) and to lead to the achievement or maintenance of a competitive position (Teece *et al.*, 1997). Managers for whom this is the goal should implement strategies and practices to improve short-term sensitivity to the market and respond to market changes through flexibility in volume and variety of products (Alfalla-Luque *et al.*, 2018). Consequently, SCA should enable firms to react more effectively to SC disruptions caused by the current turbulent and uncertain environment in order to avoid stock breakouts and delayed deliveries and contribute to lower costs and better service. There has been an increasing need to

reinforce SC capacities to deal with SC disruption and provide a better response in the wake of the COVID-19 pandemic, and SCs need to be more agile than before (Lee, 2021).

In previous empirical research, some studies have concluded a positive relationship between SCA and performance (Table 2), which indicates that SCA has a direct and positive impact on a variety of performance measures such as business performance (e.g. Zhu and Gao, 2021), CA (e.g. Chen, 2019), cost (e.g. Eckstein *et al.*, 2015), financial performance (e.g. Whitten *et al.*, 2012) and organisational performance (e.g. Attia, 2015). However, other studies exist that do not confirm or only partially confirm these relationships with, for example, business performance (Um, 2017), SC performance (Yang, 2014), financial performance (Gligor, 2016), and operational and relational performance (Gligor *et al.*, 2022). The SLR developed by Al Humdan *et al.* (2020) analyses 18 empirical papers and 4 (22.2%) provide "ambivalent" results. Scholars have, therefore, called for more research to understand this topic in greater depth (Gligor and Holcomb, 2012a).

Given the above arguments, as a dynamic capability, SCA could be expected to contribute to performance by enabling a more effective response to SC disruptions. Consequently, the meta-analysis contributes by summarising the previous research for the first time to test the following hypothesis:

H1. SCA is positively correlated to performance.

2.2 Moderators in the SCA–performance relationship

The relationship under study is very broad, due to both the independent variable, SCA, and the dependent variable, performance. This prompts the idea that there is no single fixed effect in reality but that SCA–performance effects are vastly heterogeneous, due to multiple moderating factors. In general, three types of moderators can be defined (Lipsey, 1994): substantive (variables related to the phenomenon under study), methodological (variables describing study methods and procedures) and extrinsic (variables related to exogenous conditions that could affect the strength and direction of the analysed relationship). Consequently, the following step, which is a novel contribution, is to determine the variables that could moderate the SCA–performance relationship, analyse the aggregate results of previous investigations and provide researchers and practitioners with some findings.

Based on the analysis of the previous research on the topic, the performance measure (operational, financial and overall) and the SCA operationalisation (SCA construct scale) have been considered substantive moderators. The economic region (developed versus developing regions) and the industry (manufacturing versus service) have been defined as extrinsic moderators. Other moderators usually found in meta-analyses such as the unit of analysis (firm/plant), firm/plant size and firm/plant age were initially proposed (Abreu-Ledón *et al.*, 2018) but most of the papers did not provide sufficient information in this regard. Studies were also coded according to whether they were focused on single or multiple countries and whether the performance measures were subjective or objective; however, there were very few multi-country studies or objective performance measures, so they were discarded from the analysis as they generated very small subgroups (with four or fewer articles per subgroup).

2.2.1 Substantive moderators. Construct operationalisation is the most common moderating variable in meta-analysis as variations in operationalisation could influence the direction and/or magnitude of the relationship between independent and dependent variables (Wang *et al.*, 2018a). Consequently, it can be considered a moderating effect that explains the heterogeneity between studies (Hancock *et al.*, 2013). Different ways of operationalising variables can lead to random errors that cause heterogeneity in the results as the operationalisation of the variables can affect the real correlations (Van Wijk *et al.*, 2008). In our case, what we want to know is the effect that the scales used to construct operationalisation have on the analysed relationship.

Table 2. Papers included in the meta-analysis

Paper	Sample	Type of performance	Economic region	Country	Industry	SCA base scale	Analysis methods	SCA–performance relationship
Abdallah *et al.* (2021)	284	Operational performance	Developing	Jordan	Manufacturing	Others	CB-SEM	Positive impact on SC performance
Abdelilah *et al.* (2021)	112	Operational performance	Developing	Morocco	Manufacturing	Others	PLS-SEM	Positive impact on firm's operational performance
Alam *et al.* (2019)	250	Overall performance	Developing	India	Manufacturing	Gligor *et al.* (2013)	CB-SEM	Positive impact on firms' sales performance
Aljumah (2022)	283	Overall performance	Developing	United Arab Emirates	Service	Swafford *et al.* (2006)	PLS-SEM	Positive impact on organisational performance
Al-Shboul (2017)	113	Overall performance	Developing	Multiple countries	Both	Others	CB-SEM	Positive impact on manufacturing firm performance
Altay *et al.* (2018)	335	Operational performance	Developing	India	Services	Swafford *et al.* (2006)	PLS-SEM	Positive impact on humanitarian SC performance Unconfirmed positive impact on pre-disaster phases humanitarian SC performance (post-disaster phases)
Alzoubi and Yanamandra (2020)	132	Overall performance	Developing	United Arab Emirates	Manufacturing	Others	PLS-SEM	Positive impact on SC performance
Ariadi *et al.* (2021)	139	Financial performance	Developing	Indonesia	Manufacturing	Others	PLS-SEM	Positive impact on financial performance
Attia (2015)	153	Overall performance	Developing	Egypt	Manufacturing	Others	CB-SEM	Positive impact on organisational performance
Avelar-Sosa *et al.* (2018)	225	Financial performance	Developing	Mexico	Both	Others	PLS-SEM	Positive impact on financial performance
Ayoub and Abdallah (2019)	290	Financial performance	Developing	Jordan	Manufacturing	Others	CB-SEM	Positive impact on export performance
Baah *et al.* (2022)	175	Operational performance	Developing	Ghana	Manufacturing	Gligor *et al.* (2013)	PLS-SEM	Positive impact on SC performance
Blome *et al.* (2013)	121	Operational performance	Developed	Germany	Manufacturing	Swafford *et al.* (2006)	PLS-SEM	Positive impact on operational performance

(*continued*)

Table 2.

Paper	Sample	Type of performance	Economic region	Country	Industry	SCA base scale	Analysis methods	SCA–performance relationship
Cadden *et al.* (2022)	201	Operational performance	Developed	US	Manufacturing	Swafford *et al.* (2006)	CB-SEM	Positive impact on supply chain performance
Chan *et al.* (2017)	141	Overall performance	Developing	China	Manufacturing	Swafford *et al.* (2006)	CB-SEM	Positive impact on firm performance
Chen (2019)	204	Operational performance	Developing	Taiwan	Manufacturing	Swafford *et al.* (2006)	CB-SEM	Positive impact on competitive advantage
Eckstein *et al.* (2015)	143	Operational performance	Developed	Germany	Manufacturing	Li *et al.* (2009)	CB-SEM	Positive impact on cost performance and operational performance
Fernandez-Giordano *et al.* (2021)	190	Operational performance	Developed	Spain	Manufacturing	Swafford *et al.* (2006)	CB-SEM	Positive impact on operational performance
Fosso Wamba and Akter (2019)	281	Financial performance	Developed	USA	Services	Others	PLS-SEM	Positive impact on firm performance
Garcia-Alcaraz *et al.* (2017)	306	Operational performance	Developing	Mexico	Manufacturing	Others	PLS-SEM	Positive impact on economic performance and operational performance
Geyi *et al.* (2020)	311	Operational performance	Developed	UK	Manufacturing	Li *et al.* (2009)	CB-SEM	Positive impact on operational performance
Girdwichai and Somjai (2019)	310	Operational performance	Developed	Germany	Unspecified	Swafford *et al.* (2006)	PLS-SEM	Positive impact on operational performance
Gligor (2016)	242	Financial performance	Developed	USA	Manufacturing	Gligor *et al.* (2013)	Correlational	Unconfirmed positive impact on financial performance
Gligor and Holcomb (2012b)	151	Operational performance	Developed	North America	Services	Li *et al.* (2009)	Correlational	Positive impact on operational performance and relational performance
Gligor *et al.* (2020)	182	Financial performance	Both	Multiple countries	Both	Gligor *et al.* (2013)	Correlational	Positive impact on organisational performance

(*continued*)

Paper	Sample	Type of performance	Economic region	Country	Industry	SCA base scale	Analysis methods	SCA–performance relationship
Gligor *et al.* (2022)	237	Overall performance	Undefined	Undefined	Both	Gligor *et al.* (2013)	CB-SEM	Positive impact on financial performance Unconfirmed positive impact on operational and relational performance
Gligor *et al.* (2015)	283	Financial performance	Developed	USA	Both	Gligor *et al.* (2013)	CB-SEM	Positive impact on cost efficiency and customer effectiveness. Unconfirmed positive impact on financial performance
Hu *et al.* (2022)	308	Operational performance	Developing	Pakistan	Manufacturing	Others	CB-SEM	Positive impact on competitive advantage
Hwang and Kim (2019)	279	Financial performance	Developing	South Korea	Both	Others	CB-SEM	Positive impact on financial performance
Irfan *et al.* (2019)	148	Overall performance	Developing	Pakistan	Manufacturing	Li *et al.* (2009)	PLS-SEM	Positive impact on business performance
Jafari *et al.* (2021)	369	Operational performance	Developing	Iran	Manufacturing	Others	PLS-SEM	Positive impact on SC performance
Jamjumrus and Sritragool (2019)	272	Financial performance	Developing	Thailand	Manufacturing	Others	CB-SEM	Positive impact on business performance
Jermsittiparsert *et al.* (2019a)	298	Unspecified	Developing	Indonesia	Manufacturing	Others	PLS-SEM	Positive impact on SC performance
Jermsittiparsert *et al.* (2019b)	499	Operational performance	Developing	Thailand	Manufacturing	Others	PLS-SEM	Positive impact on SC performance
Kabra and Ramesh (2016)	193	Operational performance	Developing	India	Services	Swafford *et al.* (2006)	PLS-SEM	Positive impact on Humanitarian SC performance
Khan *et al.* (2023)	146	Financial performance	Developing	Pakistan	Manufacturing	Others	PLS-SEM	Positive impact on export performance
Khan *et al.* (2022)	163	Operational performance	Developing	Pakistan	Manufacturing	Others	PLS-SEM	Positive impact on post-COVID disruption performance

(*continued*)

Table 2.

Table 2.

Paper	Sample	Type of performance	Economic region	Country	Industry	SCA base scale	Analysis methods	SCA–performance relationship
Liu *et al.* (2013)	286	Overall performance	Developing	China	Both	Others	CB-SEM	Positive impact on firm performance
Machuca *et al.* (2021)	304	Operational performance	Both	Multiple-countries	Manufacturing	Others	PLS-SEM	Positive impact on competitive advantage
Mandal (2016)	177	Operational performance	Developing	India	Manufacturing	Swafford *et al.* (2006)	CB-SEM	Positive impact on operational performance
Mandal (2018)	212	Operational performance	Developing	India	Services	Gligor *et al.* (2013)	CB-SEM	Positive impact on SC performance
Mandal and Dubey (2020)	302	Operational performance	Developing	India	Services	Swafford *et al.* (2006)	CB-SEM	Positive impact on sustainable tourism SC performance
Manzoor *et al.* (2022)	180	Overall performance	Developing	Pakistan	Manufacturing	Others	PLS-SEM	Positive impact on operational performance and competitive advantage
Martinez-Sanchez and Lahoz-Leo (2018)	231	Financial performance	Developed	Spain	Manufacturing	Others	CB-SEM	Positive impact on firm performance
Mirghafoori *et al.* (2017)	74	Financial performance	Developing	Iran	Manufacturing	Others	PLS-SEM	–
Muneer (2019)	231	Financial performance	Developing	Malaysia	Manufacturing	Others	PLS-SEM	Positive impact on financial performance
Najar (2022)	125	Operational performance	Developing	Republic of Tunisia	Manufacturing	Others	PLS-SEM	Unconfirmed positive impact on innovation performance
Nath and Agrawal (2020)	311	Operational performance	Developing	India	Manufacturing	Others	CB-SEM	Positive impact on sustainability performance
Nazempour *et al.* (2018)	500	Operational performance	Developing	Iran	Manufacturing	Gligor *et al.* (2013)	CB-SEM	Positive impact on operational performance
Panigrahi *et al.* (2022)	398	Operational performance	Developing	India	Manufacturing	Others	PLS-SEM	Positive impact on operational performance
Prawira *et al.* (2019)	560	Operational performance	Developing	Indonesia	Manufacturing	Others	CB-SEM	Positive impact on operational performance

(*continued*)

Table 2.

Paper	Sample	Type of performance	Economic region	Country	Industry	SCA base scale	Analysis methods	SCA–performance relationship
Ramos *et al.* (2023)	98	Operational performance	Developing	Peru	Both	Others	fsQCA	Positive impact on supply chain performance
Riquelme-Medina *et al.* (2022)	214	Financial performance	Developed	Spain	Both	Swafford *et al.* (2006)	Regression analysis	Positive impact on performance
Samdantsoodol *et al.* (2017)	205	Operational performance	Developing	Mongolia	Both	Others	CB-SEM	Positive impact on business performance
Sangari and Razmi (2015)	184	Operational performance	Developing	Iran	Manufacturing	Li *et al.* (2009)	CB-SEM	Positive impact on SC performance
Tarafdar and Qrunfleh (2016)	205	Operational performance	Developed	USA	Manufacturing	Others	CB-SEM	Positive impact on SC performance
Tse *et al.* (2016)	266	Financial performance	Developing	China	Manufacturing	Swafford *et al.* (2006)	CB-SEM	Positive impact on firm performance
Um (2017)	156	Financial performance	Both	Multiple countries	Manufacturing	Others	CB-SEM	Positive impact on business performance through customer service and differentiation Direct negative impact on business performance through ROS, ROA, market share growth and sales growth
Umam and Sommanawat (2019)	94	Unspecified	Developing	Indonesia	Manufacturing	Li *et al.* (2009)	PLS-SEM	Positive impact on firm performance
Whitten *et al.* (2012)	132	Financial performance	Developed	USA	Manufacturing	Others	PLS-SEM	Positive impact on financial performance and SC performance
Yang (2014)	137	Overall performance	Developing	China	Manufacturing	Others	CB-SEM	Positive impact on cost efficiency Unconfirmed positive impact on performance
Zakir *et al.* (2022)	200	Operational performance	Developing	Pakistan	Manufacturing	Others	CB-SEM	Positive impact on SC performance
Zhu and Gao (2021)	208	Financial performance	Developing	China	Manufacturing	Gligor *et al.* (2013)	CB-SEM	Positive impact on business performance

With regard to the performance construct, a broad variety of performance measures have been used in previous research on the topic (Al Humdan *et al.*, 2020). For example, Iftikhar *et al.* (2021) categorise performance into financial and non-financial. Al Humdan *et al.* (2020) distinguish between measures that range from purely operational (e.g. quality, product innovation, service, etc.) to broad strategic performance (e.g. overall competitiveness, profitability, sales growth, etc.). Feizabadi *et al.* (2019) distinguish between operational measures (quality, productivity and efficiency), relational measures (incorporating elements of the supplier–customer relationship) and financial measures (return on assets (ROA), return on investment, return on sales (ROS), etc.).

In this paper, we explore the moderating effects of different performance measures on the SCA–performance relationship. Based on the items employed in the performance scales in previous studies, three groups of performance measures have been established: operational, financial and overall performance measures. Overall performance could be defined as the total economic product of a business's activities and is the result of the activities in different performance domains, both financial and non-financial (Attia, 2015). Operational measures are taken as an indication of how efficient and effective an organisation's internal operations are in terms of cost, customer service (delivering the right quality and the right quantity at the right time), service-level performance (deliveries), and flexibility, while financial performance measures are seen to reflect how an organisation is judged by external factors (Attia, 2015). Financial performance (such as ROA, ROS, profit after tax, annual sales, market share, sales growth and margin on sales) is important as, essentially, it continues to be the basis for senior managers' base investment decisions (Abreu-Ledón *et al.*, 2018). Yet, operations may not be directly responsible for financial performance (Klingenberg *et al.*, 2013). Service-, cost-, quality-, delivery-, flexibility- and innovation-based measures are considered for operational performance. Sanghotra *et al.* (2011) state that it is essential to consider non-financial measures as they are not only measurable but also consistent and precise with organisational strategies and goals. A great deal of performance measurement and reporting is non-financial at the shop-floor level (Abdel-Maksoud *et al.*, 2005; Nawanir *et al.*, 2013).

As indicated above, some research studies confirm the relationship between SCA and performance using different types of performance measures but others do not. Table 2 shows the type of performance considered in previous papers and the SCA positive or unconfirmed impact on performance. The most studied measure has been operational performance, which does not always confirm a positive relationship. For example, Alfalla-Luque *et al.* (2018) partially confirm a positive impact as they find significant relationships between SCA and Flexibility, Financial, Cost and Delivery CA but not Quality CA. Gligor *et al.* (2022) do not confirm a positive impact of SCA on operational performance. Najar (2022) does not find a positive impact of SCA on innovation performance. Altay *et al.* (2018) consider that the relationship between SCA and post-disaster performance (operational performance) is not significant. In relation to financial performance, some studies also do not confirm a positive relationship. For example, Um (2017) indicates that SCA has a direct negative impact on business performance for the indicators ROS, ROA, market share growth and sales growth (financial performance). Gligor *et al.* (2015) do not find a direct link between SCA and financial performance (ROA). Finally, focusing on the overall performance, Yang (2014) concludes that the direct effect of SCA on overall performance is not significant, while in Gligor *et al.* (2022), there was no confirmation of a positive impact on overall performance.

The SLR developed by Al Humdan *et al.* (2020) finds that results are "ambivalent", which suggests "a complex relationship between SCA and different types of performance". Consequently, the meta-analysis provides the opportunity not only to confirm (or not) the positive link between each performance measure and SCA but also to determine the value of these correlations and compare the results of the performance measures. So, this paper tests the possible influence of the type of performance by testing the following hypothesis:

H2. SCA is positively related to (a) operational performance, (b) financial performance and (c) overall performance.

As has been indicated above, SCA has been defined from different perspectives and scopes in previous research. Therefore, previous SLRs have analysed different aspects of the SCA definition in order to organise the different themes to reduce the ambiguity surrounding the concept (see Table 1). For example, Gligor *et al.* (2019) summarise the most common themes in SCA conceptualisations as the ability to (1) quickly change direction; (2) empower the customer; (3) integrate processes within and across firms; (4) speed up operations; (5) adjust tactics and operations (flexibility) and (6) scan the environment. In this line, Al Humdan *et al.* (2020) conclude that four possible issues exist in the SCA definitions: (a) speed; (b) the scope of agility (responsiveness to changes in the demand and/or supply conditions); (c) the mode of agility (proactively and/or reactively, in anticipation of change or in response to change, respectively) and (d) the outcome of agility.

Thus, the different SCA conceptualisations imply high heterogeneity, which results in the use of different scales in the operationalisation of the SCA construct (Marin-Garcia *et al.*, 2018a, b; Gligor *et al.*, 2022). As Eckstein *et al.* (2015) state, "more work is necessary to develop the perception and reliability of scales". Consequently, the SCA concept and the scale should be aligned to capture the essence of the topic. However, although the theoretical conceptualisation of SCA could be addressed from different perspectives, the key element in empirical research is how this concept has been operationalised on the particular scale in question, i.e. the items used in the survey. Ultimately, this is a key issue as practitioners in the survey of empirical papers do not assess or discuss any theoretical SCA conceptualisation but simply respond to a survey. In this respect, Gligor *et al.* (2022) demonstrate that papers with different SCA definitions use the same measurement scale and papers with similar SCA conceptualisations propose different scales, which supports the SCA scale's use as a moderator rather than the SCA conceptualisation. In this sense, in most cases (see Table A-Online Appendix), SCA has been operationalised as a first-order construct based on a variety of scales constructed with a very different number of items ranging from a minimum of 3 items (Khan *et al.*, 2023; Garcia-Alcaraz *et al.*, 2017) to a maximum of 28 (Geyi *et al.*, 2020). A broad range is also found when SCA is a second-order construct, with between two (Zakir *et al.*, 2022) and six (Sangari and Razmi, 2015) dimensions defined. The main dimensions employed in the prior research are alertness, flexibility, decisiveness, swiftness, joint planning, process integration and accessibility and have been defined in Table B-Online Appendix (with an indication of the empirical papers that have used these dimensions in the SCA construct).

Consequently, the scarce use and great variety of dimensions in the SCA construct make it impossible to use dimensions as moderators, which leads to a focus on the source of the SCA construct. This situation is also very diverse, with very few researchers reusing scales. Theoretical works, such as Lee (2004), Van Hoek *et al.* (2001) and Christopher (2000) are taken as references for the design of some scales. However, three validated scales have been found as the most referred to, i.e. Swafford *et al.* (2006), Li *et al.* (2009) and Gligor *et al.* (2013). It should be highlighted that the scales used by Blome *et al.* (2013), Mandal (2016) and Ayoub and Abdallah (2019) are based on Swafford *et al.* (2006), so any papers that reference the former also derive from the latter. Meanwhile, the Eckstein *et al.* (2015) scale is based on Li *et al.* (2009). Finally, the Gligor *et al.* (2013) scale is used as the basis for these authors' subsequent works Gligor *et al.* (2015, 2020, 2022) and Gligor (2016).

Swafford *et al.* (2006) define SCA as "the SC's capability to adapt or respond in a speedy manner to a changing marketplace environment". They measure SCA using a first-order construct with 11 items. Gligor *et al.* (2013) define SCA as a company's "ability to quickly adjust tactics and operations within its SC to respond or adapt to changes, opportunities or threats in its environment". They develop an SCA second-order construct with five dimensions (22 items).

Li *et al.* (2009) define SCA as "the result of integrating the SC's alertness to changes (opportunities/challenges) – both internal and environmental – with the SC's capability to use resources in responding (proactively/reactively) to such changes, all in a timely and flexible manner". They design the SCA as a second-order construct with six dimensions (12 items). However, when later works use these same scales, most form the SCA construct without any dimensions at all (first-order construct). Table C-Online Appendix indicates the SCA construct dimensions and the Likert scales used in each of the three reference scales. These scales have also been conceptualised in line with the most common themes in SCA conceptualisation established by Gligor *et al.* (2019) and the four possible issues existing in the above-mentioned SCA definitions indicated by Al Humdan *et al.* (2020). The differences in conceptualisation and operationalisation in the SCA reference scales are manifest.

Therefore, SCA operationalisation has been included as a moderator through the analysis of the three scales most used in previous works (Gligor *et al.*, 2013; Swafford *et al.*, 2006; Li *et al.*, 2009) and works have been grouped according to the reference scale in question. Taking into account the above, the following hypothesis has been developed:

H3. SCA is positively related to performance in different SCA operationalisations (SCA construct scales).

2.2.2 Extrinsic moderators. The prior research has suggested that the economic region (country context) and industry are important control variables (Abreu-Ledón *et al.*, 2018; Wang *et al.*, 2018a; Iftikhar *et al.*, 2021) as firms in different regions or industries may perform differently when developing SCA. These variables have been used in previous meta-analyses and the measurement of the impact of the economic region and industry has been specifically recommended in future empirical research (Chahal *et al.*, 2020).

Several authors have considered the economic region as a moderator in the relationship between Operations Management (OM) practices and performance (Machuca *et al.*, 2021). Regarding SCA, global SC could limit performance through different traits usually associated with SCA (Prater *et al.*, 2001). The effect of contextual variables such as the effect of the economic region on the achievement level of business practices has been discussed in contingency theory (Lawrence and Lorsch, 1967) and the divergence perspective (Ralston *et al.*, 1997) based on the National Specificity argument (Child and Kieser, 1979). As the value system of a country's labour force largely continues to be effective after the country's industrialisation, the deployment of business practice ought to be influenced by a country's national culture (Ralston *et al.*, 1997) as should its effects, also. No method or theory exists that can be applied to every single context (Lawrence and Lorsch, 1967). Nonetheless, according to the convergence hypothesis (Ralston *et al.*, 1997), the increasing transfer of technology and organisational systems around the world is conducive to behaviours converging and a consequent decline in the influence of national cultures (Dore, 1973; Form, 1979). Contextual factors are being analysed more and more routinely in operations and SCM (Qamar and Hall, 2018; Gupta and Gupta, 2019), however, analyses of a country's or region's influence as a contextual factor have not been conclusive (e.g. Altay *et al.*, 2018; Alfalla-Luque *et al.*, 2018; Gligor, 2016; Um, 2017). So, this is still considered an underdeveloped area (Machuca *et al.*, 2021) and there continues to be no agreement on the influence of contextual factors. Consequently, the possible influence of national culture on improving performance must be taken into account (Naor *et al.*, 2010).

The previous literature has distinguished between two main economic regions, developed versus developing areas (Geng *et al.*, 2017; Katiyar *et al.*, 2018; Machuca *et al.*, 2021). The economic region has not been considered as a moderator or control variable in the previous research on the SCA–performance relationship except in Machuca *et al.* (2021) in the context of the Triple-A SC, which finds a significant positive relationship for both the developing and developed country samples. All the other papers focus on developing regions (Abdallah *et al.*, 2021; Ayoub and Abdallah, 2019); developed regions (e.g. Eckstein *et al.*, 2015; Gligor, 2016) or

both (e.g. Gligor *et al.*, 2020; Um, 2017). The results do not always confirm the positive effect between SCA and performance for developed areas (e.g. Alfalla-Luque *et al.*, 2018; Gligor, 2016; Gligor *et al.*, 2015; Yang, 2014), developing countries (Altay *et al.*, 2018) and a sample of both developing and developed regions (Um, 2017). Consequently, papers focused on single countries or specific regions (developed/developing) usually conclude that further research is needed on samples of other countries/regions (e.g. Swafford *et al.*, 2008; Dubey *et al.*, 2019). Based on an SCA literature review, Al Humdan *et al.* (2020) conclude that evidence has to be provided of any possible regional differences in the benefits of SCA, i.e. it has to be determined whether the economic region is an influential factor, especially as there is no general agreement on the matter. Consequently, this paper establishes the following hypothesis:

H4. SCA is positively related to performance in (a) developed and (b) developing regions.

Traditionally, the previous literature has considered the industry as a control variable and two main groups have usually been analysed, service and manufacturing. Considering that services can be characterised by their heterogeneity, intangibility, inseparability and perishability, the effect on performance, which is extremely dependent on subjective customer perception and difficult to measure, could be different from the effect in a manufacturing SC (Chahal *et al.*, 2020). There is a lack of studies addressing services in the SCA research, despite their crucial role in the current economy. This is one of the gaps in the SCA research to date; the vast majority of the literature focuses on manufacturing (Al Humdan *et al.*, 2020). Although most of the studies focus on the SCA–performance relationship and confirm a positive impact, others can be found that focus on both manufacturing (e.g. Gligor, 2016; Um, 2017; Alfalla-Luque *et al.*, 2018; Yang, 2014) and services (Altay *et al.*, 2018) that have not confirmed this. However, some papers on SCA that analyse the manufacturing and service sectors and use the industry as a control variable have found no differences between the two (e.g. Liu *et al.*, 2013; Martinez-Sanchez and Lahoz-Leo, 2018). Consequently, future research is required on this topic using samples from different industries (Dubey *et al.*, 2019). The present meta-analysis contributes to current knowledge by determining the moderating effects of the economic sectors through the following hypothesis:

H5. SCA is positively related to performance in (a) manufacturing and (b) service sectors.

3. Methodology

The literature search has been developed using an SLR protocol, which is widely accepted in a variety of scientific fields including SC management, in general (Marin-Garcia *et al.*, 2018a, b; Sanchez-Ruiz *et al.*, 2020; Marin-Garcia, 2021) and SCA, in particular (e.g. Al Humdan *et al.*, 2020; Gligor *et al.*, 2019; Li *et al.*, 2008; Sharma *et al.*, 2020). To develop a meta-analysis, the SLR is focused on empirical research (Forza and Nuzzo, 2010; Wang *et al.*, 2018b; Petersen *et al.*, 2011; Brax *et al.*, 2021). This meta-analysis follows the steps recommended in the literature (Borenstein *et al.*, 2009; Medina-López *et al.*, 2010; Sartal *et al.*, 2020; Steel *et al.*, 2021; Tranfield *et al.*, 2003; Wang *et al.*, 2018b).

The field of study in this research is SCA and performance. The inclusion criteria established in the SLR are (1) empirical articles focused on the SCA–performance relationship and showing the correlation between CA as an independent variable and performance as a dependent variable and (2) published in peer-reviewed journals indexed in the Scopus or Web of Science (WoS) databases. The exclusion criteria are (1) does not contain all the information required for the meta-analysis, such as SCA–performance correlations and sample size; (2) data from a single organisation; (3) when different research studies use the same sample (or sub-sample), only one of the works is included in the meta-analysis unless different performance measures are used (Geyskens *et al.*, 2009; Wood, 2008) and (4) papers that use

scales called SCA or performance but whose operational definition does not correspond to the definitions of the variables considered in the present meta-analysis.

The period analysed covers up to and including the references available in August 2022 (the date of the last data download) and no starting period is defined. Notwithstanding, the term "supply chain" in the search implies an implicit starting period as it is a recent concept that emerged at the beginning of the 1980s and research in the field was almost non-existent until the mid-1990s (Alfalla-Luque and Medina-López, 2009). The information sources selected are two relevant academic databases, WoS and Scopus, and are limited to scientific journals, excluding conference papers, master's dissertations, doctoral theses, textbooks and reports. These latter kinds of documents are usually less complete and not so well-informed, apart from which, they are not usually easily accessible and are often redundant (they use sub-samples of research documents that are later published as journal papers) (Chen *et al.*, 2021).

The present research seeks to focus on works that have been subjected to a rigorous peer-review process, which enables it to be considered more established knowledge (Podsakoff *et al.*, 2005; Patel and Sambasivan, 2021; Mishra *et al.*, 2021). We are aware that this procedure may be a limitation as it does not guarantee that all surveys research are included in the meta-analysis (Iftikhar *et al.*, 2021; Sihag and Rijsdijk, 2019; Fang and Zhang, 2018; Steel *et al.*, 2021). However, it is a practical way to delimit the research and make it reproducible, with the limitations indicating that it might have enough space left for later works to be analysed if the results of the present work are reproduced in other types of references. It also has to be said that this type of dynamic is common in multiple meta-analyses in the management area (Yu *et al.*, 2015; Cao and Lumineau, 2015; Ataseven and Nair, 2017; Chahal *et al.*, 2020; Mackelprang and Nair, 2010; Marín-Idárraga *et al.*, 2022; Akın Ateş *et al.*, 2022; Govindan *et al.*, 2020; Chen *et al.*, 2021) that do not consider the grey literature to ensure the data quality of the research. Be that as it may, we have conducted a pilot test to detect whether not including conference papers indexed in WoS or Scopus could have affected the results. Specifically, we have searched for works only published at conferences (with no subsequent version published as a journal paper) in 2021 and the first half of 2022. Of a total of 20 conference papers selected using this automated search strategy, none came through the exclusion criteria after screening. The pilot study results seem to endorse our decision to focus only on journal papers (which prevents the appearance of false positives while not appearing to increase the risk of false negatives to any great extent). We shall also conduct a publication bias analysis using the Trim and Fill method (Geyskens *et al.*, 2009) to verify whether there is any risk of publication bias and, at the same time, to estimate the adjusted effect size (Borenstein, 2019).

The automatic search strategy in WoS was (suppl* AND chain* AND (agil* OR Triple-A OR "Triple A")) (Title) AND Articles (Document Types). For Scopus, it was TITLE (suppl* AND chain* AND (agil* OR triple-a OR "Triple A")) AND (LIMIT-TO (DOCTYPE, "ar")). The term Triple-A SC has been included as it comprises the agile SC (along with the adaptable and aligned SCs). After removing the duplicates, a two-phase screening process was begun for the remaining 678 papers. In the first phase (screening by reviewing titles and abstracts), 534 papers were screened out. As a result, 144 selected and possible articles were stored in Mendeley. In the second phase (review of the full paper content), checks were made to verify that papers complied with the inclusion criteria but not with the exclusion criteria. Eighty-one references were excluded in this phase (Figure 1 for Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram). These two phases were carried out independently by two of the authors while the third acted as a referee to decide in the case of any disputable articles that the two initial raters could not agree upon.

The papers excluded due to overlapping samples (Iftikhar *et al.*, 2021; Geyskens *et al.*, 2009) were Attia (2016) same sample as Attia (2015), Gligor and Holcomb (2014) same sample as Gligor and Holcomb (2012b), Gligor *et al.* (2013) repeats the sample as Gligor *et al.* (2015), Gligor *et al.* (2019) same sample as Gligor *et al.* (2015), Qrunfleh and Tarafdar (2013) use the

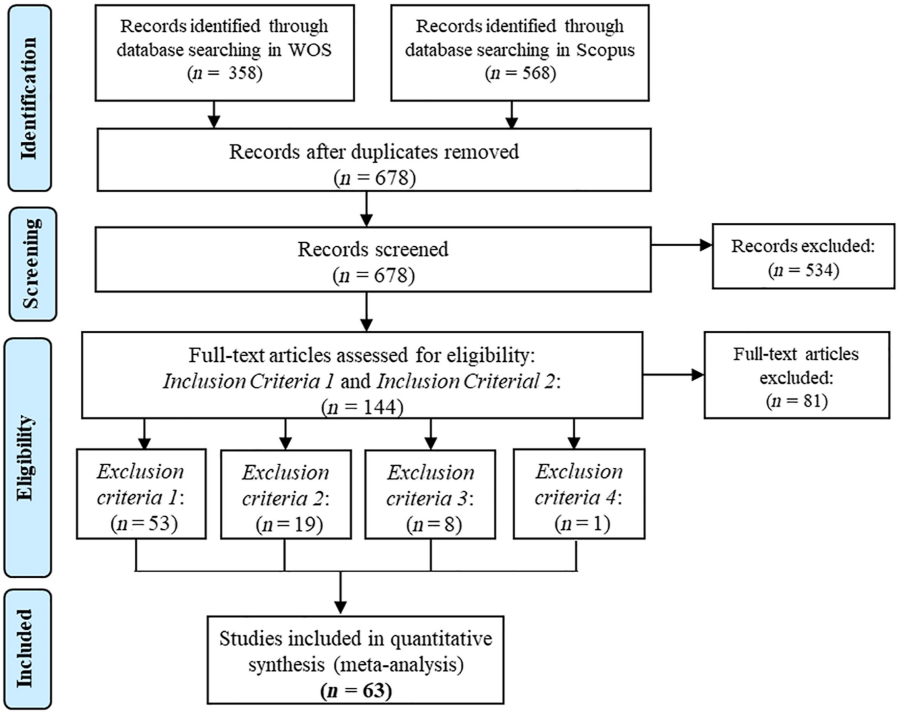

Figure 1.
Steps in sample gathering (PRISMA)

same sample as Tarafdar and Qrunfleh (2016), Feizabadi *et al.* (2019) use the same sample as Gligor *et al.* (2020), Feizabadi *et al.* (2021) use the same sample as Gligor *et al.* (2020), and Alfalla Luque *et al.* (2018) use only the Machuca *et al.* (2021) developed countries sub-sample.

After this process, a total of 63 papers were deemed suitable for coding (Table 2). Although there are 63 papers in Table 2, there are 64 rows as the work by Machuca *et al.* (2021) has two sub-samples, one for developing countries and the other for developed countries. This is a larger sample size than in other operations management meta-analyses (Abreu-Ledón *et al.*, 2018; Mackelprang and Nair, 2010; Wang *et al.*, 2018b; Petersen *et al.*, 2011). Each paper was coded in an Excel template. It should be pointed out that some papers have more than one relationship coded as, for example, they analyse the effect of SCA on more than one performance measure (e.g. Gligor *et al.*, 2022; Manzoor *et al.*, 2022).

The process followed for the coding was based on recommendations from previous works (Losilla *et al.*, 2018; Villiger *et al.*, 2022). The coding team met to clarify the coding process and together coded two randomly selected articles included in the meta-analysis. This pilot test helped debug the list of codes and the procedure. The coding and information extraction process was carried out by two independent raters who extracted the information from all the articles. When any doubt arose (for example, if there were multiple reported outcomes or if the correlations were not located in the article), they asked the third author how they should proceed and the coding protocol was updated and distributed to the two raters (in some cases, support videos were generated that detailed the procedure). Once the articles had been independently coded, the raters compared their results. If their data coincided, this was used as the consensus score. If there were any differences, the raters conferred to see whether they could agree on a consensus score. If they could not, this was put down as a rater disagreement

and the third rater acted as a referee and determined the final agreement. The two raters agreed in every case, so the agreement index was 100% (an agreement index did not have to be calculated using agreement formulae such as Kappa, ICC, Krippendor's alpha or the index of reliability (Perreault and Leigh, 1989; Villiger *et al.*, 2022; LeBreton and Senter, 2008)).

Some of the articles included in the sample (e.g. Avelar-Sosa *et al.*, 2018; Garcia-Alcaraz *et al.*, 2017) did not directly show the correlations (they informed about "Effect Size", with "direct, indirect and total effects" (paths) or R2), which meant that they were obtained indirectly. Specifically, Avelar-Sosa *et al.* (2018) stated the existence of a relationship between SCA and performance in a simple linear regression with only two variables (antecedent and result). The standardised path was known (the authors use partial least squares (PLS)), so the correlation was obtained directly from the β value. In the García-Alcaraz *et al.* (2017) work, the dependent variable "performance" only had two antecedents and the standardised β values could be used to obtain their values (PLS regressions are used with standardised variables). To calculate the correlations, we have used a formula to link the paths to the variables' correlation coefficients, which is used when there are two antecedents, one dependent variable and the betas are known (1) (2).

$$\beta_1 = \frac{r_{y1} - r_{y2}r_{12}}{1 - r_{12}^2} \quad r_{y1} = \frac{\left(1 - r_{12}^2\right) * \beta_1 + r_{12} * \left(1 - r_{12}^2\right) * \beta_2}{1 - r_{12}^2} \tag{1}$$

$$\beta_2 = \frac{r_{y2} - r_{y1}r_{12}}{1 - r_{12}^2} \quad r_{y2} = \frac{\left(1 - r_{12}^2\right) * \beta_2 + r_{12} * \left(1 - r_{12}^2\right) * \beta_1}{1 - r_{12}^2} \tag{2}$$

When no single correlation was indicated between SCA and performance but rather the correlations of different SCA dimensions with a single type of performance, following the Geyskens *et al.* (2009) recommendations, this was not calculated with an average, as that would have assumed the sizes of the effects in each study to be independent. So, composite effect sizes were calculated for each study to consider the interdependencies among the practices (Abreu-Ledón *et al.*, 2018) using the Fisher- Z -transformation, following the method proposed by Borenstein *et al.* (2009), chapters 6, 7, and 24; the transformed values were averaged, and the Fisher- Z -transformation was unpacked to obtain the correlation that represents the set of values. Table 2 shows the main descriptive statistics of the 63 coded papers. A basic bibliometric analysis (sources, year of publication, most cited papers, countries and author co-citation analysis) was performed before the meta-analysis using the bibliometrix R package (Aria and Cuccurullo, 2017).

The meta-analysis was conducted following the indications of Borenstein *et al.* (2009), Hak *et al.* (2016) and Geyskens *et al.* (2009) using the Meta-Essentials workbooks program, vers. 1.5 (https://www.erim.eur.nl/research-facilities/meta-essentials/download/) (Van Rhee *et al.*, 2018; Suurmond *et al.*, 2017). The "Random effect model" was considered at an estimated 95% as we believed the set of collected papers to be a sample of studies that were not necessarily based on the same population (samples of industrial companies vs. services, single country vs. multiple countries, etc.) and that methodologies or measurement instruments have been used that were not exactly the same (Borenstein, 2019; Chen *et al.*, 2021).

Meta-Essentials uses the "weighted variance method" with Z-transformation to estimate the confidence interval (CI) of the Combined Effect Size. This method outperforms other methods (simple t-distribution, Quantile Approximation and normal distribution) (Sanchez-Meca and Marin-Martinez, 2008). Other programs (CMA, OpenMeta[analyst], metafor and ESCI) use a normal distribution, a t-distribution or a non-central t-distribution. Moreover, Meta-Essentials follows the approach known as the Hedges–Olkin Meta-Analysis. Therefore, the values of CIs calculated with Meta-Essentials can differ slightly from those calculated with other programs (Van Rhee *et al.*, 2018; Suurmond *et al.*, 2017) used by other authors such as Abreu-Ledón *et al.* (2018), Chahal *et al.* (2020), MacKelprang and Nair (2010) and Wang *et al.* (2018b).

In general, attenuation correction is recommended for correlation values (Geyskens *et al.*, 2009) and is a common practice in almost all meta-analyses. However, Lipsey and Wilson (2001, p. 109) are not in favour of attenuation correction if other types of artefacts are not also corrected (for which information is not normally available) as this may cause the results to be inflated. When the correction is made, the most used formula is Hunter and Schmidt (2004). We shall use this formula, but we shall also follow the recommendation to inform about the results with both unattenuated and attenuated correlation scores (Geyskens *et al.*, 2009; Borenstein, 2019).

Except where articles inform otherwise, articles based on CB-SEM or consistent PLS-SEM usually inform about the estimated correlation considering the measurement error (i.e. unattenuated correlation). However, PLS-SEM or correlational works inform about attenuated correlation calculated after estimating a latent variable score as a weighted measure of the construct indicators. All the correlations have been converted to unattenuated/attenuated using the formula based on the reliability of constructs (see Borenstein *et al.* (2009) or Hunter and Schmidt (2004)). If Cronbach's alpha was not reported, we searched for composite reliability. If no reliability average was available, the average of all the reliabilities on the scale in the set of papers included in this meta-analysis was used (0.882 for SCA reliability and 0.851 for performance). The corrections were applied before inserting the data (correlation coefficients) into workbook 5 of Meta-Essentials.

We calculated the total corrected weighted mean correlation between SCA and performance, its 95% CI and its prediction interval (PI). We also calculated and informed about the usual statistics (Q, Pq, I2, T2 and T). It must be highlighted that CI is a precision index, not a dispersion index. It indicates the ranges within which the mean effect size of similar populations might fall. In other words, in 95% of the meta-analyses that were performed with samples only taken from the same population, the mean effect size would be in the range of the CI. However, the PI is a results dispersion index. If we have a sufficient number of works ($n > 10$), this indicates how the real effect size varies between different populations. The CI can tell us whether a correlation is significant in the sense that it does not include zero. However, the PI indicates the range in which the results of a specific study can fall, i.e. whether one-off results can be expected to be found for works that are above or below zero (Borenstein, 2019).

To assess heterogeneity, instead of using a cut-off value for I2 (proportion of variance of true effects compared to the variance of observed effects), we shall observe whether the PI is very wide or very narrow (Borenstein, 2019; Geyskens *et al.*, 2009). If the PI is "narrow", the weighted mean can be interpreted as a good estimation of the correlation of the population referred to in the analysed works. Should this not be the case, the study sample is too heterogeneous (very different sample populations are extracted from the articles) (Borenstein, 2019; Borenstein *et al.*, 2009; Hak *et al.*, 2016). In this case, we use categorical moderators for subgroup analysis. A random effects model was chosen in the subgroup analysis for the between-subgroup weighting as the aim of the analysis was to refer to the universe of comparable studies and not all the studies were assumed to be based on a single population (Borenstein, 2019). For the within-subgroup weighting, a random effect (Tau pooled over subgroups) model was chosen. Using pooled variance components is more appropriate when there are very few studies in any particular subgroup (Borenstein *et al.*, 2009; Van Rhee *et al.*, 2018), as is the case of this research.

4. Results

4.1 Main characteristics of the empirical research

The sample papers are distributed across 47 journals (Table D-Online Appendix). *Supply Chain Management: An International Journal* stands out with five papers and *International Journal of Operations and Production Management* with four articles. These are followed by *International Journal of Production Research and International Journal of Supply Chain Management* with 3 articles each. Five journals have published two papers and 38 journals

have published only one paper each. This demonstrates an interest in SCA in a wide range of management journals. Distribution by year of publication (Figure A-Online Appendix) shows that the first article was published in 2012 with the greatest concentration of papers (77.8%) since 2017. 2019 stands out with 14 publications. The novelty and importance of the topic in recent years are evident given the distribution and evolution of papers. The most commonly used analytical methods are the two usually employed in the SCM area, i.e. CB-SEM (50.8%) and PLS-SEM (42.9%) (Table 2).

Table E-Online Appendix reports the ten most cited papers on SCA according to Scopus and WoS. The number of citations in Scopus is slightly higher than in WoS although all the papers remain in the same relative positions. The four papers with over 200 citations in both repositories are Liu *et al.* (2013) (444/364), Blome *et al.* (2013) (285/247), Gligor *et al.* (2015) (278/229) and Eckstein *et al.* (2015) (242/210). These works analyse the direct relationship between SCA and performance but some also use SCA as a moderating variable between information technology and performance (Liu *et al.*, 2013) and supply- and demand-side competence and performance (Blome *et al.*, 2013). Meanwhile, Gligor *et al.* (2015) and Eckstein *et al.* (2015) study moderators between SCA and performance such as environmental situations and product complexity, respectively. Table F-Online Appendix gives the main objectives of the top ten papers.

An author co-citation analysis was carried out to determine the influence of the authors on the topic. Citations indicate that one author's work serves as inspiration for another but generally there is no explicit reference to the direction between authors or the significance of the impact. All references are generally considered to contribute to citing papers equally (Jeong *et al.*, 2014). However, when two documents are frequently co-cited to explain a given concept, this is a strong indication that they have a robust semantic link to the concept in question (Patel and Sambasivan, 2021). The results (Figure B-Online Appendix) show the most prolific authors. A total of 48 authors are reported to be involved in the most co-citations. Some of these authors are important for their methodological papers, including Hair, Podsakoff, Fornell, Henseler, Larcker and Nunnally. Two clusters led by Swafford and Gligor specifically related to SCA–performance stand out. These authors belong to a well-defined connection network and are the most cited in the sample. Swafford is a pioneer in the design and validation of an SCA scale. For his part, Gligor stands out for his empirical papers on SCA–performance.

4.2 Meta-analysis results

Table 3 summarises the reported correlations and reliability of the paper sample and the corrected unattenuated correlation. The 64 samples yielded a total of 14,469 firms. When analysed, they are shown to have fairly similar weights due to the samples having a similar size (min. 74; max. 560; mean 225 firms).

4.2.1 Main effects. As Figure 2 shows, the CI of virtually all of the works' correlation estimations falls in the positive area, which indicates that all except two show a positive significant correlation between SCA and performance. The unattenuated correlation estimations in the individual papers are fairly imprecise. The narrowest CI is 0.01 (Manzoor *et al.*, 2022) and the widest is 0.46 (Mirghafoori *et al.*, 2017). The majority are around a range of approx. 0.20.

The weighted mean unattenuated correlation of the sample papers is 0.56 with a CI of (0.49–0.63) (Table 4). As the CI does not contain zero, the correlation is significant ($Z = 12.99$; $p < 0.0001$) which means that the null hypothesis can be rejected (there is no correlation between SCA and performance).

Despite the popularity of the Cohen (1988) benchmarks, there is no consensus on the criterion used to classify correlations as small, medium or large (Ellis, 2010; Bosco *et al.*, 2015)

Paper	Unattenuated correlation	Number of firms	Reliability SCA	Reliability P/CA	Type of correlation	Correlations reported
Abdallah *et al.* (2021)	0.54	284	0.85	0.86	Unattenuated	0.54
Abdelilah *et al.* (2021)	0.56	112	0.91	0.88	Attenuated	0.50
Alam *et al.* (2019)	0.28	250	0.83	0.80	Unattenuated	0.28
Aljumah (2022)	0.75	283	0.89	0.83	Attenuated	0.65
Al-Shboul (2017)	0.36	113	0.84	0.83	Unattenuated	0.36
Altay *et al.* (2018)	−0.01	335	0.93	0.92	Attenuated	−0.01
Alzoubi and Yanamandra (2020)	0.65	132	0.86	0.86	Attenuated	0.56
Ariadi *et al.* (2021)	0.56	139	0.99	0.98	Attenuated	0.55
Attia (2015)	0.60	153	0.97	0.85	Unattenuated	0.60
Avelar-Sosa *et al.* (2018)	0.64	225	0.87	0.71	Attenuated	0.51
Ayoub and Abdallah (2019)	0.27	290	0.85	0.74	Unattenuated	0.27
Baah *et al.* (2022)	0.72	175	0.82	0.83	Attenuated	0.60
Blome *et al.* (2013)	0.55	121	0.79	0.79	Attenuated	0.43
Cadden *et al.* (2022)	0.33	201	0.92	0.97	Unattenuated	0.33
Chan *et al.* (2017)	0.62	141	0.87	0.74	Unattenuated	0.62
Chen (2019)	0.51	204	0.93	0.87	Unattenuated	0.51
Eckstein *et al.* (2015)	0.46	143		0.78	Unattenuated	0.46
Fernandez-Giordano *et al.* (2021)	0.35	190	0.91	0.85	Unattenuated	0.35
Fosso Wamba and Akter (2019)	0.58	281	0.95	0.95	Attenuated	0.55
Garcia-Alcaraz *et al.* (2017)	0.79	306	0.81	0.82	Attenuated	0.65
Geyi *et al.* (2020)	0.64	311	0.88	0.91	Unattenuated	0.64
Girdwichai and Somjai (2019)	0.80	310	0.93	0.83	Attenuated	0.71
Gligor (2016)	0.45	242	0.80		Attenuated	0.37
Gligor and Holcomb (2012b)	0.22	151	0.93	0.84	Attenuated	0.19
Gligor *et al.* (2020)	0.55	182	0.91	0.94	Attenuated	0.51
Gligor *et al.* (2022)	0.34	237	0.81	0.82	Unattenuated	0.34
Gligor *et al.* (2015)	0.35	283	0.94		Unattenuated	0.35
Hu *et al.* (2022)	0.26	308	0.97	0.96	Unattenuated	0.26
Hwang and Kim (2019)	0.40	279	0.91	0.91	Unattenuated	0.40
Irfan *et al.* (2019)	0.60	148	0.83	0.88	Attenuated	0.51

(*continued*)

Table 3. Summary of correlations

Paper	Unattenuated correlation	Number of firms	Reliability SCA	Reliability P/CA	Type of correlation	Correlations reported
Jafari *et al.* (2021)	0.90	369	0.94	0.95	Attenuated	0.85
Jamjumrus and Sritragool (2019)	0.56	272	0.91	0.90	Unattenuated	0.56
Jermsittiparsert *et al.* (2019a)	0.60	298	0.92	0.93	Attenuated	0.55
Jermsittiparsert *et al.* (2019b)	0.83	499	0.94	0.93	Attenuated	0.78
Kabra and Ramesh (2016)	0.75	193	0.93	0.81	Attenuated	0.65
Khan *et al.* (2023)	0.60	146	0.79	0.80	Attenuated	0.48
Khan *et al.* (2022)	0.49	163	0.92	0.88	Attenuated	0.44
Liu *et al.* (2013)	0.54	286	0.86	0.84	Unattenuated	0.54
Machuca *et al.* (2021)-Developed sub-sample	0.28	169		0.67	Attenuated	0.21
Machuca *et al.* (2021)-Developing sub-sample	0.61	135		0.67	Attenuated	0.46
Mandal (2016)	0.32	177	0.92	0.84	Unattenuated	0.32
Mandal (2018)	0.47	212	0.90	0.88	Unattenuated	0.47
Mandal and Dubey (2020)	0.32	302	0.88	0.90	Unattenuated	0.32
Manzoor *et al.* (2022)	0.99	180	0.86	0.89	Attenuated	0.87
Martinez-Sanchez and Lahoz-Leo (2018)	0.52	231	0.94	0.94	Unattenuated	0.52
Mirghafoori *et al.* (2017)	0.14	74	0.81	0.70	Attenuated	0.11
Muneer (2019)	0.73	231	0.98	0.90	Attenuated	0.69
Najar (2022)	0.68	125	0.88	0.75	Attenuated	0.55
Nath and Agrawal (2020)	0.54	311	0.96	0.90	Unattenuated	0.54
Nazempour *et al.* (2018)	0.64	500	0.78	0.82	Unattenuated	0.64
Panigrahi *et al.* (2022)	0.45	398	0.78	0.77	Attenuated	0.35
Prawira *et al.* (2019)	0.52	560	0.93	0.83	Unattenuated	0.52
Ramos *et al.* (2023)	0.54	98	0.80	0.86	Unattenuated	0.54
Riquelme-Medina *et al.* (2022)	0.45	214	0.91	0.88	Unattenuated	0.45
Samdantsoodol *et al.* (2017)	0.67	205	0.91	0.92	Unattenuated	0.67
Sangari and Razmi (2015)	0.66	184	0.82	0.84	Unattenuated	0.66
Tarafdar and Qrunfleh (2016)	0.35	205	0.92	0.84	Unattenuated	0.35
Tse *et al.* (2016)	0.28	266	0.74	0.87	Unattenuated	0.28
Um (2017)	0.30	156	0.88	0.73	Unattenuated	0.30

Table 3. (*continued*)

Paper	Unattenuated correlation	Number of firms	Reliability SCA	Reliability P/CA	Type of correlation	Correlations reported
Umam and Sommanawat (2019)	0.75	94	0.89	0.92	Attenuated	0.68
Whitten *et al.* (2012)	0.48	132	0.81	0.91	Attenuated	0.41
Yang (2014)	0.44	137	0.86	0.79	Unattenuated	0.44
Zakir *et al.* (2022)	0.46	200	0.79	0.88	Unattenuated	0.46
Zhu and Gao (2021)	0.72	208	0.92	0.91	Unattenuated	0.72

Table 3.

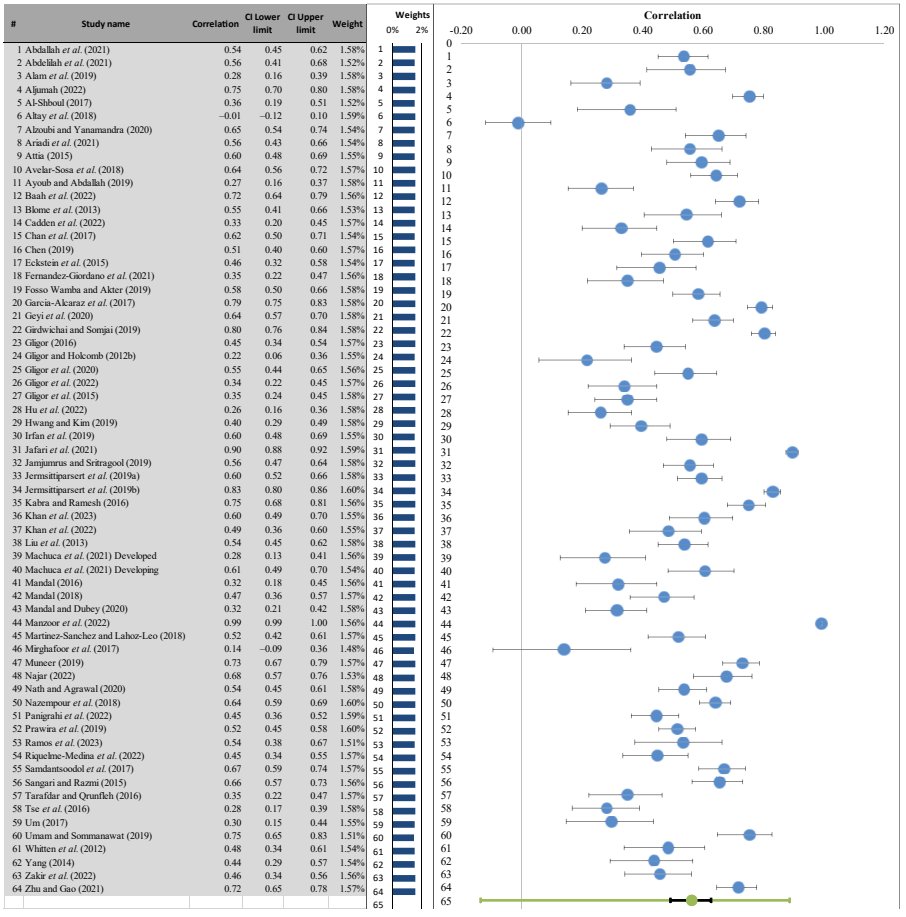

Figure 2.
Forest plot for unattenuated correlations between SC agility and performance

that can be extrapolated to all the scientific fields or management sub-areas (Cascio and Aguinis, 2008). The effect size values proposed by Cohen (1962) and revised in Cohen (1988) consider that correlations with values between 0.1 and 0.3 should be considered small; 0.3 to

Table 4.
Unattenuated correlations for categorical moderators

Analysis	N	Subjects	Correlation	CI LL	CI UL	Q	pQ	I^2	T^2	T	PI LL	PI UL
H1: Full sample	64	14,469	0.56	0.49	0.63	2133.34	0.00	0.97	0.15	0.38	−0.14	0.89
H2: Financial performance	18	3,851	0.49	0.41	0.57	157.90	0.00	0.89	0.14	0.38	−0.25	0.87
H2: Operational performance	32	7,797	0.54	0.46	0.60	690.33	0.00	0.96	0.14	0.38	−0.17	0.88
H2: Overall performance	12	2,429	0.70	0.39	0.87	1076.74	0.00	0.99	0.14	0.38	−0.08	0.95
H3: Gligor *et al.* (2013)	9	2,289	0.52	0.38	0.64	106.59	0.00	0.92	0.15	0.39	−0.32	0.90
H3: Li *et al.* (2009)	6	1,031	0.57	0.36	0.73	47.98	0.00	0.90	0.15	0.39	−0.36	0.93
H3: Swafford *et al.* (2006)	13	2,937	0.50	0.33	0.63	349.13	0.00	0.97	0.15	0.39	−0.31	0.89
H3: Other scales	36	8,202	0.59	0.48	0.69	1550.57	0.00	0.98	0.15	0.39	−0.12	0.90
H4: Developed	15	3,184	0.47	0.37	0.56	176.67	0.00	0.92	0.15	0.39	−0.32	0.87
H4: Developing	46	10,700	0.60	0.51	0.68	1862.48	0.00	0.98	0.15	0.39	−0.10	0.90
H5: Manufacturing	46	10,270	0.58	0.49	0.66	1714.72	0.00	0.97	0.15	0.38	−0.11	0.90
H5: Service	8	2,067	0.48	0.17	0.70	223.49	0.00	0.97	0.15	0.38	−0.44	0.91
H5: Both	10	2,122	0.49	0.40	0.58	53.12	0.00	0.83	0.15	0.38	−0.32	0.89

Note(s): CI (confidence interval) LL (lower limit) and UL (upper limit): 95% CI for correlation
Q: Cochran's Q
pQ: *p*-value of Q
I^2: inconsistency ratio
T^2: estimated variance of the true effects
T: estimated standard deviations of true effects
PI (prediction interval) LL (lower limit prediction) UL (upper limit prediction)

0.5 can be considered medium, while above 0.5 indicates a large effect size. However, these values are not based on any empirical works (Aguinis and Harden, 2009) and Cohen (1988) himself considered that more work had to be done to define more appropriate cut-off points (Bosco *et al.*, 2015). Focusing on the area of clinical psychology, other authors such as Ferguson (2009) propose higher values to analyse the practical significance of coefficient correlations (0.20, 0.50 and 0.8 cut-off values for small, medium and large, respectively). Given that no similar determination has been made in the area of Operations Management (OM), this research will use the reference values proposed by Bosco *et al.* (2015) for an analogous area, Human Resources Management. Specifically, a correlation of 0.05 or less will be considered small (below percentile 20); up to 0.16, small-medium (the median of our sample of Bosco *et al.* (2015) correlations); up to 0.36, medium-large; and above 0.36, large (above percentile 80). The results show that there is a positive correlation between a "large" value following Bosco *et al.* (2015) and a "medium-large" value following Cohen (1988) (above 0.49, at least – the lower boundary of aggregate CI). So, H1 is not rejected.

However, the dispersion of the values in the forest plot indicates that it is feasible to assume that the 64 studies cannot be considered to be based on the same population but that they are a heterogeneous sample of studies with different populations. The PI tells us that the unattenuated correlation between SCA and performance in any single population is as low as −0.14 in some and as high as 0.89 in others. So it would be appropriate to analyse any possible moderators of the correlation between SCA and performance. As the 64 samples are very heterogeneous, we cannot consider the weighted mean correlation as the estimation of the real correlation between SCA and performance. Therefore, we should focus on the CI for correlations, which is wide and includes zero (−0.14; 0.89).

4.2.2 Publication bias. The trim and fill method reveals very minor asymmetry in the plot. This would seem to be random but results in there being no clear tendency towards clustering of small-size studies (larger standard error) on the right side of the plot (higher correlations). This is an indication that publication bias does not seem to be relevant in this set of studies. The method only identifies one missing work that it may not be possible to impute. If it were imputed (Figure C-Online Appendix), the mean unattenuated correlation would be 0.54 instead of 0.56, with a shift to the left (0.45–0.62) of the CI and a wider PI (−0.32–0.91). Regardless, the effect size can still be considered large both in terms of Bosco *et al.* (2015) and Cohen (1988).

The conclusion is similar for the attenuated correlations (Figure D-Online Appendix); two works imputed and a mean correlation of 0.45 (instead of 0.47), with CI (0.40; 0.51) and PI (−0.10; 0.79). Various reasons could explain this minor asymmetry in the figures. One reason could be that the studies with small samples really have higher correlations or that there is heterogeneity between the populations studied. If publication bias were the real reason for this minor asymmetry, it would make sense to impute the missing studies and consider the correlation adjusted by imputed studies as the best estimate of the effect size.

4.2.3 Moderation analysis. To shed some light on this high heterogeneity, we shall test to see whether the moderators enable to create sufficiently homogeneous groups for any more precise information to be mined from one of the subgroups. Should this not be possible, the results would indicate that there are few current empirical works and that they are dispersed. More research would, therefore, be required to replicate studies in some of the populations or no moderator has been identified (or has not been used due to a lack of information in the articles) that enables any more finely tuned conclusions to be drawn.

The analysis of the proposed categorical moderators shows very high heterogeneity in all subgroups (Table 4). The studies in each of the categories appear to be analysing different populations with different behaviours. In this case, the relevant statistic is the PI, which, as can be observed, is always very wide. The PI width ranges from 1 (H4: developing) to 1.35 (H5: service). The analysed moderators were not able to reduce the heterogeneity.

H2 to H5 were not rejected. The CI does not contain zero in any of the sub-samples. The estimates for the unattenuated correlations can range between a small-medium value of 0.17 (the smallest CI lower limit, H5: service) and a large correlation of 0.87 (the highest CI upper limit, H2: overall performance). Most CIs are within the moderate-to-strong correlation range. The only exception is H5 service, where the lower limit for CI (0.17) is a small correlation following Cohen (1988) criterion, but small-medium following Bosco *et al.* (2015). Notwithstanding, it is significant in both cases (Table 4). Observation of the attenuated results (Table 5 and Figure E-Online Appendix) shows that interpretations and conclusions are similar to the unattenuated results.

5. Discussion and conclusions

In general terms, in line with the conclusion of Al Humdan *et al.* (2020) after conducting an SLR, despite the increasing interest shown in measuring the benefits of SCA, the number of peer-reviewed papers that have explored the implications of SCA for performance continues to be limited and further work is required, above all in the current context of extremely volatile markets. Previous SLRs on the topic focus on the qualitative analysis of the prior literature but this investigation makes a relevant contribution as the first to use a meta-analysis to identify and analyse the empirical research on the topic and estimate the value of the correlations between the variables studied. Furthermore, the previous SLRs do not identify any moderating variables or measure the effects by moderator in the SCA–performance link.

The previous research (63 papers) is summarised and categorised and a quantitative empirical aggregation is provided of prior empirical studies. Insights from several analyses have been cross-validated and reconciled with consistent results. Knowledge of whether SCA–performance relationships are generalisable is essential for both theory to be developed and SCA to be properly implemented in practice. One major contribution is the confirmation of the significant positive correlation between SCA and performance. The magnitude of the SCA–performance link in the sampled studies was also tested and a large impact value was found for the full sample (unattenuated correlation: 0.56; CI: 0.49–0.63). However, great heterogeneity and dispersion can be seen, which prevents us from determining whether the correlation value represents any homogenous population due to the width of the PI. This great heterogeneity and dispersion are in line with the lack of consensus on the topic indicated in previous research (e.g. Chen, 2019; Marin-Garcia *et al.*, 2018a, b; Aslam *et al.*, 2018).

Analysis by moderator seeks to identify subgroups where the correlation between SCA and performance can be estimated with less heterogeneity. All the subgroups consolidate the relationship between SCA and performance. This means that the significant positive SCA–performance relationship is confirmed, irrespective of the performance type, SCA construct scale, industry and economic region. Although heterogeneity was addressed in the main effects through the use of moderating factors, the results conclude that none of the moderators used has generated subgroups with a level of heterogeneity that enables the consideration of a single study population for the precise measurement of the SCA–performance correlation value. There may be some combination of variables that defines a context where the correlation can be different for different subgroups but it is impossible to know without new research. Therefore, more studies are required and they should be focused on similar populations, for example, service firms, to enable more precise conclusions to be drawn for the populations in question.

Regarding the substantive moderator, three performance measures have been identified in previous research: operational (32 papers), financial (18) and overall (12) performance. In line with most of the previous papers, a positive SCA–performance relationship is found in all the subgroups, related to operational (e.g. Blome *et al.*, 2013; Eckstein *et al.*, 2015; Machuca

Table 5. Attenuated correlations for categorical moderators

Analysis	N	Subjects	Correlation	CI LL	CI UL	Q	pQ	I^2	T^2	T	PI LL	PI UL
H1: Full sample of studies	64	14,469	0.47	0.42	0.52	969.03	0.00	0.93	0.06	0.25	0.00	0.77
H2: Financial performance	18	3,851	0.44	0.35	0.51	129.36	0.00	0.87	0.06	0.25	−0.08	0.77
H2: Operational performance	32	7,797	0.45	0.39	0.51	443.00	0.00	0.93	0.06	0.25	−0.03	0.77
H2: Overall performance	12	2,429	0.55	0.38	0.69	325.95	0.00	0.97	0.06	0.25	0.02	0.84
H3: Gligor *et al.* (2013)	9	2,289	0.44	0.32	0.55	64.64	0.00	0.88	0.06	0.25	−0.12	0.79
H3: Li *et al.* (2009)	6	1,031	0.49	0.30	0.65	33.29	0.00	0.85	0.06	0.25	−0.15	0.84
H3: Swafford *et al.* (2006)	13	2,937	0.41	0.29	0.52	211.34	0.00	0.94	0.06	0.25	−0.12	0.76
H3: Other scales	36	8,202	0.50	0.43	0.57	592.46	0.00	0.94	0.06	0.25	0.03	0.79
H4: Developed	15	3,184	0.41	0.32	0.49	113.89	0.00	0.88	0.07	0.26	−0.12	0.76
H4: Developing	46	10,700	0.50	0.44	0.56	807.02	0.00	0.94	0.07	0.26	0.03	0.79
H5: Manufacturing	46	10,270	0.49	0.43	0.54	715.84	0.00	0.94	0.06	0.25	0.02	0.78
H5: Service	8	2,067	0.42	0.16	0.62	144.59	0.00	0.96	0.06	0.25	−0.23	0.81
H5: Both	10	2,122	0.42	0.34	0.50	33.80	0.00	0.73	0.06	0.25	−0.12	0.77

Note(s): CI (confidence interval) LL (lower limit) and UL (upper limit): 95% CI for correlation
Q: Cochran's Q
pQ: *p*-value of Q
I^2: inconsistency ratio
T^2: estimated variance of the true effects
T: estimated standard deviations of true effects
PI (prediction interval) LL (lower limit prediction) UL (upper limit prediction)

et al., 2021), financial (e.g. Muneer, 2019; Riquelme-Medina *et al.*, 2022; Whitten *et al.*, 2012) and overall performance (e.g. Attia, 2015; Chan *et al.*, 2017; Liu *et al.*, 2013). The values of the unattenuated correlations are large. They are similar for financial (0.49) and operational (0.54) performance, and even larger for overall performance (0.70), although the CI is wider (0.39–0.87) but overlapped with the others. Consequently, no significant differences can be guaranteed between the correlations by type of performance (p-value = 0.06) and the heterogeneity is still high. This moderator only accounted for approximately 9% (pseudo-R^2) of the heterogeneity in the model. In line with Alfalla-Luque *et al.* (2018) and Al Humdan *et al.* (2020), research is called for to analyse the different performance indicators individually. Al Humdan *et al.* (2020) conclude that the variety of the performance measures used and the fact that the results are not absolutely decisive demonstrate that total agreement does not exist on adequate measures of SCA performance.

The analysis by SCA scale leads us to conclude that, although validated SCA scales exist (Swafford *et al.*, 2006; Li *et al.*, 2009; Gligor *et al.*, 2013; Marin-Garcia *et al.*, 2018a, b), many studies develop new scales, thus foregoing the advantages of applying a previous scale in different samples and contexts (Gligor *et al.*, 2022). The three most-used scales (Gligor *et al.*, 2013; Li *et al.*, 2009; Swafford *et al.*, 2006) have been analysed as possible moderators. All confirm a positive SCA–performance link, with a high unattenuated correlation (0.50–0.59) and similar overlapped CIs (between 0.33 and 0.73). Therefore, heterogeneity is not due to the use of different validated scales or, at most, only in part (less than 3%), and that other factors exist that indicate that SCA–performance relationships are different in different populations.

Focusing on the extrinsic moderators, economic region and industry, results show that the subgroup CIs cause overlapping, so no differences between these can be stated in the SCA–performance relationship. In line with these results, previous OM meta-analyses have found no differences using economic region (e.g. Chahal *et al.*, 2020; Wang *et al.*, 2018b) and industry (e.g. Abreu-Ledón *et al.*, 2018; Chahal *et al.*, 2020; Wang *et al.*, 2018b) as moderators. The economic region results are in line with the convergence hypothesis (Ralston *et al.*, 1997). Consequently, the application of SCA does not show any differences in the performance of developed and developing areas. It should be highlighted that the analysed papers (Table 2) have increasingly focused on developing areas (46 papers; 73.01%), with India (8), Pakistan (6) and China (5) being the most analysed. Although both types of economic regions present a high unattenuated correlation, it is higher in developing areas (0.60 vs 0.47 in developed), with a CI of between 0.51 and 0.68 that overlaps with the developed areas CI (0.37–0.56) at the low end.

Regarding the industry, in line with previous SLRs (Al Humdan *et al.*, 2020; Sharma *et al.*, 2020), most of the papers focus on manufacturing (46) rather than services (8). Only a few papers use industry as a control variable and they have found no significative differences between manufacturing and services (e.g. Liu *et al.*, 2013; Martinez-Sanchez and Lahoz-Leo, 2018). Manufacturing presents an unattenuated correlation (0.58) that is higher than service (0.48) and a CI that is narrower (0.49–0.66 compared to 0.17–0.70) and fully overlapped. Multi-activity samples are usually used in manufacturing, which could cause heterogeneity. SCA's influence may be different in each specific activity but the variety of sub-sectors and the sample size do not allow subgroups to be created with sufficient papers for analysis.

Summarising, a significant positive correlation is concluded for the total sample and all of the subgroups. Overlapping of the CIs and the excessive width of the PI prevent any confirmation of differences between subgroups. Consequently, the aggregate results for the current sample show that SCA is positively linked to operational, financial and overall performance, and no significant differences have been found between the types of scales used, manufacturing and service, and developed and developing areas. High heterogeneity means that the subgroups are not homogeneous, which prevents the extraction of more precise information and offers great opportunities for further research into other variables

that may potentially affect this relationship. It would be interesting to increase the amount of research per moderator and to be able to use other moderators in future meta-analyses (unit of analysis, firm/plant size, firm/plant age, etc.) For this to be possible, it would be essential for samples and results to be duly and rigorously reported.

6. Implications and recommendations for further research

6.1 Implications for managers

This paper has a major managerial implication: based on the aggregated conclusions of previous research, it confirms a significant positive correlation between SCA and performance, with a high moderated value of impact (correlation). Therefore, the findings suggest that managers can improve performance outcomes with a medium-high effect by improving SCA and that this is the case for all of the performance types analysed (operational, financial and overall). Additionally, this positive impact has been confirmed in both manufacturing and service companies and developed and developing regions. Consequently, managers from different countries and industries are encouraged to fully implement SCA as it improves financial and operational performance. In recent years, the pandemic has increased the need for an agile SC that can respond rapidly to constant changes.

Managers must understand that SCA is a multidimensional concept and they need to develop the main dimensions required to achieve SCA, i.e. alertness, flexibility, decisiveness, swiftness, joint planning, process integration and accessibility (Table B-Online Appendix). Practitioners could develop a strategic focus and tactical and operational practices that enable them to rapidly obtain any relevant data about stakeholders (accessibility); be alert to threats, unanticipated changes and opportunities in the environment, especially in the market (alertness); provide organisations with any available information to aid their decision-making to meet demand (decisiveness); make temporary short-term changes in the SC and market environment to adapt the current SC (flexibility) to product volume (volume flexibility) and product range (variety flexibility); to jointly plan or cooperate in operational planning across the SC (joint planning); to search for collaborative operations between suppliers and buyers, common systems, joint product and information sharing (process integration); to improve the firms' ability to make and rapidly implement decisions on SCM and logistics management (swiftness).

Nowadays, the use of digital technologies is crucial for enabling fast and smart sensing of demand and supply conditions in real-time (e.g. Internet of Things, Big Data and Artificial Intelligence) and allowing products to be more efficiently customised, personalised or built to order (e.g. digital sampling, virtual reality and 3D-printing) (Lee, 2021). These technologies should be present in the strategies and practices that lead to the achievement of the SCA dimensions. For example, joint planning, process integration and accessibility can be improved by the use of Cloud computing technologies (Fatorachian and Kazemi, 2021), as can flexibility by virtual agent modelling (e.g. scheduling, production plan and resource allocation) of agile SC infrastructure (Siddhartha and Sachan, 2016). If companies wish to survive and be competitive, SC managers must enhance SCA to respond to growing uncertainties, disruptions associated with offshoring and global logistics, and customer delivery urgency and variations in supply and demand in the current ever-changing business environment.

6.2 Implications for researchers

This paper provides a comprehensive view of the SCA–performance relationship and improves the understanding of how some moderators affect this link. Researchers seeking to conduct studies on this topic are also provided with a compendium of empirical peer-reviewed

papers published in the two main databases. These papers have been analysed from different perspectives (type of performance and SCA scale used, economic sector, sample used, SCA dimensions, co-citations, etc.) (Table 2 and Figure B; Tables A, B and C-Online Appendix). Additionally, the previous SLRs developed on SCA have also been reviewed and its main characteristics are given in Table 1. The objectives and main findings could be especially useful for future research. In general, the various analyses developed could be an effective starting point for future investigations into this topic.

The meta-analysis results generate findings and recommendations that are interesting for future research. In line with Al Humdan *et al.* (2020), the present results confirm that SCA and performance need to be measured more precisely and appropriately and, according to Gligor *et al.* (2022), the conceptual definition and operationalisation should be aligned through the scales. The heterogeneity found in the present research prevents any robust conclusions regarding SCA's impact on performance both in the full sample and the subgroups by moderator.

Consequently, the complex nature of SCA requires further research to cover the gaps detected by reducing dispersion and determining a correlation that is representative of a specific context. Firstly, more studies are called for that focus on financial impacts as previous research mainly focuses on operational measures. Similarly, the various dimensions of performance (quality, delivery, flexibility, financial, etc.) should be analysed separately as this would enable to determine the impact of SCA on each and would offer managers specific results that would help them achieve the specific goals of their companies. Moreover, very few studies exist that use objective indicators to measure performance rather than subjective scales. The use of objective indicators and the comparison of their alignment with results obtained with subjective scales could be of interest in future studies. We need to consider whether the traditionally used financial indicators such as ROA, ROS, profit after tax and profit margin adequately convey the efficacy of operations management given that they are a reflection of the firm's financing (financial leverage) (Klingenberg *et al.*, 2013). The financial envelopes (financial leverage) in accounting statements are not the direct responsibility of the operations manager (Klingenberg *et al.*, 2013) or SC management. So, some researchers suggest the use of financial measures such as the EBITDA margin (Earnings before interest, taxes, depreciation and amortisation), operating cash flow margin or operating profit margin (Boyd *et al.*, 2006; Fullerton and Wempe, 2009; Luján-García *et al.*, 2015). These ratios have been accepted as reliable accounting-based financial measures for capturing operational profitability, which is independent of capital investments or non-operating expenses (Eslami *et al.*, 2021). It must be stated that none of the studies reviewed in this paper and included in the meta-analysis uses the financial measures that several experts suggest for capturing SCA profitability.

Secondly, the multidimensional nature of SCA recommends studies that analyse the effects of the various SCA dimensions individually (Table B-Online Appendix). This would reveal the contribution that each (alertness, flexibility, decisiveness, etc.) makes to performance and give managers the opportunity to preferentially deploy the levers that could have the greatest effect on performance. Forty-six of the 63 studies (73%) in the sample operationalise the SCA scale as a first-order construct (with no dimensions). The remaining papers use an SCA second-order scale with a variety of dimensions (Table A-Online Appendix) although they do not usually give any information about the impact that each has on performance. As a result, this research does not cover the topic of a meta-analysis by dimension.

Thirdly, the current empirical research leads us to strongly suggest that authors should reuse validated scales with new samples and contexts to further theory and generalise the findings. Any new scales that are developed should address SCA's multidimensionality by enabling separate analyses by dimension and being rigorously validated. As Gligor *et al.* (2022) conclude, study replication is essential and when scales already exist, then investigators should not only be extremely cautious when developing any new scales but

also robustly justify doing so and align them with the theoretical conceptualisation. The items should be carefully defined so that they cover the different aspects of SCA. This is especially important in SCA first-order construct scales, which should capture the different aspects that make up the second-order scales used by, for example, Alfalla-Luque *et al.* (2018), Gligor *et al.* (2013) and Li *et al.* (2009).

Fourthly, more empirical research is needed on the service industry as a large majority of the works can be seen to focus on manufacturing SCs with a lack of results on the service sector. Also, given the different characteristics of service companies and their current importance for economies, performing separate analyses by performance measure (quality, delivery, etc.) would contribute additional information for managing both types of firms. Additionally, studies on specific sub-sectors of the service and manufacturing industries (or information provided about the partial data of the sub-samples by sub-sector) would enable specific analyses to be run to determine any differences. Consequently, this is an issue for analysis in future research.

Fifthly, most of the empirical research is focused on developing countries so new analyses are called for other regions. Although the results show that SCA has a significant positive effect on both developed and developing regions, once again, the high heterogeneity prevents any prediction of the intensity of the relationship. A greater number of studies in developed areas could improve the homogeneity of the groups and enable more robust conclusions. Previous research focuses on single countries and very few multi-country studies exist with identical scales and simultaneous data-gathering that would enable comparisons.

Finally, the studies that cover the previously mentioned gaps should be reported with the utmost rigour for their results to constitute empirical evidence to corroborate (or refute) existing hypotheses and theories. It should not be forgotten that it has not been possible to use variables such as the unit of analysis (firm/plant), firm/plant size, firm/plant age and plant type (cost centre or profit centre) as moderating variables as the papers did not provide sufficient information in this regard. As a result, this topic is not covered in the present research. In this respect, over ten years on from the Forza and Nuzzo (2010) study that analysed meta-analysis applicability to OM, it can be argued that the shortcomings that those authors encountered have once again become apparent in this meta-analysis.

6.3 Recommendations for further meta-analyses

To facilitate future meta-analyses, several best practice recommendations for researchers (and reviewers) are offered. Firstly, better conceptual definitions are needed of the variables taken from reputed previous research. Higher levels of explicitness are required with respect to assumptions, conditions, models and hypotheses. Secondly, we propose that the operational definition of all the variables in the research framework uses known reliable validated scales for comparative studies. Thirdly, in line with the above, it would be desirable for the various performance measures in OM studies to be standardised and validated, with established performance measurement items. Fourthly, the author keywords need to be carefully chosen as they are essential for bibliography searches.

All of the above would be of little use if the data are not rigorously reported. Authors, reviewers and editors should attempt to raise the level of quantitative explicitness in the reporting of research findings. The sampling design and the final sample need to be explicitly detailed: sample size, date of data collection, country or economic region, economic activity, level of analysis (plant, firm and SC), firm/plant size, firm/plant age and characteristics of the respondents (as required). Scale items should be indicated in detail. Lastly, sufficient statistical results always need to be reported, not only for the total sample but also for any subgroups. Statistical parameters such as the means, standard deviations, correlation matrices (indicating whether they are attenuated or unattenuated), sample size, missing values, etc. are essential. If the paper is too long to include all the mentioned data, the authors should put all the information in a linked Appendix. A lack of

information is not unusual (Lorente *et al.*, 2020). For example, in their analysis of the use of PLS in OM, Bayonne *et al.* (2020) concluded that papers do not reach the desired level of reporting in basic parameters such as correlation matrix (79% of the papers), variables' means and standard deviations (31%), coefficient of determination R2 (80%), effect size f2 (20%), predictive relevance Q2 (30%) and reported effect size q2 (4%). Some articles have set out guidelines on the reporting of obtained results that are very useful (e.g. Marin-Garcia and Alfalla-Luque, 2019; Jun Hwa *et al.*, 2020; Richter *et al.*, 2020; Ringle *et al.*, 2020). As Forza and Nuzzo (2010) concluded, developing a synthesis of quantitative research is needed for the OM research community and high-quality reported information is essential for this task.

7. Limitations

The limitations of meta-analyses are related to the generalisation of the results, which is determined, firstly, by the representativeness of the papers included. Attempts have been made to avoid this issue by conducting a comprehensive SLR that includes all the relevant papers on the topic. To develop this further, the proposed report guidelines should be followed to enable the inclusion of all the relevant papers in future research. Related to the representativeness of the sample of firms analysed, it has been observed that there is a greater percentage of studies on manufacturing than service firms and a greater focus on developing countries. More studies are, therefore, needed on the service sector and developed countries.

Every paper in a meta-analysis should be a study of a complete probability sample of a specified population. If this assumption is not met in a study, no inference can be taken from the "sample" for a population. In our case, some of the studies may not comply with probability sampling, for example, by using purposive sampling or having a high number of missing cases. Despite being common mistakes in works in the field, these prevent a sample from being considered probability sampling, even though some of the works have proved that there is no evident sampling bias.

Lastly, incomplete data in previous studies have prevented the analysis of some potential moderating factors (unit of analysis, firm/plant size and firm/plant age). Future research should explore these contextual factors.

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Appendix

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