Using mixed methods in logistics and supply chain management research: current state and future directions

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Abstract

Purpose – Mixed methods research is useful to enhance theoretical and practical research contributions. However, single methods have predominated much logistics and supply chain management (LSCM) research. This paper presents a review of mixed methods research across ten years in LSCM to determine their usage, identify benefits and inhibitors, and provide suggestions for LSCM researchers to realise the benefits from using mixed methods.

Design/methodology/approach – This paper adopts a mixed methods approach through a quantitative analysis of methods used in six leading LSCM journals, an e-mail survey of mixed methods article authors during the review period, and four published case studies that used mixed methods.

Findings – Only 144 (ten percent) of all empirical articles were published using mixed methods during the review period. A range of benefits and inhibitors regarding mixed methods adoption were found.

Erratum: It has come to the attention of the publisher that the article, Grant, D.B., Shaw, S., Sweeney, E., Bahr, W., Chaisurayakarn, S. and Evangelista, P. (2023), "Using mixed methods in logistics and supply chain management research: current state and future directions", *The International Journal of Logistics Management*, Vol. 34 No. 7, pp. 177-198. https://doi.org/10.1108/IJLM-04-2023-0156 incorrectly listed Pietro Evangelista's affiliation as "National Research Council (CNR), Research Institute on Innovation and Services for Development (IRISS), Roma, Italy". This has now been corrected to "Institute for Studies on the Mediterranean (ISMed), National Research Council (CNR), Naples, Italy", in the online version. This error was introduced in the production process, the publisher sincerely apologises for this error and for any inconvenience caused.

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Suggestions for LSCM authors include research training in mixed methods use and developing a project-specific research design due to the specificity and complexity associated with mixed methods research. **Originality/value** – LSCM is at a critical juncture, shaped by new contexts, themes and challenges, and would benefit from different research approaches and methods. This paper contributes to the LSCM domain through analysing the current state, benefits and inhibitors of mixed methods research in LSCM journals to provide a renewed call to action and guidelines for mixed methods LSCM research, and suggesting research design adaptation to enable agile and resilient research when investigating rapidly changing and complex phenomena.

Keywords Research, Mixed methods, Single methods, Logistics, Supply chain management
Paper type Research paper

Introduction

Current trends in logistics and supply chain management (LSCM) such as business globalisation, sustainability, the global Covid-19 pandemic, shortening product life cycles, vertical disintegration and the rapid rate of technological development have combined to create a multi-dimensional and highly complex environment. Concomitantly, problems and questions the LSCM research community are seeking to address have also become more complex and multi-faceted. It is clear that firms are operating in a new and highly disruptive business world which requires LSCM researchers to adopt a range of perspectives from philosophical and methodological points of view. This includes the effective use of mixed approaches for methodology and methods, particularly mixed methods of data collection and analysis.

While research in other domains has encouraged mixed methods LSCM research has historically lagged other domains and has tended to discuss approaches singularly, such as case studies (Ellram, 1996), action research (Näslund, 2002), and interpretive and qualitative research (Darby *et al.*, 2009). Recognising this gap, Mangan *et al.* (2004) called for more mixed methods in LSCM nearly twenty years ago. Craighead *et al.* (2007), Sanders and Wagner (2011) and Seuring (2011) concurred that the LSCM domain should do so to mitigate weaknesses of some research methods and enrich data collection and analysis.

Adopting mixed methods offers the potential to enhance the quality of research into some of the more complex LSCM phenomena under investigation by scholars globally (Mentzer and Flint, 1997; Mentzer, 2008; Golicic and Davis, 2012). Further, to better understand supply chain complexity there is a need to view supply chains not as simple linear, dyadic structures, but as complex adaptive systems (Hearnshaw and Wilson, 2013; Shaw *et al.*, 2021). These points raise questions about the extent to which mixed methods approaches have been embraced by LSCM researchers, as well as what associated benefits and inhibitors they bring.

Golicic and Davis (2012) revisited the issue of mixed methods use specifically in LSCM a decade ago and reinforced Mangan *et al.*'s (2004) "call to action". Given a continuing paucity of mixed methods usage, we believe it is time do so again, given growing challenges faced by practitioners and the critical nature of supply chains in supporting the provision of essential products and services to markets. Our paper explores this topic by developing three specific research questions based on a comprehensive journal review of the literature to date and then using a three-phase research design which itself uses a mixed methods approach.

The first phase identified and analysed mixed methods articles published in six top LSCM journals over a ten-year period 2011–2020 to obtain a current use baseline. The second phase consisted of an investigation of four case studies of projects that used mixed methods for LSCM research. Finally, a survey was conducted with corresponding authors of articles found in the first phase that used mixed methods.

Our overall objective is to provide insights into the current state of mixed methods use in LSCM research and future directions, with particular reference to the benefits and inhibitors when adopting them. Our research also identifies how LSCM researchers can realise the benefits and make more effective use of mixed methods. The findings from this research offer the potential to support LSCM researchers in enhancing theoretical and practical contributions beyond using single methods, thereby building upon previous research.

Literature review

Mixed methods philosophy and research

Researchers concerned with understanding business practices have identified significant benefits from using multiple or blended methods in research, i.e. mixed methods, which by the late 1990s, was being embraced within research designs across various disciplines such as sociology, predominantly in North America (Bryman, 2006; Teddlie and Tashakkori, 2012). Mixed methods research is defined as *"the collection, analysis, and integration of quantitative and qualitative data in a single study or in a program of inquiry. Its core characteristics include collecting both quantitative (closed-ended) and qualitative (open-ended) data"* (Sweetman *et al.*, 2010, p. 441).

The rationale for using mixed methods is that all research methods have a form of bias or weakness associated with them. Thus, collecting data using mixed methods helps to compensate for these flaws and enhance the validity and reliability of research findings. Bryman (2006) argued that mixed methods are used primarily to "expand" or "complement" research. Expansion seeks to extend the breadth and range of investigation by using different research methods while complementarity seeks to elaborate, enhance, illustrate and clarify results from one method with the results from another. In both cases, the sequence in which qualitative and quantitative elements of mixed methods research is undertaken is significant and has been the subject of discussion (e.g. Castro *et al.*, 2010).

Golicic and Davis (2012) proposed four different types of mixed method approaches embedded within a mixed method decision framework based on timing and weighting: 1) *Development* – use one study to inform a subsequent study, 2) *Initiation* – the use of a preliminary study to launch the main study, 3) *Complementarity* – concurrent examination of various facets of a phenomenon through two or more studies and 4) *Interpretation* – concurrent use of a second study to explain or confirm the results of the main study. In other words, there are several phases that researchers can adopt where Development and Initiation are sequential, and Complementarity and Interpretation are concurrent.

Mixed methods research has a long history and provenance in the natural and social science domains. For example, Galileo's telescopic investigation of the moon included qualitative observations of its geographical features and quantitative analysis of shadows in craters and from mountains, using relative positions of the earth, sun and moon, to calculate crater depth and mountain height (Maxwell, 2016). Further, the sociologist Max Weber developed the concept of *verstehen* (interpretative) understanding and also supervised large-scale surveys for the German Economic Association (*Verein für Sozialpolitik*) to develop social policy (Zeisel, 1933/1971). Other natural and social science domains using mixed methods include geology, ethnography, anthropology and archaeology – Maxwell (2016) provides further discussion on examples and techniques.

Koppman and Leahey (2019) noted it is difficult for researchers to break away from their discipline's scientific tradition for fear of career and "valuation risk", i.e. the notion that deviating from tradition will make one appear incompetent or scattered. Further, mixed methods adoption is lacking in business and management research due to three primary issues: a desire to appear "scientific" in one's methods, resistance from the gatekeepers of a discipline, and a predominance and preference for a positivist philosophical stance (Maxwell, 2016).

This has resulted in significant pressure for academic researchers to adopt "the path of least resistance" (i.e. single method approaches, which are quicker to execute) to achieve peer-reviewed publications their "publish or perish" environment (Grant *et al.*, 2018). However, there has been a call for management researchers to break out of their "normal science straitjacket" to enable acceptance and adoption of mixed methods use (Bazeley, 2015; Molina Azorín and Cameron, 2015).

Teddlie and Tashakkori (2012) suggest it is more relevant for researchers to think of the philosophy adopted in a study as a continuum rather than opposing positions. Further, Mangan *et al.* (2004, p. 565) noted a trend in LSCM research *"to use methods and approaches*

which provide the middle ground between the contrasting positivist and phenomenological paradigms and perspectives". Doing so should assist researchers to generate multi-dimensional insights and greater contributions to the discipline.

Consequently, mixed methods adoption has emerged as a third major research paradigm. The paradigm is essentially the "modus operandi" of how to conduct research. The research questions themselves should naturally inform the choice of paradigm and thus research methodological approach (Kuhn, 1996). However, there are no right or wrong paradigms; researchers must be aware and acknowledge their own worldview and philosophical stance because it will ultimately influence the research design.

Mixed method approaches are an option for integrating strengths and mitigating shortcomings of quantitative and qualitative methods. The use of each approach in isolation only provides one perspective. In contrast, the mixed use of quantitative and qualitative methods should provide deeper insights, as well as broadening the research perspective to provide valuable contributions in addressing the same research problem (Bartunek *et al.*, 1993). This is in line with the triangulation concept that argues limitations of a given method are compensated by the counter-balancing strengths of another and to provide better validity through seeking convergence across qualitative and quantitative methods (Jick, 1979). Easterby-Smith *et al.* (2008) identified four different types of research triangulation, data, investigator, methods, and theory. Methods triangulation, and to a lesser extent data triangulation, are the most significant in this paper's context.

Although mixed methods have gained visibility in the last decade, they have come under increased scrutiny regarding the scientific calibre of research designs and methods employed. Castro *et al.* (2010) proposed a conceptual model and methodology for applying an integrated mixed methods approach for researchers; they note the often sequential and concurrent deployment of mixed methods. They also pointed to the need for "*a rigorous and integrative analysis of qualitative textual evidence and quantitative numeric data*" (Castro *et al.*, 2010, p. 344) that builds on the work of Schwandt (1994), noting the potential advantages of truly integrative mixed methods (IMM) research designs.

There are three core mixed methods designs documented in the literature, convergent, explanatory and exploratory. Convergent designs consist of a quantitative stage and qualitative stage conducted independently of each other but come together at the end for interpretation (point of integration), with the aim of providing a "holistic view" of the research phenomenon. Explanatory designs are characterised by an initial quantitative stage followed up with a qualitative stage, the qualitative strand aids deeper explanation of the quantitative research findings (point of integration) (Clark, 2019; Åkerblad *et al.*, 2021). For exploratory designs, the qualitative stage is conducted first, building to a quantitative stage, i.e. the qualitative stage is used to help build theory for testing in, e.g. a survey, to provide generalisations based on the research phenomenon (Guetterman *et al.*, 2019).

Researchers new to mixed methods research often focus on the sequencing of quantitative and qualitative components, while experienced mixed method researchers focus on what happens when the quantitative and qualitative components come into conversation (i.e. "integration") with each other (Clark, 2019). Åkerblad *et al.* (2021) articulate the difference between research strategy, which implies upfront action planning and forethought, and integration, which happens as research unfolds.

Finally, Uprichard and Dawney (2019) introduced the concept of diffraction – an extension to integration – which similarly stresses the importance of paying attention to the ways in which data are produced through different methods. This can both splinter and interrupt the object of study, particularly in complex situations, thus making it difficult to interpret data. These insights provide a new perspective on the use of mixed methods research, which has yet to be explored within the LSCM domain, particularly the "why" and "how" to integrate mixed methods research.

Mixed methods use in LSCM

Mentzer and Kahn (1995), Mangan *et al.* (2004), Sachan and Datta (2005), Frankel *et al.* (2005), Spens and Kovács (2006) and Golicic and Davis (2012) have all noted that the majority of LSCM research has been traditionally populated by quantitative research viewed through a positivist lens. For example, over 60% of papers published in three major LSCM journals between 1999 and 2003 used research methods associated with that paradigm, i.e. surveys, simulation and mathematical modelling (Sachan and Datta, 2005). However, there is also evidence that the use of methods associated with the interpretivist paradigm was increasing in LSCM research, e.g. 16% of papers used a case study approach, up from 3% in Mentzer and Kahn's (1995) study of papers published between 1978 and 1993. Since then, a summary of mixed methods approaches in LSCM journals has been lacking, i.e. there has been a twenty-year gap, although there have been papers published discussing individual, or discrete, and distinct methods. A good example of this is in a special issue of IJPDLM on the use of qualitative methods, edited by Gammelgaard and Flint (2012).

The business environment in which LSCM phenomena are located is becoming increasingly complex, multi-dimensional and less suitable to using quantitative research alone (Golicic *et al.*, 2005). Complexity is related to risk, and related vulnerability and resilience, and is manifested through economic, climate, political and social systems, all of which require better qualitative understanding similar to what Galileo and Weber discovered (Pournader *et al.*, 2020; Grant *et al.*, 2021). However, there is little evidence of the effective adoption of the truly integrative mixed methods research designs discussed previously in LSCM research.

For example, the Covid-19 pandemic created a "mega-disruption" with an epic global impact that forced supply chain researchers and practitioners to revisit their mainstream concepts and challenge firmly held assumptions, venture into other unexplored domains for answers and begin looking at the discipline through alternative lenses (Flynn *et al.*, 2021)). Sodhi and Tang (2021) noted that academics must "rethink" supply chain management for research and practice to cope with these extreme conditions now and in the future, whether this be due to wars such as the Russia–Ukraine conflict, energy crises and increasing prices, new digitalisation techniques in "supply chain 4.0", or issues surrounding climate change.

As a result, LSCM research is increasingly requiring that questions and problems be investigated and viewed using multiple research lenses to generate more resilient and adaptive supply chains (Azadegan and Dooley, 2021). A key issue here is that the use of qualitative and quantitative methods within a single LSCM research study, i.e. mixed methods research, has historically been rare (Golicic and Davis, 2012) with little guidance provided on "how" to conduct mixed methods research. Thus, there is a need to view supply chains not as simple linear, dyadic structures, but as complex, interconnected, adaptive systems to tackle this complexity and address these "wicked problems" (Hearnshaw and Wilson, 2013; Carter *et al.*, 2017; Shaw *et al.*, 2021; Wieland, 2021).

However, mixed methods should not be used because they are simply in vogue (Mollenkopf, 2014). Mentzer argued that research should be both rigorous and relevant and continue to reinforce the *"appropriate* [use of] *theories and methods to avoid concluding something the research did not actually reveal"* (2008, p. 72). Nonetheless, a mixed methods approach that combines induction and deduction is useful to understand and generate theory and enable new theory testing which may benefit LSCM researchers by strengthening research results and helping mature the discipline (Mentzer and Flint, 1997). Research methods are not mutually exclusive, and if employed together, can offer greater insight and potential for enhancing new theories, rather than from one single method employed alone (Meredith, 1998).

Benefits and inhibitors of mixed methods use

Waller and Fawcett (2012), editorialising in the *Journal of Business Logistics*, identified research methods as an impactful area for LSCM research that provide several benefits. For example, opportunities to use more investigative tools, including both quantitative and qualitative investigative techniques, to create, build and test theory, in this multi-faceted and multi-disciplinary business environment. Golicic and Davis reinforced this noting there is *"a significant opportunity to advance the discipline through the rigorous application of mixed methods research"* (2012, p. 726).

This suggests that LSCM academic journals and their editors and reviewers should welcome and encourage research methods articles that put forth new and improved ways to develop and test academic theory and safeguard the validity of published academic research. However, one challenge in publishing mixed methods research is finding qualified reviewers willing to view the LSCM research from an alternative paradigmatic or theoretical approach (Waller and Fawcett, 2011). In other words, LSCM journals need to develop a better tradition that thoughtful reviews on a frequent basis should be an expectation. Mangan *et al.* (2004) suggested that positivism is relevant in the context of high-level decision making with interpretivism more useful at the micro-level. This mirrors an argument posited almost a decade earlier by New and Payne (1995).

Finally, Golicic *et al.* (2005) noted that blended techniques in LSCM enable researchers to generate more complex and explanatory insights, than if these methods were conducted in isolation. Conducting interviews within a case study setting and using questionnaire-based surveys within the same study can yield contrasting results and requires researchers to better explain why this is the case and what are the resulting implications. Thus, using several data sources and measures of phenomena provides cross-checks on data accuracy and enrichment of conclusions researchers might reach (Harrigan, 1983).

Using mixed methods in LSCM research to answer research questions requires that a wider range of underlying philosophical perspectives be adopted to ensure issues are studied holistically, and that disadvantages associated with using a single method are avoided. This in turn drives the methodological approach adopted, i.e. one which explores the research questions through an appropriate combination of quantitative and qualitative methods. However, questions remain about researchers' levels of understanding of the benefits and disadvantages of using mixed methods.

Fawcett *et al.'s* (2014) publishing "trail guide" discussed the need for an "inclusive toolset" for LSCM researchers to help move the discipline into new and unchartered territory. This toolset, comprising qualitative and quantitative techniques, provides opportunities for LSCM researchers to explore and to contribute to both theory and practice. However, such a toolset requires understanding and guidance – for example "how" to conduct mixed methods research, "overcoming design issues" and "drawing conclusions from the data" (Teddlie and Tashakkori, 2012). Such toolsets could build on work by Castro *et al.* (2010) by providing guidance to undertake integrated mixed methods research approaches in LSCM. This is lacking in the literature, particularly in relation to the processes, steps and techniques that need to be undertaken.

Methodology

Thus, there is a need for a clearer understanding of the status of current mixed methods use and their relationship to potential future trends and directions in LSCM research. Accordingly, we developed the following three research questions for study.

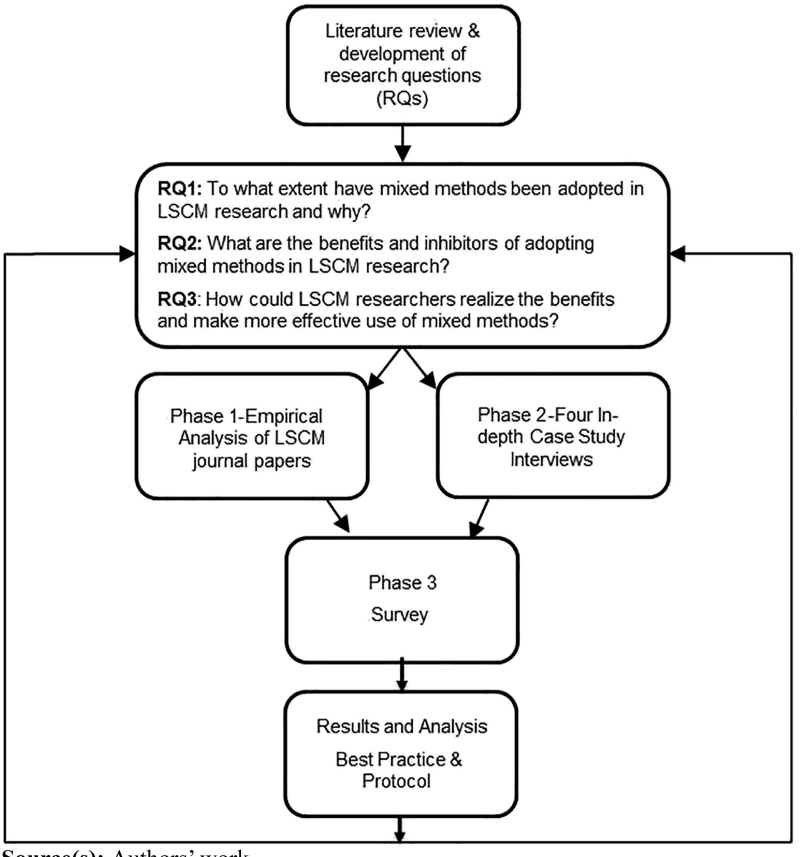
RQ1: To what extent have mixed methods been adopted in LSCM research and why?

RQ2: What are the benefits and inhibitors of adopting mixed methods in LSCM research?

RQ3: How could LSCM researchers realise the benefits and make more effective use of mixed methods?

Answering RQ1 provides an up-to-date and detailed profile of mixed methods usage in LSCM. It is clear that the use of mixed methods in LSCM can bring benefits and inhibitors in adoption, and RQ2 focuses on identifying them in a LSCM context. Both these provide a foundation for RQ3 to provide insights for researchers into the effective adoption of mixed methods in LSCM. In this way, this work builds on studies that have addressed the "how" question in a generic, i.e. non-LSCM context and on studies which have focussed on other fields (Bryman, 2006; Clark, 2019; Åkerblad *et al.*, 2021).

A first step for any researcher is to identify *why* they plan to integrate and use mixed methods, and this is done initially through the research questions themselves (Cresswell and Plano Clark, 2018). Accordingly, our methodology employed a mixed methods approach that combined both qualitative and quantitative elements (Cresswell and Plano Clark, 2018) with both a sequential and concurrent approach (Golicic and Davis, 2012), given the "what" and "how" type of research questions we posed. There were three phases with discrete methods of data collection as shown in Figure 1. This overall research design emphasises the importance of integration between the constituent phases in line with the IMM concept introduced earlier.



Source(s): Authors' work

Figure 1.
Research design

Phase one comprised an analysis of LSCM empirical papers that describe research using mixed methods and published in six leading LSCM journals. This phase covered a decade's worth of LSCM research and is considered a reasonable length of time to capture the situation in the domain (Corazon *et al.*, 2019; Khan *et al.*, 2020). This provided an evaluation of the extent to which mixed methods have been adopted in LSCM, thereby providing some insights into RQ1. This phase focussed on empirical research articles published in a ten-year period from 2011 to 2020 in six top LSCM journals (Menachof *et al.*, 2009), in alphabetical order as follows:

(1) *The International Journal of Logistics Management* (IJLM)

(2) *International Journal of Logistics: Research and Applications* (IJLRA)

(3) *International Journal of Physical Distribution and Logistics Management* (IJPDLM)

(4) *Journal of Business Logistics* (JBL)

(5) *Journal of Supply Chain Management* (JSCM), and

(6) *Supply Chain Management: An International Journal* (SCMIJ)

These six journals have been appraised as being "significant", "leading", "top-tier", "highly impactful" and "high-quality" in the field of LSCM research (Sachan and Datta, 2005; Menachof *et al.*, 2009; Ellinger and Chapman, 2011; Liu *et al.*, 2016). We recognise there is some subjectivity in this choice of journals which excludes other journals that focus on specific facets of LSCM, such as operations management and production, purchasing and wider aspects of transportation.

Nevertheless, we consider the work done by the aforementioned authors fairly represent the premise and impact of these mainstream LSCM journals and provide a good barometer of the current state of the art. We also consider our ten-year analysis provides a good baseline of mixed methods used in LSCM, i.e. in the minority as discussed in Findings below, and that there is much more that could be done. There is no additional research available that includes the additional journals, but we are confident mixed methods use in them would also be in the minority. As discussed, in the Conclusions section, a wider analysis across more journals represents a future research opportunity.

The selected six journals and their bibliographic and ranking information for 2022 are presented in Table 1.

The second phase, which took place concurrently with phase one, involved in-depth case studies of four LSCM research projects that used mixed methods. This facilitates the development of deeper and richer insights than is possible either in the first phase (i.e. journal analysis) or the third phase (i.e. the survey). The choice of cases was based on considerations of thematic focus, geographical context and methodological orientation. The four chosen projects represent a good range of LSCM themes – including sustainability, performance measurement and technology deployment – and were carried out in a variety of geographical contexts

Table 1.
Six leading LSCM journals and their bibliographic information

Journal	SCOPUS Source-ID identifier	SCOPUS CiteScore 2019	SCImago SJR 2019
IJLM	19700201449	3.6	1.06
IJLRA	11400153310	4	0.873
IJPDLM	144922	8.4	2.749
JBL	19700201522	7.2	2.344
JSCM	100147317	11.9	3.983
SCMIJ	23644	8	1.676

Source(s): Authors' work compiled from SCOPUS website

(i.e. Ireland, UK, Italy and Thailand). The projects also deployed a range of methodologies and data collection methods including case studies, interviews, focus groups and questionnaire surveys. The aim of the four cases was to provide a contextually rich and deep understanding of the phenomena under investigation, thereby enhancing the internal validity of the study. This is important in the context of building on the findings from phase one.

In addition to thoroughly reviewing written reports and published outputs from each project, semi-structured interviews are conducted with the PI of each project to determine why mixed methods were used, how they were used, and the level of additional meaning and understanding achieved as a result. Semi-structured interviews were used to ensure that all key areas were covered and to allow the PIs some latitude in sharing their experiences of the use of mixed methods.

A data collection guide was developed based on twelve core questions and a short concluding section (see Appendix 1). These core questions were designed to collect the data needed to provide insights into all three RQs but paid particular attention to RQ2 and RQ3, i.e. the more qualitative questions. All interviews were recorded and transcribed. Details of the four case studies are shown in Table 2.

The third phase, which took place after phases one and two, comprised an e-mail survey of all corresponding authors of the LSCM empirical journal papers identified in phase one that used mixed methods. Appendix 2 provides the e-mail survey questions developed by the authors from the techniques in the second phase, which when combined addressed RQ2.

Analysis for phases 2 and 3 followed a qualitative data iterative cycle (Miles *et al.*, 2014). Data were transcribed and coded into categories, and analysed and discussed among the authors to identify any discrepancies. This process enhanced data credibility and reliability and enabled development of a refined set of categories including mixed methods, benefits, inhibitors, qualitative research and quantitative research. The authors' thematic analysis paid particular attention to points of convergence and divergence which were evident among interviewees and survey respondents as they related specific to one or more of our RQs. No further details are provided to respect respondent confidentiality and anonymity. In relation to analytical considerations, the authors were mindful of the need for a holistic approach in line with the IMM concept discussed above.

Findings

Phase 1 – LSCM empirical papers

The process used was based on Ngai *et al.* (2008) with additional steps to prepare the dataset. First, the bibliographic content of the six journals was extracted from SCOPUS. An advanced

Project content	Implementing SCM in practice	Green performance measures in supply chains	ICT in SME supply chains	Green service quality of LSPs
Principal investigator	PI-1	PI-2	PI-3	PI-4
Phase 1	Interviews	Focus Groups	Focus Groups	Interviews
Phase 2	Focus Groups	Questionnaire Survey	Questionnaire Survey	Questionnaire Survey
Phase 3	Questionnaire Survey	Focus Groups	Focus Groups and Case Study	Interviews
Geographic context	Europe (Ireland)	Europe (UK)	Europe (Italy)	Asia (Thailand)

Source(s): Authors' work

Table 2.
Case study details

search query was constructed using operators and field codes and included fields of authorship details, title, journal name, year, abstract and DOI identifier. Entries such as editorials, errata, notes and letters were then removed from all articles resulting in a dataset for analysis of 1,972 articles from 2011 to 2020.

For each of these articles, evidence of their methods approach was extracted either from the paper's abstract or full text and added to the dataset. Two authors analysed the dataset and discrepancies between the authors' judgement were reconciled by discussions with input and agreement from a third author, until a unanimous decision was made about article classification and categorisation. In line Sweetman *et al.* (2010), articles were categorised as using mixed methods where a mix of quantitative and qualitative data was collected and analysed.

The final classification yielded a total of 1,463 empirical articles as shown in Table 3. The remaining 509 articles were primarily conceptual/theoretical papers, systematic or other types of literature review, or mathematical models that did not use real data. Empirical articles were further divided into two categories: 1,319 (90%) single and 144 (10%) mixed methods articles.

Publication trends by year for all types of empirical articles in the dataset from 2011 to 2020 are presented in Figure 2, with the 144 mixed methods articles noted per year on its respective line graph. A trend line for mixed methods articles suggests a slight increase. Mixed methods articles were also classified by the type of methodologies they used: i.e. two-, three- and four-method types. Two-method articles constituted 73% with three- and four-methods articles constituting 26% and 1% respectively. However, the increase of mixed methods papers remains nominal compared to the rise in other types of papers, suggesting

Table 3.
Empirical and methods classification of articles 2011–2020

Journal	Dataset	Empirical	Single method	Mixed methods
IJLM	378	294	262	32
IJLRA	350	260	241	19
IJPDLM	384	276	257	19
JBL	217	154	143	11
JSCM	219	138	120	18
SCMIJ	424	341	296	45
Total	*1972*	*1463*	*1319*	*144*

Source(s): Authors' work compiled from journal websites

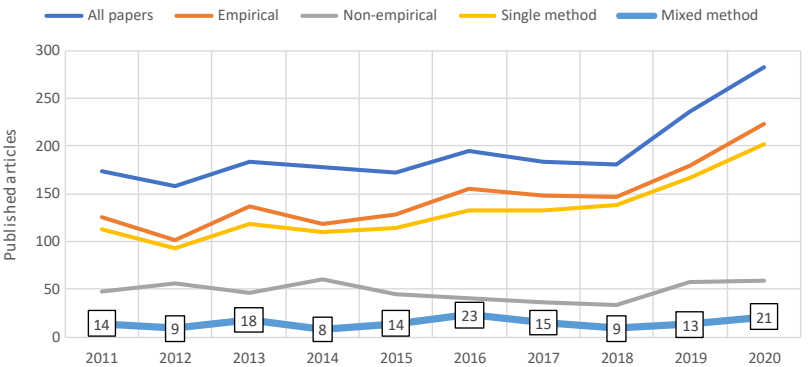


Figure 2.
Publication types per year

Source(s): Authors' work compiled from journal websites

adoption of these techniques still lags. Finally, given time lags for analysis, writing and journal review and interruptions due to the Covid-19 pandemic, articles published during 2021–22 were briefly checked and no significant or discernible changes in the number of mixed methods were found, i.e. they still represent 10% of all empirical papers.

Phase 2 – four case studies using mixed methods

Analysis of interview transcripts revealed several findings relevant to the three research questions. In all cases, the PI had gone beyond a second stage to a third to validate their results.

There was evidence in all four cases that alternative methodological approaches and data collection methods were given due consideration. In other words, mixed methods approaches were chosen quite deliberately as part of considered research design processes. Second, the principal reason cited by all four PIs for the use of mixed methods relates to the research questions being explored in the projects. This was summarised very well by PI-2 who stated that *"the research questions were the key driver"* and that *"generating the necessary insights required a mix of qualitative and quantitative data"*. In this work on environmentally sustainable supply chains, a series of semi-structured interviews with carefully selected key informants provided a good overview of the key issues associated with effective performance measurement, with a survey then providing insights into detailed operational considerations.

Third, all PIs alluded – to greater or lesser extent – to the importance of viewing complex phenomena through different prisms. For example, PI-2 stated that *"by adopting multiple lenses I could gain greater clarity on the research issue"*. PI-4 provided a specific example of how greater clarity can be gained by noting that the qualitative elements of the research provided useful insights into issues associated with the specific geographical context of the work (Thailand) while analysis of the quantitative data collected using the questionnaire survey allowed hypotheses that had been developed to be rigorously tested. Interestingly, all four studies used mixed methods in a sequential and/or concurrent manner; there was little evidence of the use of truly integrated approaches, i.e. the IMM designs proposed by Castro *et al.* (2010).

Three common themes emerged from the PIs regarding inhibitors to the use of mixed methods in LSCM research. The first related to the amount of work and time required to undertake mixed methods studies. PI-3 captured this very well stating that *"the main obstacle in developing research using mixed methods is the increased amount of time and work needed for undertaking and concluding the study"*. PI-2 referred to the *"sheer volume of data"* that typically needs to be collected and analysed. PI-1 and PI-3 specifically noted the financial implications in the context of constrained budgets.

The second theme raised by all PIs related to the breadth and depth of skill and knowledge required to undertake mixed methods research effectively. PI-1 noted the requirement for *"either a highly trained researcher (e.g. for individual projects such as PhD work) or teams of researchers with the appropriate blend of skills and knowledge across the team (e.g. for larger funded research projects)"*. This raises issues regarding how, and how well, researchers are trained. PI-3 raised the question *"do we train researchers well enough to deal with these scenarios?"*

Finally, PI-2 referred to a perceived bias towards specific research methods among journal editors and PhD supervisors in the context of a need to encourage the effective and appropriate use of more pluralist approaches. This supports Bazeley (2015, p. 27) that while researchers generally have *"thorough training in the fine details of statistical methods of analysis; understanding of qualitative analysis is weaker and restricted to a few; and none appears to have any awareness of a growing literature on mixed methods"*. This finding has implications for the training of researchers who currently may have a limited repertoire of non-statistical methods on which to draw when undertaking research.

In the context of research skills development, PI-4 highlighted a specific issue of incorporating qualitative and quantitative components into an overall integrated research design in line with the IMM concept. The work of PI-1 is illustrative in this regard, with the overall research design including exploratory and explanatory elements. The former comprised two phases – a series of semi-structured interviews with key informants and a questionnaire survey – with the latter comprising a series of focus groups. The research design indicates that the outputs from the former phases provide inputs into the latter phase. However, PI-1 was unable to provide clear detail on how this worked in practice. This is not in line with the concept of integration that lies at the heart of the IMM approach to research design.

Finally, all PIs commented on the practical difficulties associated with the use of mixed methods in LSCM research but were nonetheless adamant that if the research was undertaken again, they would still use the mixed methods approach. PI-3 noted that *"... if I could conduct the research study again, I would use exactly the same research design and methods as the results I got were very satisfying"*. There was however some acknowledgement by PIs that significant learning had been derived from the implementation of their chosen research designs, thereby providing a basis for future improvement. As succinctly put by PI-2 *"hindsight is a wonderful thing"*.

Phase 3 – survey of LSCM empirical articles using mixed methods

The third phase comprised an e-mail survey of corresponding authors for the 144 mixed methods articles, and asked them to provide comments on why they used mixed methods in their articles and what they saw the benefits were in doing so. Some of the questions used for the case study interviews were considered redundant, with little differentiation between responses, and hence nine questions were formulated for this phase as shown in Appendix 2.

An initial e-mail and two reminder e-mails were sent over a three-month period. Ten e-mails were returned with invalid contact details, providing a net sample of 134 articles. Twenty-six responses were received (19.4% net) and details of the number of articles per journal are in Table 4 along with an identifier for quotes to maintain anonymity for respondents. The journal with the most mixed methods articles during the period reviewed was SCMIJ and survey respondents from this journal also provided the highest response rate at 27%.

Survey data were analysed using content analysis of comments provided by respondents and comparison of themes determined though comparing comments for each question in an Excel spreadsheet using pivot tables. The analysis revealed a number of key themes that relate to the RQs, particularly RQ2 and RQ3. Most respondents chose a multi-method approach because it allowed them to consider a phenomenon from several perspectives, particularly when little was known about the phenomenon, supporting Golicic *et al.* (2005)

Table 4.
Number of articles per journal in sample and survey responses

Journal	Sample	Responses	Response rate per journal (%)	Respondent quote designation
IJLM	32	7	2	IJLRA1-7
IJLRA	19	1	5	IJLM8
IJPDLM	19	3	15	IJPDLM9-11
JBL	11	2	18	JBL12-13
JSCM	18	1	6	JSCM14
SCMIJ	45	12	27	SCMIJ15-26
Total	*144*	*26*		

Source(s): Authors' work compiled from journal websites

and Waller and Fawcett (2012). Mixed methods allow researchers to *"... capture valuable and comprehensive insights that a single research method cannot easily accomplish"* (IJLM1), and *"... produce research that makes a higher-level contribution to our understanding and managerial decision-making, we need to be able to answer the 'may be' questions ... survey and archival data can provide a benchmark what is happening and help test hypotheses, but it* [sic] *does not answer the whys and hows"* (IJLM6).

The choice of methodological approach and interdisciplinary work influenced respondents' reasons for using mixed methods, as called for by New and Payne (1995) and Mangan *et al.* (2004). IJPDLM9 used a *"... a critical realist perspective on supply chain management research, namely, critical realism that goes deeper to explain ... supply chain related phenomena"*. Some noted there is also a need for different types of research in LSCM, mirroring Näslund (2002) and Sachan and Datta (2005).

Respondents identified a need for triangulation to ensure they obtained the best possible explanation, supporting Jick (1979) and Mentzer and Flint (1997). For example, triangulation *"... provided both insights into causal issues as well as* [a] *hierarchy for the relevancy of different attributes"* (IJLM4) and enabled *"... the advantage of reducing bias in data sources and methods* [or] *triangulation* [where] *one method can compensate the weaknesses of another method"* (SCMIJ24).

Respondents overwhelmingly considered a single method study would not have enabled them to enhance their understanding of the phenomenon nor provide for any level of cross-checking required (Harrigan, 1983; Golicic *et al.*, 2005). IJLM2 believed a *"... single method could have answered the* [research questions] *... in a much less robust and complete manner"* while JBL13 suggested *"... single methods seldom provide the nuanced understanding needed to create unique and meaningful insight"*.

A few respondents noted an additional benefit of involving stakeholders such as practitioners in LSCM's very practice-oriented and focussed discipline (Golicic and Davis, 2012; Waller and Fawcett, 2012). For example, IJLM1 opined that *"... mixed methods bring the research participants more directly into the research, not only as questionnaire respondents but as interview informants who help to influence where we go with the research each year"*.

Finally, not many respondents would have done anything differently but there were some further interesting insights. IJLM1 called for even more stakeholder involvement: *"We would consider adding a third step in which we convene a panel of industry experts to help us interpret the results of the questionnaire* [and] *... provide experiential interpretations of the results based on their experiences ..."*, while IJLM6 would like to use ethnography (Maxwell, 2016).

Discussion

RQ1. To what extent have mixed methods been adopted in LSCM research and why?

The results of this study show that while there has been a slight increase in the adoption of mixed methods in LSCM research, there is still a lack in their use with only 10% of articles, or about 14 per year, of empirical research being conducted. Further, most mixed methods research used predominantly two methods, i.e. an interview and a survey. The most dominant single method was the survey with a 45% adoption rate, followed closely by interviews at 30%. Thus, there has been little shift by LSCM researchers towards using more and different mixed methods approaches since Mangan *et al.* (2004).

Of the six journals, SCMIJ has the highest frequency of mixed method articles and notes on its website that it considers research articles and case studies that push the boundaries of supply chain research and practice and which "*extends supply chain knowledge beyond the dyadic perspective*", particularly around the development of new theory. IJLM, the second

dominant journal for mixed methods, state in their scope they are interested in empirical, with a special preference for qualitative research.

Sachan and Datta (2005) reported over 60% of papers use research methods associated with the positivist paradigm and thus surveys continue to be the "method of choice" for LSCM researchers. However, a fundamental question remains as to what is driving this and how it is impacting the domain.

RQ2. What are the benefits and inhibitors of adopting mixed methods in LSCM research?

The results from the four case study interviews and the survey show that there are potential benefits driving the adoption of multi-method approaches with the research also identifying several significant inhibitors. A summary of the benefits and inhibitors is provided in Table 5.

The ability to obtain a more holistic view of the issues under investigation using mixed methods was alluded to by participants in both phases 2 and 3 of our research (PI-2 and IJLM1). This is linked to the desirability of having multiple lenses to provide greater clarity and detail to answer research questions (see PI-2 in phase 2 and IJLM6 in phase 3). This helps to provide better validation and expansion of overall results, as well as producing research that makes a higher-level contribution to managerial practice and enables researchers to answer "maybe" and "how/why" questions (see, for example, IJLM6). The need to bring research participants and key stakeholders more directly into the research itself emerged during phase 3 (see comment from IJLM1 above). These and other benefits of mixed methods in combination can help to reduce the bias sometimes inherent in the use of single methods.

However, several significant inhibitors were also identified. As highlighted by multiple participants in phases 2 and 3 of our research, significant breadth and depth of skill and knowledge is required to effectively undertake mixed methods research. There may be an issue here related to research training being provided for the next generation of LSCM researchers, as well as in relation to awareness of the potential benefits of mixed methods outlined above. Some higher education institutions offer separate quantitative and qualitative research training programmes, but not necessarily combined and treated in an integrated way. This raises questions about the manner in which doctoral training encourages bias towards one approach.

Current pressures of "publish or perish" influencing a research approach which provides a "path of least resistance" (i.e. single method quantitative approaches are quicker to execute, publish, and disseminate with industry and academia). This aligns with the perspective of

Benefits	Challenges
• A need to obtain a more holistic view of the research phenomena • Having multiple lenses to provide greater clarity and detail to answer research questions • Better validation and expansion of overall results • Producing research that makes a higher-level contribution to managerial practice • Enabling researchers to answer "maybe" and "how/why" questions, and • Bringing research participants and key stakeholders more directly into the research itself • Reducing bias	• Lack of skill set and training to undertake mixed method research (conducting, analysing and interpreting) • Research training is separated into the traditional dichotomy of quantitative and qualitative in academic institutions • Lack of awareness off the benefits of conducting mixed method research • Time to conduct mixed method research (publish or perish!) • Cost to conduct mixed method research • Journal paper bias towards singular methods • Supervisory bias towards singular methods

Source(s): Authors' work

Table 5.
Mixed methods research – summary of benefits and challenges

PI-2 reported above. Furthermore, the amount of time needed to conduct mixed methods research is an important factor to consider with the sheer volume of "big data" generated for analysis often making mixed methods approaches time-consuming compared to single method approaches, thereby deterring some researchers. This specific point – see above – was specifically alluded to by PI-2 and PI-4 in phase 2 of our research.

The key for researchers is to be aware of these potential inhibitors so that they can plan to mitigate them.

RQ3. How could LSCM researchers realise the benefits and make more effective use of mixed methods?

Current research has clearly identified key potential advantages and benefits of adopting mixed methods approaches in LSCM studies, as well as the factors that inhibit their effective deployment. If LSCM researchers are to realise the potential advantages and benefits of mixed methods, then it is important that these advantages and benefits are more clearly communicated and understood. It is also imperative that action is undertaken to address the various inhibitors that have been identified. For example, it is important that research training equips the next generation of LSCM scholars with the necessary skills, knowledge and behaviours to deploy IMM research designs effectively.

However, there is no panacea here, given the wide range of challenges being addressed by LSCM researchers, i.e. each research project has its own unique characteristics and, therefore, requires its own unique research approach and methodology. In this context, a "one-size-fits-all" approach is unsuitable for providing guidelines or templates on the effective adoption of mixed methods. The key for researchers is to develop a project-specific research methods plan to ensure that the inhibitors likely to be encountered, in a particular piece of research, are tackled in a logical and systematic way by the relevant parties.

Also, LSCM researchers should share their own experiences and challenges of using mixed methods research. For example, Zhou and Wu (2022) advocated that researchers who use mixed method research should be proactive in expounding methodological challenges that they confronted and report what they did to enable cascade of best practice. Finally, our findings highlight the relative specificity and complexity associated with mixed methods research. In this context, it is important that research design and implementation is undertaken in a rigorous way so that findings are uncovered in a logical and systematic manner. Our research points to three points of specific significance here.

First, our experience in undertaking this piece of mixed methods research points to the need for LSCM researchers to be aware of their own paradigmatic preferences, and personal or work experiences, as these will ultimately influence what they research and how that research will be conducted. This issue was also evident in all four case studies in phase 2 with all PIs indicting that mixed methods approaches were chosen quite deliberately as part of considered research design processes.

Second, the nature of the research topic is important – for instance, is the topic in a new, complex or emerging area or is already well researched and understood? This will influence the type of research questions that are formulated. The research questions then essentially determine the "modus operandi" of the research and will naturally inform methodological choice (Ellram, 1996). For example, the selection of mixed methods may be intuitively implied as a result of new phenomena under investigation with a purpose of investigating "how" and "why" research objectives. As reported above, all PIs in the phase 2 case studies and most respondents to the phase 3 survey highlighted the key role of research questions in informing research design.

Third, early identification of the data required to respond to the formulated research questions is important. However, this often appears to be neglected. This may present a problem if it transpires that these data – possibly qualitative and quantitative – can only be

captured using mixed methods. This is well illustrated by the experience of PI-1 in phase 2 reported above, particularly in the context of how the outputs from the earlier phases of the research informed identification of the data required in subsequent phases.

Conclusions

LSCM research is at a critical crossroads as empirical research is still primarily based on single method approaches, particularly quantitative studies which are focused on testing existing theory. This suggests LSCM researchers are missing an opportunity to make the step changes needed to advance knowledge and to build new theory. As a result, we may have hit a barrier in LSCM knowledge creation. There is also evidence that LSCM researchers are often inadequately equipped to address the supply chain "mega-challenges" characterised by complexity and often require the use of methodologically pluralist approaches and the attendant adoption of mixed methods of data collection and analysis.

Our reflection on our use of mixed methods in this study suggests that the success requires that overall research designs are "dynamic" in nature, i.e. the findings from each phase need to inform subsequent stages of the work and the research will unfold. Although our research approach aligned well with Clark's (2019) convergent mixed methods design through combining quantitative and qualitative stages of research concurrently in phases 1 and 2, we added an additional qualitative stage in phase 3, as the research unfolded to strengthen and be able to make generalisations from our findings, i.e. phase 3 emerged from phases 1 and 2 outputs and was not pre-planned or predetermined.

Thus, our design was a hybrid of convergent, explanatory and exploratory models. For this reason, it is impossible to fully define the research methodology in every detail at the outset, also in a linear way (for example sequential, concurrent); researchers need to allow the detail to evolve, be flexible, as new insights are generated. This facilitates the adoption of highly integrated mixed methods designs and processes such as diffraction to better understand the different ways in which mixed methods research can be undertaken.

Such research designs also provide useful guidance for undertaking mixed methods research, but researchers need to be prepared to allow the research to evolve and unfold and focus on what happens when the quantitative and qualitative components come into conversation with each other and act upon this real time. Finally, it vital that sufficient strategic research planning time is built in upfront to determine the goals or deliverables of the research to help researchers obtain a holistic, exploratory or explanatory view of the research problem.

Our paper has contributed to LSCM research in several ways. First, it is the only paper to our knowledge that has quantitatively analysed the current state of mixed methods research in six major LSCM journals and qualitatively investigated the benefits along with identifying the inhibitors to adoption. Second, it provides a renewed call to action for LSCM researchers, editors and reviewers to enhance the use of mixed methods and provide more meaningful and validated results through that use, adding to previous research over the past twenty years with our three empirical study phases. Third, it provides guidelines for LSCM researchers to follow when and if they choose to use mixed methods to ensure research rigour, especially when the research is interdisciplinary in nature. Fourth, while strategic research design and planning forethought are essential, our findings suggest researchers need to be prepared to adapt designs when integration or diffraction occurs, i.e. when quantitative and qualitative strands and their associated data outputs interrelate with each other, to enable agile and resilient research when investigating rapidly changing and complex phenomena.

This paper also contributes to practice through its call to action. More mixed methods research that is executed and communicated effectively will give practitioners and other stakeholders comfort in research results through their increased veracity, validity and reliability, which will in turn allow practitioners and other stakeholders to make better and

more informed decisions. Furthermore, effectively dealing with today's biggest supply chain opportunities and challenges – e.g. supply chain 4.0 and digitalisation, sustainability and crisis management – requires that practitioners and academics take a multi-faceted team view rather than a singular view. Doing so will enable LSCM to evolve as a domain in an increasingly complex operating environment.

As with all research, this paper has two limitations that suggest research to further enhance our knowledge on using mixed methods research in LSCM. First, the number of in-depth research project case studies was relatively small and further research on this topic could fruitfully utilise more case studies to either further validate the findings or determine any additional benefits and inhibitors. As noted, the cases were chosen as the authors were familiar with the work and the projects' PIs were conveniently placed to participate in our study. This limitation notwithstanding, the third phase survey of LSCM mixed methods authors supports key insights from the case studies, thereby providing some confidence that the findings can be considered accurate and robust. However, future work could consider undertaking in depth analysis of a more carefully selected sample of case studies, perhaps focussing on work which has resulted in demonstrable impact.

The second limitation is the number of journals used for the first phase analysis. The method used for journal selection was based on peer reviews of the most important LSCM journals, and the almost decade long time frame used provides a good indication in the amount and direction of travel in LSCM multi-method research. Nevertheless, research could further expand the journal database and investigate a longer time frame to determine if there are any significant changes to this paper's findings. As noted earlier, a limited analysis of papers published since 2020 has already been undertaken by the authors and no discernible changes were found. This aspect could also be extended and elaborated upon going forward. The authors also suggest that expanding the survey to include authors of papers that used single methods could potentially be fruitful. This is likely to particularly the case in relation to generating insights into RQ2, and specifically in relation to the adoption inhibitors.

Finally, insights from this research provide a rational basis for progress in relation to the effective deployment of mixed methods in LCSM research. They particularly provide guidance for researchers to facilitates a shift towards IMM research designs and creates the potential to begin addressing the most pressing and difficult issues in the increasingly complex and volatile LSCM landscape.

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Further reading

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Appendix 1:
Case study semi-structured interview guide
<Usual protocol about anonymity>

Definitions
Research Methodology – a systematic set of procedures, rules or ideas, i.e. a strategy that underlies a particular research problem or questions.

Research Methods – a particular procedure to specifically answer a particular research problem or questions through the collection and analysis of data.

Questions

1. What methodological approach did you use for your research study?
2. Did you consider using any other methodological approach? Why?
3. Why did you choose your particular approach in the end?
4. Why did you reject any other approaches?
5. Why did you choose to use mixed methods for your study?
6. What do you believe are the benefits and challenges of using mixed methods?
7. Did you consider using any single method(s)?
8. Would it(they) have answered your study's research questions? If so why, if not why?
9. Why did you not choose a single method in the end?
10. What were the steps in your research design, including methodology and methods?
11. What additional insights do you consider your use of mixed methods provided for your study? Why?
12. If you could conduct the research study again, what would you do differently as regard methodology and/or methods? Why?

Closure
Do you have any other comments?

Appendix 2:
E-mail survey
We are investigating the use of mixed methods in logistics and supply chain management (LSCM) research. We have examined all issues of various LSCM journals from 2011 to 2018 and found that your paper in <journal> in <year> used same.

<Usual protocol about anonymity>

Instructions
Please provide your responses underneath each question below and return the completed survey by e-mail.

Definitions
Research Methodology – a systematic set of procedures, rules or ideas, i.e. a strategy that underlies a particular research problem or questions.

Research Methods – a particular procedure to specifically answer the particular research problem or questions through the collection and analysis of data.

Questions

1. Why did you choose to use mixed methods for your study? Did you consider using any single method(s)?
2. What methodological approach did you use for your research study and why did you choose it?
3. Did you consider using any other methodological approach? Why did you not use it(them)?
4. Would it(they) have answered your study's research questions? If so why, if not why?
5. Why did you not choose a single method in the end?
6. What were the steps in your research design, including methodology and methods?
7. What additional insights do you consider your use of mixed methods provided for your study? Why?
8. If you could conduct the research study again, what would you do differently as regard methodology and/or methods? Why?
9. Do you have any other comments?

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