

The current use and future potential of theories, methods, and applications in qualitative and quantitative SSCM research

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Abstract

Qualitative and quantitative research approaches are driving research on sustainable supply chain management (SSCM). The Delphi study at hand attempts to map the theories, methods, and fields of application focused by qualitative and quantitative research in order to identify overlaps and gaps amongst them as well as to outline possible integration avenues. The findings of the first survey round give preliminary insights into the current use and the future potential of theories, methods, and application contexts as well as on the role of sustainability and multi-tier SCM dimensions in qualitative and quantitative SSCM research.

Keywords: Sustainable supply chain management research, Methods, Delphi study

Introduction

Research approaches to sustainable supply chain management (SSCM) avail of conceptual frameworks and formal models from Operations Management (OM) and Operations Research (OR) to extend the scope of analysis toward environmental and social aspects relevant for managing operations and supply chains (SCs). However, qualitative and quantitative research streams in SSCM still appear disconnected with regard to a common literature background, which is indicated by low citation numbers between conceptual, empirical, and formal modeling publications that consider stakeholders and risks in SSCM (Rebs et al., 2017). These observed rare interactions point at the potential of benefits gained from integrating qualitative and quantitative research approaches for SSCM.

Different research approaches in SSCM have been reviewed thoroughly by recent publications (Reefke and Sundaram, 2017; Rajeev et al., 2017). However, an overarching investigation into the use of different theories, methods, and application contexts in SSCM research is not available, but strongly needed to unveil potentials of considering both qualitative and quantitative approaches.

The Delphi study, as a survey research design, enables a structured debate on the issue by engaging the researchers in the field (Linstone and Turoff, 1975), i.e., the very nucleus

of the current split of approaches. This is a crucial step towards the identification of synergies between different research approaches as well as enhanced cooperation opportunities that eventually lead to an overall higher impact of SSCM research. To this end, we pose the following research questions (RQs) to be answered by this survey study:

RQ1: What are the theories, methods, and application contexts that are deemed highly relevant for future SSCM-related research?

RQ2: How is the current maturity and future potential of the use of economic, environmental, and social dimensions of sustainability as well as for different multi-tier SC levels of analysis in SSCM perceived by the SSCM experts?

RQ3: How could qualitative and quantitative approaches be linked to reap the benefits from integrating and extending theories, methods, and application contexts for future SSCM-related research?

Literature background

Delphi studies have proven to be appropriate to capture the scope of complex problems or the structure of emerging research fields like SSCM (see, e.g., Seuring and Müller, 2008a). Recently, Reefke and Sundaram (2017) enquired into the key themes for SSCM research using the SC planning matrix as a conceptual basis. While the past use of theories, methods, and applications can be discerned by systematic literature reviews, the current use and future potential can only be identified at a current given point in time by a survey research approach so that no considerable gap exists between the research endeavors and their publication.

A range of (qualitative) theories and (quantitative) formal models has been applied in SSCM research. Sarkis et al. (2011) reflect the role of organizational theories in green supply chain management (GSCM) research and identify promising theories for future GSCM research. Apart from qualitative- and quantitative-empirical research designs, e.g., case studies or surveys, the use of quantitative-theoretical formal models in SSCM-related research articles was reviewed (see, e.g., Brandenburg et al., 2014). Central to the discourse on sustainable management is the role of the economic, environmental, and social dimensions of sustainability, i.e., the so-called triple bottom line (TBL) of sustainability (Elkington, 1998; Carter and Rogers, 2008). Their interplay is of constant interest, particularly with regard to their operationalization by formal models. Finally, multi-tier supply chain management (multi-tier SCM) appears to receive increasing attention for managing sub-suppliers (e.g., Mena et al., 2013; Grimm et al., 2014) and enhanced SC transparency.

When reflecting qualitative and quantitative approaches in SSCM with regard to a generic “normal research cycle” (Meredith et al., 1993: 4), theoretical frameworks and formal models are involved in an iterative process of describing and explaining certain phenomena to build theory, which is subsequently tested, e.g., by quantitative models. In this context, Rebs et al. (2017), recommend to strengthen the nexus between conceptual, empirical, and formal modeling research for SSCM in order to close the cycle and drive SSCM research further.

Methodology

The study at hand represents a Delphi study, i.e., “a structured group communication [...] to deal with a complex problem” (Linstone and Turoff, 1975, p. 3). The method is particularly suitable for exploratory theory building on under-researched, complex, and interdisciplinary topics (Akkermans et al., 2003) such as the outlined interaction between qualitative and quantitative research streams in SSCM. Adopting methodological suggestions by Linstone and Turoff (1975) as well as Okoli and Pawlowski (2004),

individual panels are built to gather the opinion and expertise of authors of research articles in SSCM.

Delphi studies feature a high construct validity as the participants comment on their previous answers (Okoli and Pawlowski, 2004). Reliability is ensured by rigorous study design and documentation as well as pre-testing the single questionnaires (Okoli and Pawlowski, 2004). These drivers of validity and reliability are part of our study design and conduction to ensure high quality results.

This study adheres to a typical three-round structure which encompasses (1) open questions in order to comprehensively map the methods and theories (Sarkis et al., 2011; Brandenburg et al., 2014) as well as fields of application of qualitative and quantitative approaches, (2) closed questions to narrow them down to the core, and (3) an investigation of differences and integration potentials among the approaches. Round 1 was completed and the results are currently being analyzed and interpreted to prepare round 2.

The addressees of the study were systematically identified according to clearly defined selection criteria in the following steps. Authors of research articles in SSCM had to be listed as a first author in the paper samples of at least 2 of 22 analyzed literature review papers on SSCM published between 2008 and 2017. The consideration of only the first author of a sample papers ensures that the identified person is familiar with the topic. Moreover, in this way, both researchers and practitioners, who once published a research article but are now in-active researchers, are considered as source of expert knowledge with regard to their opinion on and perception of the current use and future potential of theories, methods, and application contexts in SSCM research. Finally, further experts that were recommended by the identified experts could be included. This is a valid approach to populate the panel (Okoli and Pawlowski, 2004), as deeming that the answers given by the initially identified experts are valid, then it is valid to trust their recommendations for further experts.

The first round questionnaire does not introduce definitions of SSCM, OM, and OR at the start of the questionnaire to avoid bias that would result in a mental limitation of what theories, methods, and application contexts play a role for SSCM research. Hence, the definitional scope shall be determined inductively to frame the role of OM and OR for SSCM. This induction is captured via a cluster analysis which groups the respondents according to their answers regarding their use of quantitative and qualitative research methods (see Table 3).

Results

In this section, we present general information about the panel, the possible clusters and, subsequently, about the results relating to theories, methods, and applications as well as the TBL dimensions, multi-tier SCM, and current academic discussion highly relevant for future SSCM research.

Information about participants

In total, 104 participants completed the first round questionnaire. Table 1 gives an overview about characteristics of the respondents. It includes the number of years in academia (including PhD years), years in industry/praxis, the last year being involved in SSCM-related research, the familiarity with SSCM, and the institutional sector of current occupation. The descriptive information about the participants helps to consider the respondents' expertise, which can be estimated based on the responses on, e.g., the degree of familiarity with SSCM-related topics in research and practice. The results are displayed in quartiles to show the structure of the data and reveal focal points within the single characteristics.

The results in Table 1 show that the median of years in academia (15) and praxis (2.5) are highly different and that 75% of the respondents have spent 5 years or less in industry. This is clearly a limitation of the study, which is however natural to the choice of experts via publications. Moreover, the vast majority of respondents (77%) is currently conducting SSCM research and the familiarity with SSCM (rated on 10 point Likert scale; 0=“completely new to me”; 10=“my area of expertise”) is very high with a median of 8 and the final quartile exclusively covering respondents with maximum familiarity. These results underline the expertise covered by the expert panel which drives the validity of the study results (Häder, 2014). These figures furthermore validate the expert selection process.

Table 1 – Characteristics of respondents (n=104)

Quartiles	25% limit	50% limit	75% limit
Years in academia (incl. PhD years)	10	15	22
Years in industry/praxis	1	2.5	5
Last year involved in SSCM research	2017	2017	2017
Familiarity with SSCM	7	8	10 – “my area of expertise”
Institutional sector of current occupation	100x Academia; 7x Industry; 1x NGO; 1x GO, 1x others (multiple choice possible)		

As the study aims at differences in SSCM according to the use of qualitative or quantitative methods, we have checked the characteristics against the use of research methods by means of a Kruskal-Wallis-Test for multiple independent groups. As this has not revealed statistically significant differences in the characteristics, they are presented for the entire panel as one.

Block 1: Research approaches employed by the respondents

Table 2 displays the regularity of usage with regard to qualitative/quantitative and theoretical/empirical research approaches. Quantitative studies with both theoretical and empirical orientation as well as qualitative-empirical research are equally distributed as most used research approaches. Qualitative-theoretical studies are less frequently used.

Table 2 – Usage of qualitative/quantitative and theoretical/empirical research approaches

Q1 items	Usage	Quantitative-Empirical		Quantitative-Theoretical		Qualitative-Empirical		Qualitative-Theoretical	
1	Most used	31	30%	33	32%	28	27%	16	15%
2	2 nd most used	23	22%	11	11%	34	33%	29	28%
3	3 rd most used	19	18%	7	7%	22	21%	30	29%
4	4 th most used	10	10%	14	13%	8	8%	11	11%
5	not used	21	20%	39	38%	12	12%	18	17%
		104	100%	104	100%	104	100%	104	100%

The items above were transformed into a three-level ordinal scale (1 and 2 = “high use”; 3 and 4 = “low use”; 5 = “no use”) for each respondent and fed into a K-means cluster analysis. Solutions for a minimum of 2 and a maximum of 6 clusters were calculated. Based on the homogeneity of cluster sizes, logical cluster interpretability and the results of a related ANOVA, a three-cluster solution was selected. The clusters and

the driving differences in the research approaches identified in the ANOVA are presented in Table 3.

As shown in Table 3, the use of quantitative theoretical approaches is the main driver of the clustering. The modeling cluster exclusively encompasses those 21 respondents which employ these approaches most, while largely bypassing quantitative empirical research. Contrastingly, the qualitative cluster covers all 39 respondents, who do not use quantitative theoretical methods at all. The quantitative cluster represents a mixed group of 44 researches which all combine theoretical and empirical quantitative methods. The qualitative methods were all applied in all intensities across all clusters and are thus not displayed here.

Table 3 – Use of research approaches in the clusters (n=104)

Clusters	Quantitative n=44	Qualitative n=39	Modeling n=21
Research approaches			
Quant_emp_high	31	23	0
Quant_emp_low	13	8	8
Quant_emp_no	0	8	13
Quant_theo_high	23	0	21
Quant_theo_low	21	0	0
Quant_theo_no	0	39	0

These three clusters are used as a basis for the systematic evaluation of theories, methods, and applications in the following rounds of the study. This aims at using the identified panels for generating and validating implications for further research in the individual panels and overarching integration avenues for shaping a more coherent body of research in SSCM.

Block 2: Theories, methods, and application contexts

In the following block of three open questions, the experts were asked to list up to 5 (1) application contexts, (2) theories, and (3) methods or theoretical problems they perceive as highly relevant for future SSCM-related research. The individual answers were collected and content analyzed along different deductively and inductively built categories in order to process the wide variety of answers into a consolidated list, i.e., the aim of the first round (Okoli and Pawlowski, 2004). These lists will be systematically rated by all respondents in the next round, which will then enable statistical tests against the three clusters of respondents.

The answers for the application contexts are classified according to Brandenburg et al. (2014) into either industry sectors or functional application areas, while some categories are inductively built in the course of data consolidation. Table 4 lists the five most prominent items per category and distinguishes between respondents who allocate themselves predominantly as OM-related (66 % of the panel) or OR-related (34% of the panel) researchers.

Table 4 – Application contexts perceived highly relevant for future SSCM research

Industry Sector			Operational Functions		
Industry	OM	OR	Function	OM	OR
Food	19	8	Logistics	13	12
Logistics	14	12	R&D	3	4
Automobile	16	7	SCM	4	3
End-consumer products in general	10	7	Waste management in general	5	1
Electrical and electronics	9	5	Recycling	2	4

Apart from the industry sectors and operational functions, some respondents listed application topics relating a macroscopic level of analysis. The most often mentioned topics are SSCM in emerging economies, sustainable urban logistics, circular economy, waste and energy management.

The second question addressed theories and theoretical problems for future SSCM research. The content analysis of the answers was oriented along Sarkis et al. (2011), who elaborated on a range of organization theories in GSCM research, as well as Brandenburg et al. (2014), who systematize modeling approaches in SSCM research. Table 5 lists the five most prominent items per category mentioned by the OM- and OR-related experts. Institutional theory, resource-based view, network, and stakeholder theory are mentioned by a considerable number of respondents, followed by resource dependence theory. These findings widely match the findings of Toboulic and Walker (2015), who found the resource-based view, stakeholder, institutional and transaction cost theory among the predominantly used theoretical lenses, whereas network theory was only marginally found in their sample. According to our findings, network theory is ranked first by the OR-related experts and fourth by the OM-related researchers. This is in stark contrast to the findings by Toboulic and Walker (2015), thus, we see that network theory is of rising relevance for future SSCM research.

Table 5 – Theories and theoretical/mathematical problems perceived highly relevant for future SSCM research

Theories (T.)			Theoretical / Mathematical Problems (P.)		
Theory	OM	OR	Problem	OM	OR
Institutional T.	18	2	Optimization P. in general	1	9
Resource-Based View	15	4	Planning & Scheduling P.	5	3
Network T.	9	9	Vehicle/Production Routing P.	2	5
Stakeholder T.	13	4	Location P.	2	3
Resource Dependence T.	8	-	Allocation P.	1	3

The third question covered the qualitative and quantitative methods that are perceived highly relevant for future SSCM research. Table 6 shows that even though quantitative approaches prevail, a remarkable number of responses relate to qualitative-empirical approaches. Case studies, as hybrid method research designs that may avail of both qualitative and quantitative approaches, are mentioned by a considerable number of respondents. Optimization and programming models, analytical models, and simulation models are equally often mentioned as quantitative approaches, while analytical and simulation models are predominantly addressed by OM-related experts. Still, the approximate 2 to 1 ratio among OM and OR scholars mirrors the total number of OM and OR-related respondents in the panel.

Table 6 – Methods perceived highly relevant for future SSCM research

Qualitative Methods			Quantitative Methods		
Method	OM	OR	Method	OM	OR
Action Research	15	1	Optimization / Programming	4	16
Interview	9	-	Survey (Statistics)	16	3
Ethnography	6	1	Analytical Models	13	6
Conceptual	5	1	Simulation Models	12	7
Focus Groups	5	-	Heuristics	3	4

Block 3: Maturity and future relevance of TBL dimensions and SC levels of analysis

Ever since its definition, two major debates are evident in the field of SSCM. The first one on which dimensions of the TBL should be investigated (Seuring and Müller, 2008b) and the second one on which SC level of analysis to use (e.g., Mentzer et al., 2001). This Delphi study thus includes individual closed questions on the maturity and future relevance of the TBL dimensions as well as five generic types of SC definitions. In both cases, the participants have been asked to rate the issues on a five-point Likert scale (1-very low; 5-very high). The results are first presented for the entire panel in Tables 7 and 8, before the results of a statistical comparison of the clusters is outlined.

Table 7 – Maturity and future relevance of TBL dimension in SSCM

	Maturity		Future relevance	
	Mean	StanDev	Mean	StanDev
Financial	3.82	1.08	4.05	0.82
Non-financial	3.39	0.99	4.01	0.85
Social_within the SC	2.54	0.96	4.11	0.79
Social_external to the SC	2.21	0.98	3.84	0.96
Environmental_focus on inputs	3.57	0.96	4.33	0.73
Environmental_focus on outputs	3.68	0.96	4.30	0.81

As shown in Table 7, all TBL dimensions have been rated as highly relevant with the social dimensions external to the SC as the lowest ranking. The same item is rated with the lowest maturity, implying a substantial need to develop the issue further, as it is seen as relevant in future SSCM research. Looking at the other dimensions, there is a striking evidence for the maturity as well as high relevance of economic and environmental research in SSCM. In total, the environmental dimension is seen as the most relevant in future SSCM. This is related to systems thinking approaches, which see a sound environmental dimension as an essential precursor of the other two dimensions which are inherently relying on environmental factors.

(S)SCM has traditionally researched dyadic buyer-supplier relationships but is currently at the verge of extending its scope to more complex units of analysis (Choi and Wu, 2009; Mena et al., 2013). The ratings on the maturity and future relevance of SC levels of analysis in SSCM are displayed in Table 8.

Table 8 – Maturity and future relevance of SC levels of analysis in SSCM

SC unit of analysis	Maturity		Future relevance	
	Mean	StanDev	Mean	StanDev
Intra-organizational	3.75	1.01	3.55	0.92
Linear dyadic SC	3.62	0.94	3.72	0.86
Linear multi-tier SC	2.66	1.08	4.06	0.87
Dyadic supply network	2.80	0.97	3.91	0.92
Multi-tier supply network	2.38	1.06	4.10	0.87

The future relevance of all items is rated high in the upper third of the scale. The main differences become evident in the maturity domain. Here we see a high maturity for the “traditional” levels of analysis, i.e., the organization itself as well as the dyadic SC. The more complex levels of analysis have been rated considerably less mature but relatively more relevant in the future. According to these results, we labelled the two traditional levels as the “core levels of SSCM analysis” and the bottom three levels as the “research

frontier levels of SSCM analysis”. Among the “research frontier levels” it is clearly the multi-tier supply network which shows the largest gap among maturity and future relevance. We thus see it as the most promising level of analysis, which however brings up the biggest challenges in terms of data collection research designs (Choi and Wu, 2009).

An ANOVA of the three clusters revealed statistically significant differences in the ratings among those. As displayed in Table 9, there is a significantly higher rating of the maturity of the “research frontier levels of SSCM analysis” among the more quantitative clusters. Contrastingly, the relevance of social issues in the SC is regarded significantly lower in the modeling cluster. Still, the relevance rating for the social dimension is comparably high in both groups.

Table 9 – Statistically significant differences in ratings among those experts conducting quantitative-theoretical research and those who do not (ANOVA; n=104)

	Mean Values			Sign.
	Qualitative	Quantitative	Modeling	
Maturity of				
Linear multi-tier SC	2.184	2.864	3.095	0.002
Dyadic supply network	2.447	3.023	2.952	0.014
Multi-tier supply network	1.921	2.628	2.700	0.003
Future relevance of				
Social_within the SC	4.359	4.045	3.750	0.008
Social_external to the SC	3.946	3.977	3.350	0.028

Table 9 delivers two implications: Either the groups can learn from each other in terms of how to research a complex SC, as suggested in the research cycle (Meredith, 1993) or the groups differ in their research so much, that the more qualitative researchers see some kind of a “longer way to go”. The same seems to apply for the future relevance of social issues in the SC.

Block 4: Academic discussions perceived highly relevant for future SSCM research

The academic discussions perceived highly relevant for future SSCM research have been coded inductively. The discussions mentioned by at least five respondents are displayed in Table 10.

Table 10 – Current academic discussions perceived highly relevant for future SSCM research

Rank	Highly relevant discussions	Total	Rank	Highly relevant discussions	Total
1	Goal conflicts	20	9	Stakeholder management	8
2	Social sustainability	15	10	CLSCM	6
3	Collaboration	13	11	Multi-Tier SCM	6
4	Business/SC strategy	12	12	Practical impact	6
5	Environmental sustainability	10	13	Procurement	6
6	Measurement	10	14	Risk management	6
7	ICT/Big Data	10	15	Emerging countries/BoP	5
8	Circular economy	8	16	Formal models	5

From a methodological point of view, the use of formal models and, moreover, the overall practical impact of SSCM research are mentioned as key themes. While risk management, emerging countries/Base of the Pyramid (BoP), multi-tier, and closed-loop SCM (CLSCM) are described by only a couple of respondents, several highly relevant discussions appear to be at the forefront of the current academic discourse. Stakeholder

management, the circular economy, the use of information and communication technology (ICT)/Big Data, measurement, business/SC strategy, and collaboration are identified as highly relevant for future SSCM research. Moreover, social sustainability is perceived as more relevant for future research than environmental aspects. Finally, goal conflicts between economic, environmental, and social sustainability objectives is clearly the most important discussion.

Conclusion and next steps

The paper at hand presents the findings of the first round of a Delphi study on theories, methods, and applications contexts in SSCM research. The findings build the basis for the systematic evaluation of the dominant and underrepresented theories, methods, and application contexts in qualitative and quantitative SSCM research. Regarding the maturity and relevance of TBL dimensions and SC levels of analyses, the experts see a clear need for driving the social dimension and extending the scope of researched SC complexity. However, this need is perceived stronger by qualitative researchers in SSCM, while the maturity for complex SC levels of analysis is significantly higher in the quantitative domain.

In the end, the completed Delphi study is supposed to provide a basis to derive guidelines for future SSCM research and a more coherent body of research, ultimately aiming at contributions relevant to academia and praxis. Recent studies particularly called for linking conceptual, empirical, and formal modeling research methods, and, furthermore, to elaborate ways to operationalize the TBL dimensions of sustainability, stakeholder influences, and risks in SSCM (see, e.g., Rebs et al., 2017; Reefke and Sundaram, 2017). Moreover, empirical studies based on or supported by quantitative models with regard to the industry specifics of sustainable SCs should be envisaged to give managerial recommendations for different industrial sectors (Rebs et al., 2017).

Research approaches in the relatively young field of SSCM need to be continuously revised and refined to capture the complexities between economic, environmental, and social aspects in SCs. The integrative consideration of qualitative and quantitative methods will strengthen the validity and impact of SSCM research in both academia and praxis. This study enables a structured debate by engaging the researchers in the field, i.e., the very nucleus of the current split of approaches.

At the same time, this focus on researchers represents one of the major limitations of the study. While the expert panels show high ratings on familiarity with SSCM, current engagement in SSCM research as well as on average 15 years of experience in academia, there is a lack of industry experience in the panel. The research activities of the respondents ensure some contact to practitioners, however this limits the results of the study to academic issues. Still, these academic issues are at the heart of this research.

As next steps, the questionnaire for the second survey round needs to be designed so that the consolidated data from round 1 can be re-evaluated by the participants. Possible questions include the estimation of the maturity and future relevance of frequently mentioned theories, methods, and application contexts. In addition, drivers and barriers with regard to the researchability with either qualitative or quantitative approaches could be assessed. Finally, the different ratings of the TBL dimensions and SC levels of analysis might be investigated in more detail.

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