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A Review of Supply Chain Risk Management: Definition, Theory, and Research Agenda

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A Review of Supply Chain Risk Management: Definition, Theory, and Research Agenda

Abstract

Purpose: To review the extant literature on supply chain risk management (SCRM, including risk identification, assessment, treatment, and monitoring), developing a comprehensive definition and conceptual framework; to evaluate prior theory use; and to identify future research directions.

Design/methodology/approach: A systematic literature review of 354 articles (published 2000-2016) based on descriptive, thematic, and content analysis.

Findings: There has been a considerable focus on identifying risk types and proposing risk mitigation strategies. Research has emphasised organisational responses to supply chain risks and made only limited use of theory. Ten key future research directions are identified.

Research implications: A broad, contemporary understanding of SCRM is provided; and a new, comprehensive definition is presented covering the process, pathway, and objectives of SCRM, leading to a conceptual framework. The research agenda guides future work towards maturation of the discipline.

Practical implications: Managers are encouraged to adopt a holistic approach to SCRM. Guidance is provided on how to select appropriate risk treatment actions according to the probability and impact of a risk.

Originality/value: The first review to consider theory use in SCRM research and to use four SCRM stages to structure the review.

Keywords: Supply chain risk, Supply chain risk management (SCRM), Risk management, Systematic literature review (SLR), Theory

Paper type: Literature review

Introduction

Various industrial trends, including outsourcing, supply base reduction, just-in-time, and shorter product life cycles have increased firm exposure to supply chain risks (SCRs) (Colicchia and Strozzi, 2012; Trkman *et al.*, 2016). These risks may result from man-made problems or natural disasters, and can have major consequences for organisations, including financial and operational problems, potentially leading to business discontinuity (Craighead *et al.*, 2007; Rajesh *et al.*, 2015). Within the SCR literature, supply chain risk management (SCRM) has become a key area of interest. SCRM is aimed at developing strategies for the identification, assessment, treatment, and monitoring of risks in supply chains (e.g. Neiger *et al.*, 2009; Tummala and Schoenherr, 2011; Ho *et al.*, 2015), yet several gaps in knowledge exist. From a conceptual perspective, researchers are yet to agree on a definition of SCRM, with the literature stressing its multifaceted and complex nature (Sodhi *et al.*, 2012; Ho *et al.*, 2015). From a theoretical perspective, it is unclear how theories have been used in the extant literature to further our understanding of SCRM. And from an integrative perspective, knowledge gathered along narrow functional disciplines (such as purchasing and logistics) needs to be consolidated to advance SCRM research and create a coherent knowledge framework.

We contend that in order to develop a better understanding of the above-mentioned issues, a systematic review of the current state-of-the-art is needed. While there have been several recent reviews, these have only partially addressed conceptual issues and have not systematically examined how theory has been used. For example, there have been 15 'traditional' (non-systematic) literature reviews in the last decade (e.g. Tang and Musa, 2011; Ho *et al.*, 2015). While valuable, these studies have either been based on a limited number of articles, e.g. 55 articles in Rao and Goldsby (2009) and 138 articles in Tang and Musa (2011), or have had a specific focus, e.g. on quantitative models (e.g. Tang, 2006; Heckmann *et al.*, 2015) or a particular industry (e.g. Aloini *et al.*, 2012; Boyson, 2014). An exception is the review of SCRM research between 2003 and 2013 by Ho *et al.* (2015). But the SCRM field is so rapidly growing that 138 papers have been published since 2013. There have also been five systematic literature reviews (SLRs) – a type of structured approach to conducting a literature review (Denyer and Tranfield, 2009; Saenz and Koufteros, 2015) – on SCR. Yet similar observations regarding size and scope apply to these SLRs, which have either been based on a limited number of articles, e.g. 55 articles in Colicchia and Strozzi (2012) and 86 articles in Kilubi (2016), or had a narrow focus, e.g. on price risk (Fischl *et al.*, 2014) or quantitative models (Fahimnia *et al.*, 2015). Again,

none of these reviews have given particular attention to theory. It is therefore argued that a new SLR on SCRM is needed. The objectives of this review are to:

1. Provide a comprehensive definition of SCRM;
2. Present a state-of-the-art assessment of SCRM research across four SCRM stages (i.e. risk identification, assessment, treatment, and monitoring); and,
3. Assess the use of theory in SCRM research.

The remainder of this paper is organised as follows. The SLR approach is first outlined followed by the development of a new, comprehensive definition of SCRM and a conceptual framework. General descriptive statistics are then presented before the extant literature is classified and analysed according to the four SCRM stages. Theory use is then assessed before future research directions are identified; finally, conclusions are provided.

Methodology

A seven-stage systematic literature review process has been followed, as illustrated in Figure 1 and described below.

[Take in Figure 1]

Stage 1 – Question Formulation

This review seeks to address the research questions included in Figure 1. The questions guide the review, defining which studies to include and what data to extract (Denyer and Tranfield, 2009). As suggested by Tranfield *et al.* (2003), multiple researchers have been involved to reduce subjective bias.

Stage 2 – Keyword Search

Two search engines were used: Business Source Complete (EBSCO host) and Web of Science. These two databases provide arguably the best coverage of operations and SCM, and they are commonly used in literature reviews. The search terms 'supply chain' AND 'risk' were used, as adopted by Ho *et al.* (2015), for the title, abstract, keywords, and thereafter main text. We have adopted a unionist perspective (Larson and Halldorsson, 2004) whereby 'logistics' is considered part of SCM. Therefore, the term 'supply chain' was used for our search instead of 'logistics'. Logistics risk is considered to be one type of SCR; similarly, we did not search individually for quality risk, price risk, etc. These broad terms ensured papers adopting alternative nomenclature were identified. As a first proxy for quality, only international scholarly peer-reviewed articles were selected. Further, the

search was limited to articles published 2000-2016 to provide a contemporary perspective on the phenomenon. This returned 5,412 articles.

Stage 3 – Removing Duplicates

After removal of duplicates, the number of articles was reduced to 4,150 papers.

Stage 4 – Article Quality and Relevance

As a second proxy for quality, articles published in journals not included in the 2015 ABS list were eliminated. This approach was also adopted by Ghadge *et al.* (2012) using an earlier version of the list. Irrelevant studies, including on accounting and economics, and less relevant papers on topics other than SCRM, including those focused on supplier selection and outsourcing, were also removed. The retained papers mainly included a focus on at least one SCRM stage. To ensure the spotlight remained on SCRM, articles that focused on related concepts, such as uncertainty, disruption, and resilience were only retained if they explicitly employed SCRM practices. Overall, this reduced the database to 345 papers.

Stage 5 – Capturing Other Relevant Articles

To identify other relevant work that had not been captured, the references of the 345 papers were checked, resulting in a further 5 articles. An additional search for completeness was conducted in Google Scholar but retrieved only a further 4 articles, thereby confirming the previous steps were appropriate. Thus, the final database contains 354 articles.

Stage 6 – Full-text Analysis and Coding

In addition to basic bibliographic information (e.g. author(s), year, and journal), the 354 papers were coded in NVivo according to: country context; industry sector; theory; type of theory use; research perspective; research method; and SCRM (including risk identification, assessment, treatment, and monitoring). As an example, research perspective was broken down into four sub-codes: supplier's perspective, buyer's perspective, dyadic perspective, and triadic perspective. Some of the analysis was clearly deductive (e.g. categorisation according to developed *vs.* developing country), while others (e.g. enablers of risk mitigation strategies and evaluation of strategies) were more inductive (i.e. emerging from the papers). Multiple researchers were involved in determining and validating the final set of codes.

Stage 7 – Reporting

After SCRM has been defined below, the general descriptive and thematic analysis are reported, respectively.

Defining SCRM and Proposing a Conceptual Framework

Existing definitions of SCRM, summarised in Table I, can be divided into three categories of characteristics.

[Take in Table I]

SCRM Process

It has been suggested that risk identification, risk assessment, risk treatment, and risk monitoring represent the four main stages of the SCRM process (Zsidisin *et al.*, 2005; Hachicha and Elmsalmi, 2014). This is in accordance with the main stages defined in ISO 31000 (2009), an alternative approach. These four stages have been used to classify the definitions of SCRM in Table I.

Pathway to SCRM

Several definitions highlight the importance of selecting and implementing appropriate SCRM strategies (Faisal *et al.*, 2007; Manuj and Mentzer, 2008b). This is broadly referred to as the pathway to SCRM; and includes external coordination and collaboration among supply chain partners, and the internal implementation of SCRM strategies.

Objective of SCRM

Several definitions refer to the objective(s) of SCRM (e.g. Wieland and Wallenburg, 2012). For example, from a financial perspective, SCRM involves cash-flow management to ensure profitability (e.g. Faisal *et al.*, 2007) and to save costs (Manuj and Mentzer, 2008b). From a business continuity perspective, SCRM manages exposure to serious business disruptions arising from risk within and outside the supply chain. In this sense, SCRM aims to build the capability to reduce vulnerability and ensure business continuity (Jüttner, 2005; Goh *et al.*, 2007; Wieland and Wallenburg, 2012). When a firm is better able to manage risks than the competition, it can lead to an improved market position. Thus, SCRM aims not only to reduce costs and vulnerability but also to ensure profitability, business continuity, and potentially longer-term growth.

A New Definition of SCRM

SCRM is a multi-faceted concept. As a result, different researchers have defined SCRM in

different ways. Some emphasise the pathway and objectives of SCRM but do not pay explicit attention to the SCRM stages (Norrman and Jansson, 2004; Tang, 2006). Ho *et al.* (2015) and Wieland and Wallenburg (2012) meanwhile took a holistic view, incorporating the four stages of SCRM, but they omitted either the objectives or the pathway to SCRM. Others have only included a subset of the SCRM process; for example, Lavastre *et al.* (2012) highlighted risk assessment in particular but ignored the characteristics of the pathway to SCRM and the objectives of SCRM.

The above calls for a new, comprehensive definition that is: (i) internally consistent, so SCRM can reflect both the nature of risk management and SCM, providing researchers from different fields with a common understanding of SCRM; and, (ii) externally consistent, so researchers can guide their work towards solving real business problems. Our definition is therefore:

> *The identification, assessment, treatment, and monitoring of supply chain risks, with the aid of the internal implementation of tools, techniques and strategies and of external coordination and collaboration with supply chain members so as to reduce vulnerability and ensure continuity coupled with profitability, leading to competitive advantage.*

This definition reflects the full SCRM process, the pathway to SCRM, and the objectives of SCRM. It is a holistic definition that denotes the positive outcome of managing negative forms of SCR, eventually resulting in competitive advantage, and it offers a conceptualisation embedded in Figure 2 that integrates Objectives-based, Process-based, and Outcome-based thinking into one (OPO-based) framework. The conceptual framework helps understand the objectives of SCRM that motivate a firm to select and implement strategies in the SCRM process while also investigating how internal and external pathways influence SCRM practices and their outcomes from a holistic viewpoint.

[Take in Figure 2]

Descriptive Analysis

General Trends in the Literature

Figure 3 illustrates the number of articles (out of 354) published on SCRM annually since 2000. It shows the high growth rate of the field, with the number of papers increasing year-on-year since 2005, with the exception of 2010 and 2015. Only 8% of articles were

published 2000-2005; 24% were published 2006-2010; and 68% were published 2011-2016. As shown in Figure 4, 51% of articles were published in 9 key journals, including the *International Journal of Physical Distribution & Logistics Management,* with the other (approximately) half scattered across 60 journals, e.g. *Decision Sciences* and *Management Science*.

[Take in Figure 3 and Figure 4]

Country & Industry Sector

Among the 354 papers, 124 referred to the country context (either a single country or multiple countries), as shown in Table II. Most work is conducted in a single country (106 of 124). Further, most work is in a developed country context (69 papers), such as the UK (e.g. Johnson *et al.*, 2013; Roehrich *et al.*, 2014) or USA (e.g. Ellis *et al.*, 2010), with 48 papers focused purely on a developing country context.

[Take in Table II]

Many studies focused on a specific industry (115 papers) or industries (70 papers), as shown in Table II. The most studied sectors are automotive (e.g. Blackhurst *et al.*, 2008; Ceryno *et al.*, 2015), manufacturing (e.g. Schoenherr *et al.*, 2008; Ellinger *et al.*, 2015), and food (e.g. Jensen *et al.*, 2015). The nature of the risks and most suitable management practices may differ across countries and industries; hence, there is scope to further our understanding of SCRM by considering other contexts.

Research Perspective

Table II also summarises the research perspective adopted (for 115 out of 354 papers). The most dominant approach has been to adopt a buyer perspective (88 papers). Only 5 papers were from the supplier's perspective (e.g. Ojala and Hallikas, 2006). Studies from a dyadic or triadic perspective are also few (e.g. Simangunsong *et al.*, 2016), which may reflect the difficulty of data collection across multiple actors in the same network. More studies from a supplier perspective or that obtain multiple perspectives would help further our understanding of SCRM.

Research Method

As shown in Table III, 99% of papers have employed one research method in a single paper while 1% presented a mixed methods approach. Among single research method papers, 167 papers are based on empirical data, mainly the (single or multiple) case study (103 papers) or survey method (55 papers). In addition, 63 conceptual studies and 113 analytical studies

based on quantitative analysis were found. The use of secondary data has been limited, with only 7 papers included. There is scope to use a broader range of research methods, including innovative approaches, to further our understanding of SCRM.

[Take in Table III]

Thematic Analysis: The SCRM Process

In total, 339 (out of 354) papers on SCRM explicitly refer to at least one SCRM stage, while the remainder contribute to our general understanding of SCRM (e.g. Sodhi *et al.*, 2012). According to Table IV, most papers have focused on a single stage, developing a narrow but deep understanding. The majority focus has been on risk treatment, and particularly on risk mitigation approaches to treating risk, while least attention has been on risk monitoring. Only 6 papers (Norrman and Jansson, 2004; Sinha *et al.*, 2004; Zsidisin *et al.*, 2005; Manuj and Mentzer, 2008a; Tummala and Schoenherr, 2011; Lavastre *et al.*, 2012) considered all four stages (i.e. a holistic approach). Where papers cover two (or three) stages, most work has logically focused on consecutive stages (e.g. Tsai *et al.*, 2008; Chang *et al.*, 2015), except some (40 out of 339 papers) that 'jump' from risk identification to risk treatment without substantial coverage of risk assessment (e.g. Ceryno *et al.*, 2015).

[Take in Table IV]

Risk Identification

Risk identification aims to discover all relevant risks (Kern *et al.*, 2012) and recognise future uncertainties to manage them proactively. This stage is critical to the success of managing SCRs (Neiger *et al.*, 2009) – only by identifying a risk can any risk management activity be triggered. This implies an early judgement is needed in risk identification to decide whether a risk is relevant and thus should be further assessed or mitigated (Enyinda *et al.*, 2010). Hence, risk identification needs to follow a comprehensive approach to identifying all potential supply chain threats and vulnerabilities (Kern *et al.*, 2012).

Drivers of SCR

Drivers of SCRs include probability and impact drivers. Probability drivers are competitive pressures with risk-source implications (Ritchie and Brindley, 2007) that might increase or decrease supply chain vulnerability (Wagner and Bode, 2006). For example, a focus on efficiency by applying lean approaches can make a supply chain vulnerable (Thun and Hoenig, 2011). Impact drivers are conditions with risk-consequence implications (Sinha *et al.*, 2004; Wagner and Bode, 2006) that affect the magnitude of loss (e.g. standardised

contracts and supplier dependence). Some risk drivers, including withholding information (Sinha *et al.*, 2004), partnerships, and other close relationships (Li *et al.*, 2015; Chen *et al.*, 2016), can be both probability and impact drivers. By understanding these drivers, not only can SCRs be identified but, more crucially, risk treatment plans can be designed that remove both probability and impact drivers.

Types of SCR

Approximately 26% of the articles (91 out of 354) have included a focus on risk identification. Disagreements over how to classify risks are influenced by the fact that most empirical research is context-specific and the data are collected from diverse industries and countries. There are studies that produce extensive lists of risk types (18 papers) but without further classification of the risks (e.g. Olson and Wu, 2011; Lavastre *et al.*, 2014). There are others that suggest classification schemes (20 papers) but without identifying the specific risks in each category (e.g. Matook *et al.*, 2009). And there are studies (53 papers) that integrate the two, listing the potential risks in each category (e.g. Faisal *et al.*, 2007; Christopher *et al.*, 2011; Rangel *et al.*, 2015). This indicates that most scholars have been aware of two phases of risk identification, i.e. risk listing and categorising; however, research has failed to identify inter-relationships between risks and risk categories.

SCR Identification Strategies

There are many approaches in the literature for identifying risks. Some have been proposed by researchers but not yet applied; some have been proposed and applied by researchers; and there are some with evidence of use in practice by companies. Whereas research has focused on relatively complex approaches to risk identification, e.g. via the analytical hierarchy process (AHP) (Gaudenzi and Borghesi, 2006) and the value-focused process engineering (VFPE) methodology (Neiger *et al.*, 2009), practitioners appear more focused on simple and established methods (e.g. the Ishikawa diagram and value stream mapping). Kayis and Karningsih (2012) developed and applied a risk identification tool known as the supply chain risk identification system (SCRIS), but there is no evidence of this being routinely applied by practitioners themselves. The cause-effect diagram appears to be the only technique applied by both researchers (Lin and Zhou, 2011) and practitioners (Lavastre *et al.*, 2012). It remains to be seen how some of the methods proposed by researchers perform in practice (e.g. versus simpler approaches) and whether they would be independently applied by practitioners. It may therefore be important to find a way of bridging the gap between the methods advocated by research and routinely adopted in

practice.

Risk Assessment

Effective SCRM requires a comprehensive yet rapid and cost-efficient assessment (Zsidisin *et al.*, 2004) of SCRs. Risk can be assessed using data (if available) or expert judgement and scenarios (Cohen and Kunreuther, 2007). This means risk assessment can be formal or informal and quantitative or qualitative (Zsidisin *et al.*, 2004). Gaudenzi and Borghesi (2006) argued risk assessment is inherently subjective as each analyst has his/her own concept of what constitutes a risk and of the nature of upstream/downstream relationships. Tsai *et al.* (2008) concluded that combining objective data and subjective perception might result in a more robust construction of risks, which in turn would improve the effectiveness of risk prediction and assessment. In assessing risk, the following factors should be considered.

SCR Prioritisation

Risk prioritisation helps organisations identify the most significant risks. High priority might be given to risks that have a high degree of impact or that can be mitigated immediately (Sinha *et al.*, 2004). Developing and implementing risk treatment actions involves considerable investment, and it is unlikely that a company will be able to deal with all possible risks. Risk prioritisation therefore helps decide which risk types to develop actions against, allowing a firm to manage its limited risk treatment resources (Zsidisin *et al.*, 2004). So far, researchers have attempted to prioritise risks mainly in the process of uncovering risk inter-relationships (e.g. Hachicha and Elmsalmi, 2014; Govindan and Chaudhuri, 2016) or by applying risk assessment tools, such as failure modes and effects analysis (FEEA) (e.g. Bradley, 2014) and the analytic hierarchy process (AHP) (e.g. Mu and Carroll, 2016).

SCR Inter-relationships

A risk event is rarely an isolated incident; there are often inter-relationships with other risks and the impact of risks can be felt across the supply chain (Kayis and Karningsih, 2012). Understanding knock-on effects and inter-relationships helps with risk prioritisation, assessing the criticality of supply risks (Guertler and Spinler, 2015), creating risk treatment plans (Chopra and Sodhi, 2004), and implementing effective risk management activities (Sarker *et al.*, 2016). Yet few studies (e.g. Hachicha and Elmsalmi, 2014; Venkatesh *et al.*, 2015) have applied structural modelling tools to identify risk inter-relationships. Hachicha

and Elmsalmi (2014) and Venkatesh *et al.* (2015) did however apply interpretive structural modelling (ISM) and MICMAC (Matriced Impacts Cruoses Multiplication Applique a un Classement) analysis in the food and apparel industries, respectively to show the inter-relationships between risk sources and variables. The central idea is to determine the most critical risk that may give rise to multiple risks, resulting in a domino effect (Venkatesh *et al.*, 2015). Sarker *et al.* (2016) further uncovered and classified different types of dependences amongst various risks into positive dependence (i.e. where removing one risk helps mitigate one or several risks) and negative dependence (i.e. where removing one risk may create one or several other risks). Further empirical research is needed to reveal more complex inter-relationships as removing one risk might help mitigate certain risks whilst simultaneously creating others.

SCR Assessment Strategies

Out of the 354 papers, 76 advocated, implemented or reported on an industrial application of a risk assessment strategy. Much of this work has focused on formalised tools for SCR assessment, such as bayesian belief networks (BBN) (Nepal and Yadav, 2015). But the most popular method applied by both researchers and companies is the probability-impact (P-I) risk matrix. This was advocated by, e.g. Blackhurst *et al.* (2008), applied in practice through research by, e.g. Chang *et al.* (2015), and used by Marks & Spencer (Khan *et al.*, 2008).

Although many studies have discussed risk assessment strategies, there are still areas in need of further study. First, assessments of risk should take into account intangible, non-regulated consequences and losses. For instance, credibility, reputation, status, authority, and trust can be damaged if a risk is realised (Roehrich *et al.*, 2014). These immaterial consequences are often overlooked by researchers. Second, managers often assess probability based on their own experience and companies' performance, but it is important to consider how other indicators or signals of change in the business environment can be incorporated (Hora and Klassen, 2013). Third, a broader supply chain understanding of risk is needed; for example, not only do direct risks need to be assessed, the potential causes or sources of those risks also need to be examined at every significant link along the chain (Wever *et al.*, 2012).

Risk Treatment

The literature adopts various terms for the types of risk treatment actions available, influenced by the business context under study (e.g. Diabat *et al.*, 2012; Lavastre *et al.*,

2014). In the following, five generic risk treatment types are outlined: risk acceptance, avoidance, transfer, sharing, and mitigation. The majority of research has focused on risk mitigation.

Risk Acceptance

There are no standard guidelines to determine how much risk an organisation should accept. The acceptable level is context-dependent and may be linked, for example, to risk propensity, i.e. the willingness of a person or organisation to engage in risky behaviours and accept uncertain outcomes in decision-making (Park *et al.*, 2016). But willingness to accept a risk does not mean the risk has to be ignored. It should continue to be tracked to ensure the accepted consequences do not escalate (Aqlan and Lam, 2015). If the consequences exceed a certain threshold, organisations need to consider how to avoid, transfer, share, or mitigate the risk.

Risk Avoidance

Risk avoidance seeks to eliminate the types of events that could trigger a risk (Ritchie and Brindley, 2007). For example, a company could discontinue specific products, suppliers, or geographical markets if supply is unreliable (Jüttner *et al.*, 2003; Hajmohammad and Vachon, 2016). Thus, the company is removing the root cause of the risk (Aqlan and Lam, 2015).

Risk Transfer

Risk transfer indicates that responsibility is assigned to another party (Diabat *et al.*, 2012). For example, business disruption risks can be transferred through business interruption insurance (Zhen *et al.*, 2016). Risk transfer however appears more appropriate for disruption risks with a small probability and high impact, e.g. natural disasters and terrorist attacks, than for operational risks with a high probability and low impact (Aqlan and Lam, 2015).

Risk Sharing

Risk sharing involves another party sharing some or all risks. From the buyer's perspective, risk can be shared usually through contracts with clauses that account for potential changes in associated risks (Buzacott and Peng, 2012) and relationship development (Camuffo *et al.*, 2007). Suppliers, for example, would pre-order to share inventory risk in the presence of financial constraints (Lai *et al.*, 2009) or increase capacity when orders are guaranteed by their customers (Scheller-Wolf and Tayur, 2009). Similar to risk transfer, risk sharing

seems appropriate for dealing with risks that have a low probability and high impact in order to reduce the associated costs (Lai *et al.*, 2009) and increase customer service levels (Scheller-Wolf and Tayur, 2009).

Risk Mitigation

Mitigation seeks to actively reduce risk to an acceptable level. It applies both to the reduction of the probability of a risk event and to the consequences (Norrman and Jansson, 2004). Mitigation strategies are typically suitable for operational risks with a high probability and low impact (Aqlan and Lam, 2015). The selection of a risk mitigation strategy also depends on the risk type and the organisation's budget (Tummala and Schoenherr, 2011); and organisations should carefully evaluate the acceptance, avoidance, sharing, and transfer options before selecting a mitigation strategy. As risks are often interconnected, alleviating one risk type might aggravate and/or mitigate another (positive *vs.* negative dependence); hence, mitigation strategies should be employed with minimal contradiction (Chopra and Sodhi, 2004) and with particular attention to those risks that have negative dependences (Sarker *et al.*, 2016).

Different clusters of risks may need different risk treatment strategies, as illustrated in Figure 5. As a firm has limited resources, it is important to understand where these resources can be best deployed and when to change outdated strategies. Investing in risk avoidance seems necessary for high probability, high impact risks to reduce their likelihood of occurrence, whereas risk acceptance may be permitted for low probability, low impact risks. Risk mitigation appears most suitable for high probability, low impact risks while risk transfer/sharing seems most appropriate for disruption risks with a low probability and high impact, such as natural disasters and terrorist attacks. But the situation needs to be continually monitored – the theme of the next section – for each risk and across risks to capture the evolution of the strategies and ensure the strategies remain aligned with the threats.

[Take in Figure 5]

Risk Monitoring

Risk is not a static phenomenon. It needs to be continuously monitored to evaluate how risk sources are developing and if any changes to the treatment strategies need to be applied. It is important to ensure that risk monitoring is based not only on judgemental assessments but also on formal processes, e.g. so the on-going progress of SCRM is continuously

updated and reviewed, so changes are managed, and so new information is obtained (Zsidisin, 2003). Although risk monitoring is an important part of SCRM, it has received limited attention (Blackhurst *et al.*, 2008; Hoffmann *et al.*, 2013). Only ten papers (out of 354) paid explicit attention to monitoring. There is a need for further research at this stage, particularly given the differences in opinions between researchers and practitioners. Researchers have suggested establishing specific data management systems for risk monitoring (Tummala and Schoenherr, 2011), developing monitoring capabilities (Klassen and Vereecke, 2012) and early-warning management processes (Xie *et al.*, 2009), and designing tools (Blackhurst *et al.*, 2008) to identify trends. In contrast, managers tend to incorporate monitoring tasks into existing management routines, such as by combining monitoring with risk assessment (Blackhurst *et al.*, 2008) and by monitoring through key performance indicators (KPIs) (Lavastre *et al.*, 2012) and performance measurement systems (Bühler *et al.*, 2016).

Assessment of the SCRM Process

The four SCRM stages have received differing degrees of attention. For example, there has been more research on risk identification and treatment than on risk assessment and monitoring. The literature has provided various tools and strategies that can be used during each stage, but few studies have examined their effectiveness or provided managerial guidance on when and how to select them. Moreover, there appear to be differences in terms of the strategies advocated by researchers and those typically employed in practice.

In terms of the pathway to SCRM, coordination and collaboration with other members of the supply chain is important. As part of this, relational aspects, and not simply contracts, are key. Contractual mechanisms can be important to developing effective risk management between firms (Ojala and Hallikas, 2006), but it has even been argued that long term relationships may be efficient without contracts in some cases (Cohen and Kunreuther, 2007). Indeed, a few studies have highlighted how effective relationships can help manage potential SCRs (e.g. Cruz and Liu, 2011; Chen *et al.*, 2016). But further work is needed to disentangle the dynamic interplay between contractual mechanisms and relational mechanisms; and to give greater attention to relational mechanisms (including in dyadic and triadic relationships) during the SCRM process.

Implementing a SCRM strategy involves an investment as well as potential benefits. Although some studies have attempted to examine the effect of SCRM activities on supply chain performance (Thun and Hoenig, 2011) or risk performance (Kern *et al.*, 2012), there

is limited research on the operationalisation of supply chain performance measures and of the associated moderators and mediators in relation to SCRM. For example, factors such as national culture (Jia and Rutherford, 2010), buyer's perceptions (Ellis *et al.*, 2010), and the decision-making process (Ellis *et al.*, 2011) could influence SCRM and its effect on performance.

Thematic Analysis: Theories in SCRM Research

This section focuses on the use of theory in SCRM research, which has been neglected in previous reviews. For the subset of articles that have used theory, this review has determined: whether a single or multiple theories were used; which theories were used; and, the number of key constructs included from each theory. The extent, or degree, of theory use was coded along a continuum from informed by theory to building theory, as below. These points on the continuum were informed by Painter *et al.* (2008) and further developed based on the authors' preliminary analysis:

- **Informed by theory**: Where a theoretical framework or construct is identified but there is no or limited application of the framework in the study's components and measures.
- **Applying theory**: Where a theoretical framework is specified and between one and all constructs is/are applied in components of the study.
- **Testing theory**: Where a theoretical framework is specified and some or all of the theoretical constructs are measured and explicitly tested.
- **Building theory**: Where new or revised/expanded theory is developed using constructs specified, measured, and analysed in the study.

Table V summarises the trend in using theory, demonstrating a gradual broadening out of the range of theories used. In total, only 45 papers utilised theory, with most adopting a single lens (e.g. Yang and Yang, 2010; Hoffmann *et al.*, 2013). Most studies imported theory from other fields, with Transaction Cost Economics (TCE) the most commonly employed theory frame. Nine papers used multiple theories (e.g. Ellis *et al.*, 2010; Speier *et al.*, 2011); most notably, TCE with the Resource-Based View (RBV) (Ojala and Hallikas, 2006; Tsai *et al.*, 2008). Therefore, theory is used on 53 occasions across the 45 papers. Details of each type of theory use are explained below, using examples from the papers.

[Take in Table V]

Informed by Theory

Many of the SCRM contributions that make some use of theory fall towards this end of the continuum (20 out of 53 theory uses). This suggests many researchers provide limited insight into how theories were operationalised in measurement, analysis, and/or the design of SCRM research; or there is reference to a theory but the empirical data is presented with no or little connection to the theory. For example, Hallikas *et al.* (2002) mentioned TCE, but there was little evidence of it adding explanatory power to the research topic (i.e. risk analysis and assessment). More specifically, it does not appear as though removing explanation of the theory from the paper would greatly affect the research findings. Other examples have drawn upon established theories to develop propositions (Blome and Schoenherr, 2011), propose other arguments (e.g. Guertler and Spinler, 2015) or provide background information (e.g. Cantor *et al.*, 2014), but none of the theoretical constructs were explicitly discussed.

Arguably, research at this end of the continuum is not taking full advantage of theory potential. Being informed by theory however is still valuable and can influence the way in which SCR is conceptualised. For example, systems theory has been used to inform understanding of risk, where risk has been understood as the links tying open systems together into large and interconnected networks of systems (Peck, 2005), indicating risks are inherently inter-related (Guertler and Spinler, 2015). Without this theory, such studies would have been more likely to ignore risk inter-relationships.

Applying Theory

Research of this kind has applied theory to increase research rigour or add explanatory power to research findings (25 out of 53). A good example is Johnson *et al.* (2013) who, based on a single case study, used all of the key constructs of social capital theory to provide new insight into formative capabilities for supply chain resilience.

Testing Theory

In this category, a theoretical framework is specified and some or all of the constructs are measured and explicitly tested (7 out of 53). For example, Camuffo *et al.* (2007) applied agency theory to study risk sharing between buyers and first-tier suppliers and develop hypotheses. Similarly, Ellinger *et al.* (2015) used the Knowledge Based View (KBV) to develop a conceptual framework and hypotheses to understand that learning orientation is a cultural factor that favourably influences SCRM. Further, survey data was used to test the hypotheses in the conceptual framework. Such employment of theory demonstrates

consistency between the theory itself and the research findings.

Building Theory

Only one paper was classified as theory building. Wever *et al.* (2012) expanded TCE from a focus on bilateral transactions to examine transactions by taking a supply chain-wide approach to reduce transaction risk exposure. This research reshaped our understanding of managerial practices derived from traditional TCE and justified why a supply chain-wide perspective is needed in managing transaction risks, thereby reducing imbalances between supply- and demand-side contracts.

Assessment of Theory Use

Although only a limited number of papers have used theory in the SCRM literature, there is evidence of a broad range of different theories being adopted. Not all of these theory applications have added greatly to understanding of SCRM, although this does not mean the papers did not provide a valuable contribution. Further analysis revealed that the papers using theory tended to focus on a particular stage or subset of stages in the SCRM process. Overall, no theoretical perspective has captured the full SCRM process, and thus it remains to be seen whether a holistic approach to SCRM would require the use of multiple theory frames.

Discussion: Gaps in SCRM Research

Ten key research gaps are identified, as summarised in Table VI**,** together with proposed potential research questions. These gaps and questions represent an agenda for future research and are derived from addressing our two research questions via the previous sections of this paper.

[Take in Table VI]

In answering Research Question 1, it was found that research has tended to focus on a single stage or a subset of the four SCRM stages. While this is understandable, it means a holistic approach to studying the full SCRM process is missing (Gap 1). Such an approach is important in understanding the adoption of some Decision Support Systems (DSS) that benefit from a holistic approach to managing SCRs (Mogre *et al.*, 2016). For work that is to focus on a particular SCRM stage, two key directions are identified. First, further research is required into classifying and prioritising risks in supply chains. Many studies provide typologies or taxonomies but rarely consider risk inter-relationships, interactions

amongst risk drivers, or intangible factors in risk assessment. A few studies use ISM to identify risk inter-relationships but without proposing a risk categorisation. It is suggested that a more appropriate approach to risk categorisation is required, constituting a comprehensive risk structure with hierarchies and interactions (Gap 2). Second, the final stage of the SCRM process, i.e. risk monitoring, has received only limited attention to date (Gap 3) yet is an important part of the overall SCRM approach.

In terms of the pathway to SCRM, several researchers highlight the importance of coordination and collaboration with supply chain partners (e.g. Giunipero and Eltantawy, 2004; Faisal *et al.*, 2007). Yet most SCRM research has been primarily conducted from a focal firm perspective and has not addressed the impact of the full complexity of inter-organisational relationships on SCRM. Research suggests that building relationships and enhancing collaboration may provide more effective SCRM (e.g. Ojala and Hallikas, 2006; Ritchie and Brindley, 2007; Christopher *et al.*, 2011; Kam *et al.*, 2011; Hallikas and Lintukangas, 2016). Empirical evidence is however needed to reassess the general premise that more collaboration is better for the buyer as there is no added benefit from investing resources in managing risk in some situations (Hajmohammad and Vachon, 2016) and then to examine how to effectively bring traditional supplier and customer relationship management practices into SCRM (Gap 4). Much of the literature on the pathway to SCRM has focused on internal management decisions and capabilities (e.g., Riley *et al.*, 2016). It has proposed SCRM strategies but rarely examined their motivating factors (Mishra *et al.*, 2016), how these strategies evolve over time (Kaufmann *et al.*, 2016), their effectiveness, or provided suitable guidance for managers on when and how to select the most appropriate strategy or replace existing but ineffective strategies. Thus, further research is needed to benchmark SCRM strategies (Gap 5) and develop more validated risk management strategies (Gap 6). It could also be helpful to examine the complementarity and balance between internal and external pathways to SCRM.

SCRM seeks to ensure profitability (e.g. Faisal *et al.*, 2007), save costs (Manuj and Mentzer, 2008b) and potentially generate value (Trkman *et al.*, 2016), meaning companies need to strike a balance between the benefits of SCRM and investments in these strategies. This relates to the probability and impact of risk events, but also to interactions between strategies, such as complementary or substitutable interactions (Zhen *et al.*, 2016). Some strategies may have compounding effects, but the literature has paid limited attention to the effectiveness of combinations of strategies or how individual strategies could respond to multiple risks. In general, there is only limited work on the effect of SCRM on supply

chain performance (Thun and Hoenig, 2011; Mishra *et al.*, 2016) or risk performance (Kern *et al.*, 2012; Hallikas and Lintukangas, 2016). Thus, further research is needed that investigates interactions between SCRM strategies and evaluates trade-offs between the costs, such as investments in improving supply chain capabilities (Nooraie and Parast, 2016), and benefits of SCRM including learning benefits (Silbermayr and Minner, 2016) (Gap 7).

In answering Research Question 2, only one example (Wever *et al.*, 2012) has been found of genuine theory building, although several authors have used theory to improve understanding of SCRM. Thus, there is a need for further and more expansive use of theory to deepen understanding of SCRM and add external validity to the research (Gap 8). Overall, the theoretical perspectives utilised to date have failed to capture all aspects of the SCRM process in the field.

Context is an important element of SCRM; for example, the nature of the risk or the effectiveness of a strategy is likely to be affected by the industry, country, etc. There is a need to conduct further research in under-represented contexts, including developing countries (Gap 9). The supplier perspective is also under-represented. This is important as suppliers can cause downstream disruptions, resulting in losses or even business discontinuity, and inter-organisational responses to SCRs may be required. Thus, more research is required to obtain insights from the perspective of suppliers (Gap 10) to help firms better manage risks.

Conclusions

This paper has presented a SLR – a type of structured approach to conducting a search (Denyer and Tranfield, 2009; Saenz and Koufteros, 2015) – that is consistent with the frameworks recently outlined in the operations and SCM literature by Thomé *et al*. (2016) and Durach *et al*. (2017) but more specific to the topic of SCRM. In our study, we have used broad search terms to retrieve our initial set of articles thereby allowing us to capture relevant papers that use a variety of related terms. This approach retrieved a large number of articles that were then filtered down using our inclusion and exclusion criteria. This was a manual process but also meant that very few papers were added in at a later organic stage. The alternative would have been to use more specific keywords to search the literature and add in a greater number of papers organically, but such an approach would have increased the risk of missing some key articles.

Our SLR has provided a number of insights into the topic of SCRM. It is

complementary to, but does not substitute, prior systematic reviews on SCR (Colicchia and Strozzi, 2012; Ghadge *et al.*, 2012; Fischl *et al.*, 2014; Fahimnia *et al.*, 2015; Kilubi, 2016). We have presented our results based on a different approach to analysis than has been used in prior studies. Earlier work has used, for example, citation network analysis (Colicchia and Strozzi, 2012), text mining (Ghadge *et al.*, 2012), and bibiometric & network analysis (Fahimnia *et al.*, 2015) whereas we have adopted a descriptive, thematic, and content analysis of the literature. It was found that there has been a considerable focus on identifying types of risks and proposing risk mitigation strategies. This includes the typology of risk factors in Rao and Goldsby (2009), which helps to understand the SCRs organisations might encounter thereby improving their risk identification; but such work needed to be connected with subsequent stages of SCRM.

Our paper encapsulates the four key stages of SCRM, i.e. risk identification, assessment, treatment, and monitoring, thereby responding to the observation by Ghadge *et al.* (2012) that a holistic approach to SCRM is missing. An overview of the entire SCRM field is provided, which complements prior reviews on specific topics that allow the reader to drill down deeper into particular areas, including price risk (Fischl *et al.*, 2014) and quantitative models (Fahimnia *et al.*, 2015). A holistic approach was needed at both a macro level, i.e. to cover the four stages of SCRM, but also at a more micro level. For example, within the SCRM stage of risk treatment, the focus is often on risk mitigation only and not on other treatment options such as risk avoidance or risk sharing. The most comprehensive of the non-systematic literature reviews was provided by Ho *et al.* (2015). Our paper is similar to this work in that it adopts a holistic approach and classifies the literature according to four stages of SCRM. Thus, both our paper and that by Ho *et al*. (2015) respond to Ghadge *et al*.'s (2012) call for holistic work on SCRM. But by taking a systematic approach, our review expands this earlier work to include further important literature on SCRM, including related to how SCRM is defined (e.g. Giunipero and Eltantawy, 2004; Manuj and Mentzer, 2008b; Wieland and Wallenburg, 2012) and the range of risk treatment options available. Moreover, we expand the scope of all prior reviews by including the most contemporary literature and by unpacking how theory has been used.

Research Implications

This study contributes to the SCRM literature in six key ways. First, we have provided a new and more comprehensive definition of SCRM. This enables researchers from different

fields to develop a common understanding of SCRM for internal consistency and it facilitates potential application to the business world for external consistency. Second, we have proposed an OPO-based (objective-process-outcome) conceptual framework (Figure 2) that encapsulates the four SCRM stages and pathways to SCRM depending on the characteristics of the organisation and the objectives of SCRM. Third, we have provided a classification scheme for SCRM research (Tables II, III, and IV). This offers guidance to other researchers who can independently classify upcoming articles or choose larger samples. Fourth, we have created a 2x2 matrix that categorises risk treatment strategies based on the probability and impact of a risk (Figure 5). The prevalence of risk mitigation in the extant SCRM literature appears to have prevented the plurality of ideas in terms of how the various other treatment actions can be researched. Fifth, we have provided a first step towards understanding the use of theory in the SCRM literature. Four types of theory use are identified, which could inform future theory application and encourage further analyses to enrich findings. Sixth, we have identified ten key research gaps and suggested research questions for each gap. This represents a research agenda for the SCRM field.

Practical Implications

This review has three key managerial implications. First, our holistic approach to SCRM encourages managers to develop an orientation to the context as a whole so that they can form a complete picture of SCR and SCRM. It is important that managers consider the interrelatedness of the four stages, of SCRs, and of supply chain actors. For example, applying one treatment approach may be effective at mitigating a risk but it might induce another risk that then needs to be identified and assessed; or it may have consequences at other points in the supply chain. Joint decision making for selecting and implementing SCRM strategies – supported by software, such as what-if scenario planning tools – may therefore be appropriate. Second, we have highlighted the internal and external pathways that managers can adopt to manage SCRs. If SCRM is not coordinated internally with key stakeholders or there is a lack of external collaboration with supply chain partners, SCRM strategies may not have the desired outcomes. Third, our 2x2 matrix (Figure 5) provides guidance to managers on how to select appropriate risk treatment actions according to the characteristics of risks.

Limitations

Our analysis is limited by the availability and accessibility of relevant studies. Although we followed the SLR approach, it is still possible that some papers were missed. It seems

likely however that this would be a small set of papers and would not dramatically alter the conclusions. Also, assessment of the articles was arguably subjective although the papers were reviewed by multiple researchers.

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Table I: Definitions of SCRM in the Literature

Characteristics / Author(s)	Process				Pathway			Objective			
	Risk Identification	Risk Assessment	Risk Treatment	Risk Monitoring	External Coordination	External Collaboration	Internal Implementation of SCRM Strategies	Ensure Profitability	Cost Savings	Reduce Vulnerability	Ensure Continuity
Jüttner *et al.* (2003, p. 201) and Jüttner (2005, p. 124)	X		X		X					X	
Giunipero and Eltantawy (2004, p. 703)				X	X						
Norrman and Jansson (2004, p. 436)			X			X	X				
Tang (2006, p. 453)			X		X	X		X			X
Faisal *et al.* (2007, p. 68)			X		X	X	X	X			X
Goh *et al.* (2007, p. 164-165)	X		X		X					X	
Manuj and Mentzer (2008b, p. 205)	X	X	X		X		X	X	X		
Lavastre *et al.* (2012, p. 830)		X	X								
Wieland and Wallenburg (2012, p. 890-891)	X	X	X	X						X	X
Ho *et al.* (2015, p. 5036)	X	X	X	X		X					

Table II: Descriptive Analysis of Country, Industry Sector, and Research Perspective

Code	Description		No. Papers	% of Total (354 Papers)
Country	**Single Country (30%)**	Developed Country	60	17%
		Developing Country	46	13%
	Multiple Countries (6%)	Developed Countries	9	3%
		Developing Countries	2	0.6%
		Developed and Developing Countries	7	2%
		Total	124	35%
Industry		Single Industry	115	32%
		Multiple Industries	70	20%
		Total	185	52%
Research Perspective		Supplier's Perspective	5	1.4%
		Buyer's Perspective	88	25%
		Dyadic Perspective	15	4%
		Triadic Perspective	7	2%
		Total	115	32%

Table III: Number of Articles by Research Method

Research Method				No. Papers	% of Total Papers
Single Research Method (99%)	Conceptual (18%)	Literature Review (6%)	Traditional Literature Review	15	4.2%
			Systematic Literature Review	5	1.4%
		Other Conceptual Research		43	12.1%
	Empirical (47%)	Case Study (29%)	Single Case Study	55	15.5%
			Multiple Case Study	48	13.6%
		Survey		55	15.5%
		Action Research		4	1.1%
		Experiment		3	0.8%
		Grounded Theory		2	0.6%
	Analytical (32%)	Mathematical		67	18.9%
		Simulation		40	11.3%
		Multi-agent		2	0.6%
		Programming		4	1.1%
	Secondary Data (2%)			7	2%
Mixed Research Method (1%)				4	1.1%
Total				354	100%

Table IV: SCRM Process Coding Scheme

SCRM Process	Sub Classification Codes		No. Papers	% of Total Papers (339 Papers)
Risk Identification	Drivers of SCR		16	4.7%
	Sources of SCR		18	5.3%
	Classify types of SCR	Classification Categories Only	20	5.9%
		List Risks in Each Category	53	16%
		List of Risks Without Categorising	18	5.3%
	Proposed Strategies		12	3.5%
	Applied Strategies		18	5.3%
Risk Assessment	Risk Prioritisation		9	2.6%
	Risk Inter-relationship		16	4.7%
	Applied Strategies		62	18.3%
	Proposed Strategies		26	7.7%
Risk Treatment	Risk Acceptance		3	0.9%
	Risk Avoidance		8	2.4%
	Risk Transfer		6	1.8%
	Risk Mitigation	Proposed Strategies	185	54.6%
		Applied Strategies	16	4.7%
		Enabler & Antecedents	31	9.1%
		Benchmarking and Evaluating Mitigation Strategies	16	4.7%
	Risk Sharing		14	4.1%
	Miscellaneous		5	1.5%
Risk Monitoring	Proposed Strategies		8	2.4%
	Applied Strategies		2	0.6%

Table V: Frequency of Theory Use in the Extant Literature by Year

	2000				2001				2002				2003				2004				2005				2006				2007				2008				2009				2010				2011				2012				2013				2014				2015				2016				Total					% of Total
Theory Use	I	A	T	B	I	A	T	B	I	A	T	B	I	A	T	B	I	A	T	B	I	A	T	B	I	A	T	B	I	A	T	B	I	A	T	B	I	A	T	B	I	A	T	B	I	A	T	B	I	A	T	B	I	A	T	B	I	A	T	B	I	A	T	B	I	A	T	B	I	A	T	B	Tota	
TCE									1	1							1									1								1							1				1							1			1															4	3	1	1	9	17%
Agency Theory														1				1													1		1																									1								1			1	4	1	0	6	11%
System Theory																	1				1																																								1								3	0	0	0	3	6%
Institution Theory																						1																																											1				1	1	0	0	2	4%
RBV																										1								1			1																												1				2	2	0	0	4	8%
Resource Dependence Theory																																	1								1																									1			2	1	0	0	3	6%
Contingency Theory																																					1																1								1					2			3	2	0	0	5	9%
Normal Accident Theory																																										1				1													1							1				1	2	1	0	4	8%
Real Option Theory																																											1																												0	0	1	0	1	2%
Enactment Theory																																														1																								0	1	0	0	1	2%
High Reliability Theory																																														1																			1				1	1	0	0	2	4%
Social Capital Theory																																																		1				1				1											0	3	0	0	3	6%
Modular Systems Theory																																																							1															0	0	1	0	1	2%
Stakeholder Theory																																																									1	1											1	1	0	0	2	4%
Regulatory Focus Theory																																																											1										0	0	1	0	1	2%
KBV																																																															1						0	0	1	0	1	2%
Manufacturing Strategy Theory																																																																	1				1	0	0	0	1	2%
Expectation Confirmation Theory																																																																		1			0	1	0	0	1	2%
Information Processing Theory																																																																		2			0	2	0	0	2	4%
Complementarity Theory																																																																		1			0	1	0	0	1	2%
Total									1	1				1			2	1			1	1				2					1		2	2			2				2	1	1		1	3				1		1	1	1	2		1	3	2		2		1		5	8			20	25	7	1	53	100%

Note: **I**: Informed by theory; **A**: Applying theory; **T**: Testing theory; **B**: Building theory

Table VI: From Present to Future – Research Questions for the Identified Research Gaps

Gap	Starting From		Description (Present)	Example Research Questions (Future)
1	RQ1	Four SCRM stages	Limited research has adopted a holistic approach to the SCRM process	How can SCRM research be conducted from a holistic perspective? How are the 4 SCRM stages inter-related?
2			A holistic risk categorisation structure is needed to classify and prioritise risks, identify inter-relationships, and consider intangible factors in risk assessment.	What methods can be used to classify, prioritise and identify risk inter-relationships in a hierarchical structure? How are SCRs inter-related, and what does this mean for SCRM? What intangible factors need to be considered in risk assessment?
3			Risk monitoring has received limited attention.	What methods and strategies can be used to monitor SCRs during the SCRM process?
4		Pathway to SCRM	There is a need to disentangle the role of dyadic supply chain relationships in the SCRM process.	How does the nature of the buyer-supplier relationship affect SCRs and the SCRM process?
5			Benchmarking of SCRM strategies is needed to identify promising practices.	How can firms benchmark SCRM strategies?
6			SCRM strategies that provide guidance for practitioners need to be developed.	What SCRM strategies are appropriate for practitioners?
7		Goal of SCRM	A cost-benefit analysis of SCRM is needed.	How can firms best trade-off the costs and benefits of SCRM?
8	RQ2	Theory	Theories need to be employed more appropriately to deepen understanding of SCRM and add external validity.	How can theories be used to improve our understanding of SCRM?
9	RQ1+RQ2	Research Context	Insufficient understanding of SCRM in developing country contexts.	How does country context influence SCRM?
10		Research Perspective	More research is needed from the supplier perspective.	How does supply chain position affect SCRM?

Figure 1: Systematic Literature Review Process (adapted from Tranfield et al., 2003)

Stage 1: Question Formulation

SLR Research Questions:
1. What is the current state-of-the-art in SCRM research on risk identification, risk assessment, risk treatment, and risk monitoring?
2. How has theory been used in SCRM research?

Stage 2: Keyword Search in Identified Databases

Criteria	*Rationale*
1. Keywords: "supply chain" AND "risk"	As used by Ho *et al.* (2015), broad keywords allowed to thoroughly uncover all the relevant literature.
2. Business Source Complete Database (BSR) and Web of Science Database (WoS)	These databases were selected as they have arguably the best coverage of operations and supply chain and management and are typically used in literature reviews (e.g. Gimenez and Tachizawa, 2012).
3. International peer-reviewed academic journals selected	In an attempt to include high-quality scientific studies in English and exclude books, book chapters, conference proceedings, dissertations, and working papers.
4. Time range: January 2000 to December 2016	Focused on 2000-2016 to develop a contemporary understanding of the phenomenon. In addition, the back-tracking method (Olhager *et al*., 2015) was used to find the most relevant earlier stuides (prior to 2000).

Number of Selected Papers in Stage 2: **5412** = 2272 (BSR) + 3140 (WoS)

Stage 3: Removal of Duplicates (1262)

Number of Selected Papers in Stage 3: **4150** (= 5412 - 1262)

Stage 4: Article Quality and Relevance Assessment

Criteria	*Rationale*
1. Eliminated articles published in journals that are not listed in the ABS Academic Journal Quality Guide 2015 (1763 articles)	We chose the ABS Guide as it was found to be the most widely used and accepted quality indicator in the academic world (Ghadge *et al*., 2012).
2. Irrelevant articles were removed after title and abstract analysis (1677 articles)	These papers were excluded as they are not contributing to answering the research questions.
3. Less relevant articles were removed after full-text scanning (365 articles)	These papers were excluded as their main focus is not on any stage of the SCRM process.

Number of Selected Papers in Stage 4: **345** (= 4150 - 1763 - 1677 - 365)

Stage 5: Capturing Other Relevant Articles

Criteria	*Rationale*
1. Five articles added into database through citation checking process	Used forward-tracking method (Olhager *et al*., 2015) to include articles that referred to central sources.
2. Four articles that meet above criteria (see Stage 4) have been found in Google Scholar	In an attempt to ascertain whether a list of peer-reviewed papers may be available through other databases.

Number of Selected Papers in Stage 5: **354** (= 345 + 5 + 4)

Stage 6: Full-Text Analysis and Coding

1. Full-text analysis of 354 papers
2. Use NVivo to create a list of classification codes covering country, industry sector, adopted theory, research perspective, research method, the four stages in the SCRM process.

Number of Selected Papers in Stage 6: **354**

Stage 7: Reporting

1. ***Descriptive analysis*** on country, industry sector, research perspective, and research method
2. ***Thematic analysis*** on the four stages in the SCRM process and the use of theory

Figure 2: Objective-Process-Outcome (OPO) Based SCRM Conceptual Framework

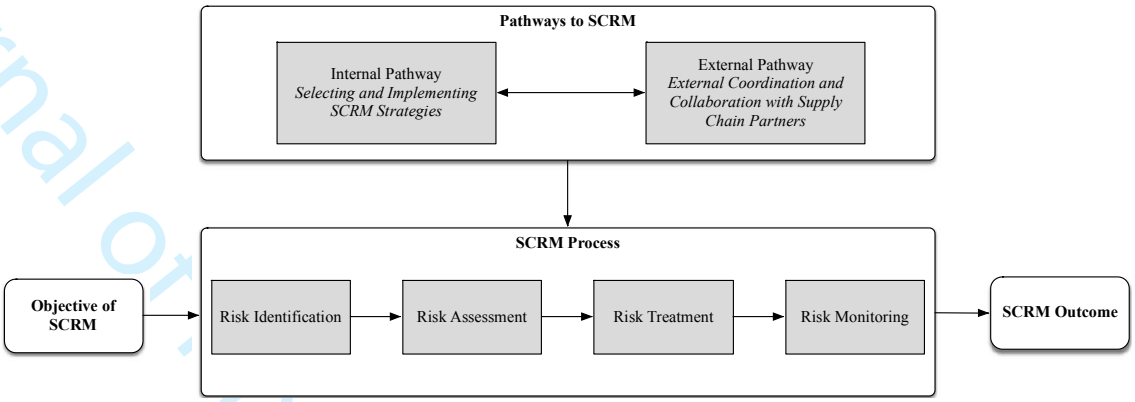

Figure 3: Number of Articles by Year (out of 354 Articles)

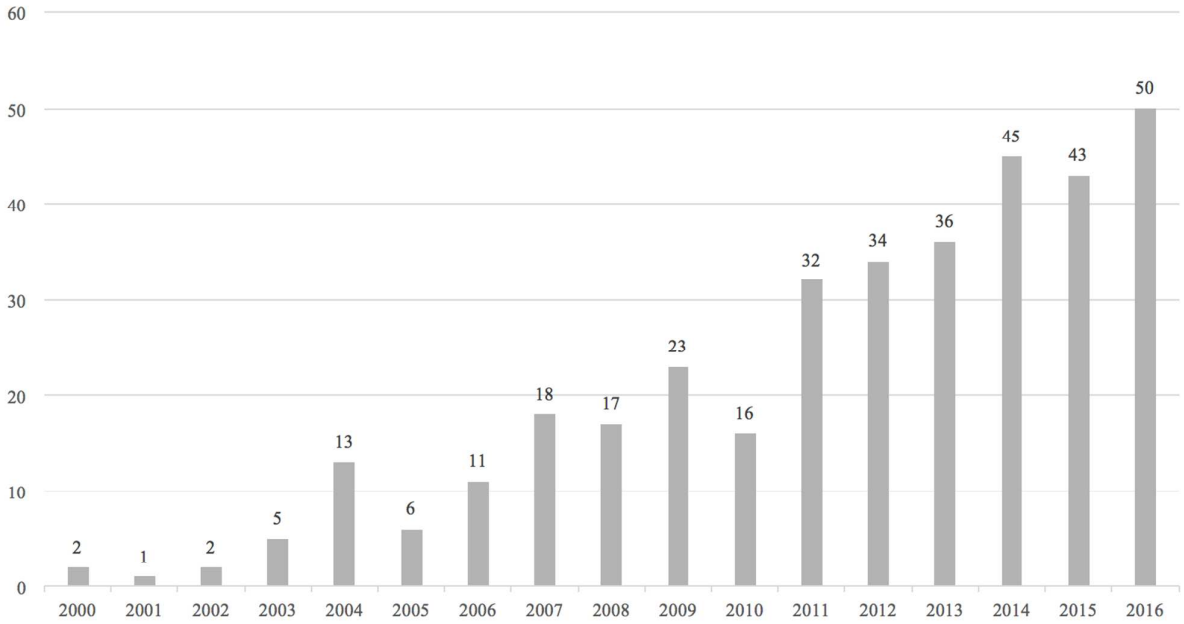

Figure 4: Number of Articles by Journal (out of 354 Articles)

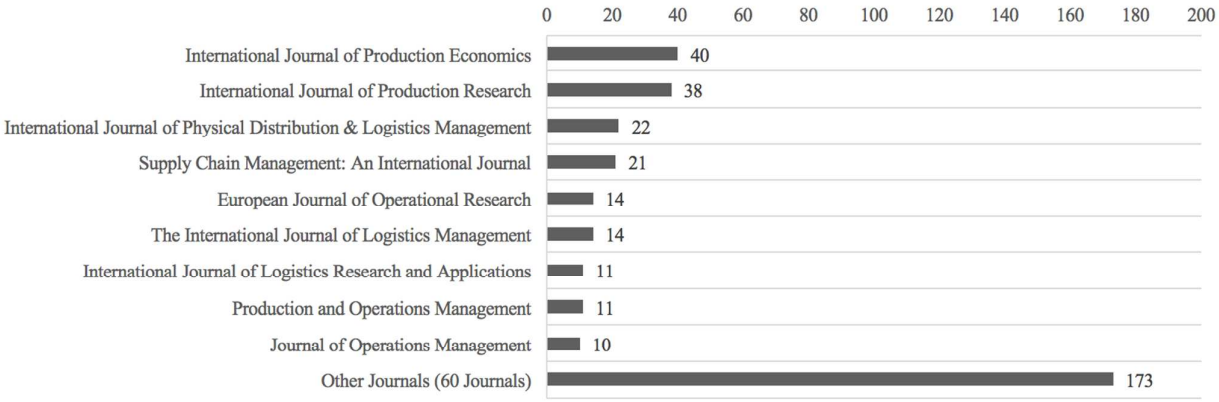

Figure 5: Matrix of Risk Treatment Strategies based on Probability and Impact