Developing resilient supply chains: Lessons from High-Reliability Organisations

Sawyerr, E. and Harrison, C.

The final, published version in Supply Chain Management: An International Journal, 25 (1), pp. 77-100, 2019 is available at:

https://doi.org/10.1108/SCM-09-2018-0329

Developing resilient supply chains: Lessons from High-Reliability Organisations

Abstract

Purpose: The purpose of this study is to identify the prescribed formative elements of supply chain resilience (SCR) in literature, to compare them with the unique characteristics of High Reliability Organisations (HROs) and derive lessons useful for improving SCR.

Design/methodology/approach: Two systematic literature reviews are carried out; one on SCR and the other on HRO which identified 107 studies and 18 papers respectively. The results from the review are presented, analysed and synthesised.

Findings: Findings suggest that, despite significant similarities in some of the proposed formative elements for SCR and the characteristics of HROs, the strong managerial commitment exhibited in HROs is absent in SCR literature. More importantly, the most cited characteristic of HROs – which is their flexible decision-making structure – is pointed out as a prima lesson towards developing resilience in supply chains.

Practical implications: A decision-making framework to facilitate flexible decision making for supply chains during crisis is presented. Further, practical lessons are pointed out from principles common to both streams of literature such as redundancy, human resource management, collaboration, agility, flexibility, culture and risk avoidance that can be implemented in supply chains.

Originality/value: This paper is the first study to systematically review HROs, adapt a HRO decision-making framework and also apply the Cynefin framework to SCR. This therefore provides the basis to launch further research into the use of these theories and the role of decision making in SCR creation.

Keywords: Supply chain resilience, supply chain risks, high reliability organisations, decision making, resilience, Cynefin

Article Classification: Literature Review

Introduction

The repetitive and exigent pressure arising from globalisation, increased outsourcing, competition and continuous changes in the dynamics of the market has made companies to identify and incorporate supply chain management as a critical component towards the attainment of sustainable competitive advantage (Lee, 2002). The subsequent benefits gleaned from the application of supply chain management principles are widely captured in literature and research (Oke and Gopalakrishnan, 2009).

However, these changes together with the effects of many unexpected occurrences have exposed organisational supply chains to higher levels of vulnerability than ever before – even more so because of the global nature of today's supply chains as well as higher inter-organisational dependence (Norrman and Jansson, 2004; Sheffi, 2005b; Wagner and Bode, 2006). Supply chain vulnerability is defined as "an exposure to serious disturbance, arising from risks within the supply chain as well as risks external to the supply chain" (Christopher and Peck, 2004, p.6). It can be inferred quite clearly from this definition that risks to a supply chain may arise from within an organisation, within the supply chain or outside of the supply chain network. This reveals the broad range of exposure for today's supply chains and amplifies the need to attentively address these risks and therefore accentuates the criticality of resilience in supply chains.

A number of management studies have reviewed SCR literature in the past few years. Bhamra et al. (2011) reviewed literature on resilience from 1976 to 2010, discussed resilience as applied to Small and Medium-scale enterprises and called for more empirical research using case-based methods. Pereira et al. (2014) systematically reviewed research on SCR, identified various enablers and barriers but restricted the analysis to the upstream side of the supply chain, particularly the procurement function and how it could impact the resilience of the supply chain. Wang et al. (2016) reviewed SCR using systems theory while Hohenstein et al. (2015) adopted the sand cone model to develop a comprehensive SCR framework after reviewing 67 peer-reviewed articles from 2003 to 2013. This paper identified SCR elements and grouped them under proactive and reactive strategies. After reviewing 91 peer-reviewed journal articles, refereed conference papers and PhD dissertations from 2003 to 2014, Tukamuhabwa et al. (2015) noted the inadequacy in the application of theoretical lenses in SCR studies and like Pereira et al. (2014) called for an increase in the use of theory. It further proposed studies into other strategies for resilience other than flexibility, redundancy, agility and collaboration and how such can be implemented while Kamalahmadi and Parast (2016) in a 15-year review highlighted SCR elements under Christopher and Peck's (2004) resilience capabilities and proposed new definitions for both enterprise and supply chain resilience. Linnenluecke (2017) examined High Reliability and Normal Accident Theories pointing out how insights from High Reliability studies could prove useful for resilience research while Datta (2017) reviewed articles from 1996 to 2016 to identify different supply chain practices in literature that ensure resilience and uses the CIMO (context, interventions mechanisms and outcomes) logic to analyse the data, proposing the need for more research into context-specific interventions. Finally, scholars such as Ali et al. (2017), are in agreement with the identified need for the application of theoretical lenses by calling for studies into the applicability and utility of High Reliability theory (HRT) within SCR studies. They had identified some essential elements from reviewing articles between 2000 and June 2015, linking them to five resilience capabilities and aligning them to SCR strategies and phases.

From these previous reviews, the need for the application of other theories in SCR studies is undeniable. However, a few previous studies have applied various theories in examining SCR. For example, Ponomarov and Holcomb (2009), Blackhurst et al., (2011) and Brusseta and Teller (2017)

adopted the resource-based view theory, Spiegler et al. (2012) and Wang et al. (2016) used the systems theory while Day (2014) and Tukamuhabwa et al. (2015) used complex adaptive systems. However, no research has thus far explored the usefulness of the Cynefin framework and/or High Reliability Theory in SCR research.

In one of the earliest studies on high reliability, Rochlin et al. (1987) provides an account of how despite the notion of accidents being normal was well-grounded in both experience and theory, a small group of organisations were succeeding under trying circumstances in the daily performance of highly complex technical tasks in which failure could not be afforded. The flight operations at sea on U. S. Navy aircraft carriers may represent the most extreme of operating conditions in the least of stable environment. It perhaps has the greatest tension between preserving safety and reliability and attaining the maximum obtainable operational efficiency. In fact, operations on aircraft carriers are so dangerous a normal working day could pass for a day with a major disruption at a traditional airport where only one short runway is available with salt water and oil spilled on its surface. To add to this, radars are dysfunctional and conventional safety regulations have been abandoned while operators are expected to prevent accidents and any loss of human life (Rochlin et al., 1987). Notwithstanding, operations aboard these carriers have been developed to be so resilient that accidents whether internally induced or caused by treacherous weather conditions at sea are kept at the minimum and are dealt with in the quickest most efficient way possible when they do occur.

Generally, HROs have been described as *mindful* organisations (Weick and Sutcliffe, 2001, p.3) because of their ability to avoid failures even though they operate under continuously precarious and complex conditions (Linnenluecke, 2017). There is a focus on reducing system complexity and tight coupling in order to achieve reliability and safety through human processes and relationships (Weick, 1987, 1989; Roberts, 1990; La Porte and Consolini, 1991; Schulman, 1993; Roberts et al, 2001; Weick and Sutcliffe, 2001; Rousseau et al., 2008; Sutcliffe, 2011). This continuous pursuit of reliability and avoidance of accidents make the overall goal of these organisations congruous to the end-goal of supply chains that seek resilience through avoidance of disruptions or recovery and adaptability after disruptions. Thus, HRO research present a useful area where lessons could be learnt and applied in the pursuance of SCR.

Consequently, this research seeks to address the gaps of further theoretical application (Pereira et al., 2014; Tukamuhabwa et al., 2015; Ali et al., 2017; Linnenluecke, 2017), the need to explore other strategies for resilience (Tukamuhabwa et al., 2015) and the provision of context-specific interventions (Datta, 2017) by identifying the unique characteristics of HROs, compare them with the formative elements of SCR as provided in extant and current literature and to propose applicable lessons from HROs for developing SCR. To do this, two systematic literature reviews are conducted: one for SCR and the other for HROs. The paper contributes to the SCR phenomenon by pointing out transferable lessons on human resource management, redundancy, avoidance, collaboration, culture, agility, flexibility and decision making that could prove useful in attaining SCR. The paper starts with a brief literature overview of supply chain resilience and high reliability theory, followed by a discussion of the two systematic literature reviews. The findings are then presented and discussed after which the flexible decision-making framework is presented and explained. The paper concludes by pointing out its implications for research and practice, its limitations, and then recommendations for future research are made.

Supply Chain Resilience

In one of the earliest definitions of resilience in academic literature, Holling (1973, p. 17) posited resilience in an ecological science context, as that system property which "determines the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist." Reviewing the concept of resilience over three decades later as applied in various disciplines, Folke (2006) came up with two distinguishable definitions where one was related to the quality of robustness in systems to withstand significant shocks while maintaining function and the other was more focused on the impact of disturbance on a system, its reorganisation and its ability to transform, learn and innovate (Brand and Jax, 2007).

Beyond the prevention of a range of recognisable risks, resilience from an organisational perspective incorporates the ability to meet business objectives irrespective of how significant disruptions may be (McClelland, 2009) as well as how quickly performance levels attain equilibrium post-disruption (Sheffi, 2005a). Further, it is also seen as a source of sustainable competitive advantage (both at the strategic and operational levels) as well as critical to organisational success (Coutu, 2002; Hamel and Valikangas, 2003; Stoltz, 2004). However, the development of significant levels of resilience by an organisation acting in isolation is almost unattainable (Seville et al., 2006; Bell, 2010) and hence, the need to extend resilience to integrate supply chain network players has become undeniable.

From this perspective, it is recognisable that activities that take place at various points within a supply chain all have the tendency to suffer the occurrence of an unexpected disruption. Seeing that such disruptions could adversely affect revenue and cost, there is the need to design supply chains to anticipate them, efficiently and effectively respond and then recover subsequently to preferably a better state after the disruption (Ponomarov and Holcomb, 2009).

To this end, the study of resilience in supply chains has been going on for the past couple of decades; but considering it is still fairly new, there still remains a lack of consensus in the understanding and application of the concept and even its definition (Melnyk et al., 2014; Hohenstein et al., 2015; Tukamuhabwa et al., 2015). It is however undeniable that its definition has evolved over the years (Ali et al., 2017) starting from the earliest cited definition by Rice and Caniato (2003) to more recent ones by Tukamuhabwa et al., (2015), Kamalahmadi and Parast (2016) and Datta (2017). The most recent conceptualisation of the SCR has moved from just the ability to respond and recover from disruptions (e.g. Rice et. al, 2003, Christopher and Peck, 2004) to include the ability of the supply chain to prepare for, avoid, adapt to, recover and also learn from disruptions (e.g. Hohenstein et. al, 2015 and Datta, 2017). For this research, SCR is defined as:

"*the ability to proactively plan and design the supply chain network for anticipating unexpected disruptive (negative) events, respond adaptively to disruptions while maintaining control over structure and function and transcending to a post-event robust state of operations, if possible, more favourable than the one prior to the event, thus gaining competitive advantage*" (Ponis and Koronis, 2012 pp. 925-6).

Preparedness, robustness, recovery and adaptability in the face of disruptions can clearly be inferred from the definition above – albeit within a supply chain context. For the supply chain to be able to achieve these, researchers have prescribed various formative elements. They have been termed differently by various authors including core dimensions (Ponis and Koronis, 2012), antecedents (Ponomarov and Holcomb, 2009; Scholten and Schilder, 2015), capabilities (Jüttner and Maklan, 2011; Pettit et al., 2013), enablers (Soni et al., 2014; Pereira et al., 2014), competencies (Wieland and Wallenburg, 2013) or simply elements (Christopher and Peck, 2004; Peck, 2005; Hohenstein et al.,

2015; Ali et al., 2017). However, to ensure consistency, this study maintains them as formative elements similar to Jüttner and Maklan (2011), Ponis and Koronis (2012) and Soni et al. (2014).

High Reliability Theory

The high reliability theory is the result of the work of an interdisciplinary research group that studied three high-risk, high-hazard organisations and discovered significant similarities in their modes of operation (Rochlin et al., 1987; Weick, 1987; Roberts, 1990; cf. Hopkins, 2007). The organisations were a nuclear power station, the US Navy nuclear aircraft carrier operations and the US Air Traffic control systems. It was concluded that despite the high possibility for failure, these organisations consciously pursue reliability (Rochlin 1999; Sutcliffe 2011). The fundamental proffer of the theory is that accidents and failures can be prevented by making continuous minor modifications that prevent error accumulation.

However, this theory has suffered its fair share of criticisms including the lack of a clear definition of what a HRO is (Hopkins, 2007). Furthermore, Marais et al. (2004) and Hopkins (2007) questioned the objectivity of the statistical classification suggested by Roberts (1991) and raised issues with the ostensible confusion between the use of 'reliability' and 'safety' within the theory.

Notwithstanding, HRT as opposed to the normal accident theory posited first by Perrow (1984) has emerged as the more dominant theory (Linnenluecke, 2017). It is suggested that this may be because of its dedicated researchers from the University of California, Berkeley and because it is less deterministic (Smart et al., 2003). Also, the question of the transferability of the theory's principles to other organisations has been discussed by authors such as Boin and 't Hart, (2010), Linnenluecke (2017), La Porte (1994) and Sagan (1993). Despite the differing opinions on this, this paper agrees with Linnenluecke (2017) and Boin and McConnell (2007) that the attributes of HROs could serve as a utilitarian guide towards the operationalisation of supply chain resilience.

The Systematic Literature Reviews

A systematic literature review (SLR) is at the heart of a pragmatic management research (Anderson et al., 2001) as it balances both rigour and relevance (Tranfield et al., 2003). Further, it has been argued that its purpose in management studies is to aid evidence-based decision making (Wilding and Wagner, 2014). It is thus the research method deemed most appropriate to attain the aim of this paper. The use of systematic review in supply chain management studies has become increasingly popular over the past decade (Wilding and Wagner, 2014). Some studies that have employed it include Bhamra et al. (2011), Gimenez and Tachizawa (2012), Colicchia and Strozzi (2012), Pilbeam et al. (2012), Gligor and Holcomb (2012), Wong et al. (2012), Pereira et al. (2014), Hohenstein et al. (2015), Kamalahmadi and Parast (2016), Ali et al. (2017) and Datta (2017).

In reviewing literature however, the various methods available to the researcher as identified by Banomyong et al. (2017) may include argumentative (Petticrew and Helen, 2006), integrative (Torracro, 2005), historical (Baumeister and Leary, 1997), methodological (Hart, 1998), theoretical (Rocco and Plakhotnik, 2008) and/or a systematic review (Tranfield et al., 2003; Harrison et al., 2016, Sutton, 2016). The first five are broadly considered narrative literature reviews. For a SLR, a clearly formulated research question(s) guides a researcher through the identification, selection and evaluation of relevant studies. This is followed by the analysis, synthesis and reporting of evidence

from the review to facilitate elucidative conclusions on the state of knowledge (Denyer and Tranfield, 2009; Alexander et al., 2014; Harrison et al., 2016; Sutton, 2016; Nurmala et al., 2017).

The narrative literature review approach has been criticised for lacking criticality (Tranfield et al., 2003; Wilding and Wagner, 2014; Harrison et al., 2016), and a systematic approach to reviewing literature has been proposed (Denyer and Tranfield, 2009). A systematic literature review can be defined as "…a replicable, scientific and transparent process; in other words, a detailed technology that aims to minimise bias through exhaustive literature searches of published and unpublished studies, and by providing an audit trail of the reviewer's decisions, procedures, and conclusions" (Tranfield et al., 2003, p. 209).

A SLR differs from a traditional narrative review because it adopts a replicable, transparent, and scientific process (Tranfield et al., 2003; Harrison et al., 2016). It is also preferred because it aims at a peer-reviewed and properly recorded process so as to achieve comprehensive coverage, criticality and relevance to practice (Denyer and Tranfield, 2009; Alexander et al., 2014; Wilding and Wagner, 2014). It further provides better clarity in scholarly communication and increases the internal validity of the research by removing or minimising researcher's bias in the article selection process (Booth et al., 2012). Incorporation of all these into a SLR research improves its quality, credibility and readability (Wilding and Wagner, 2014). To this end, the implementation process for the SLR employed for this research is that of Denyer and Tranfield (2009) which consists of the following steps:

1. formulating research questions;
2. locating studies;
3. selecting and evaluating studies;
4. analysing and synthesising results; and
5. reporting.

These are expounded below.

Research Questions formulation

As the first requirement, research questions have to be formulated to clearly define the focus for the study (Light and Pillemar, 1984; Cooper and Hedges, 1994; Denyer and Tranfield, 2009) thereby establishing the criteria for primary study inclusion (Counsell, 1997). Three main approaches have been adopted in literature to formulate research questions and identify keywords for SLRs. These include the use of expert panels to identify the main issues of the phenomenon to be studied (e.g. Wong et. al, 2012; Abidi et al., 2014; Alexander et. al, 2014; Durach et al., 2015; Dubey and Gunasekaran, 2016; Harrison et al., 2016) and the use of Denyer and Tranfield's (2009) CIMO (Context, Interventions, Mechanisms, Outcomes) logic approach (e.g. Colicchia and Strozzi, 2012; Pilbeam et al., 2012; Nurmala, 2017). The last approach is by establishing a conceptual framework or focus of research through review of literature (e.g. Pereira et al., 2014; Hohenstein et al., 2015; Bag, 2016; Ali et al., 2017; Datta, 2017) and this is the adopted approach for this paper. From extensive reading of relevant literature, the following research questions were formulated.

Q1. *What formative elements have been proposed in the relevant literature to attain supply chain resilience?*

Q2. *What organisations have been identified in literature as High Reliability Organisations and what are their peculiar characteristics?*

Q3. *What similarities are present in the identified formative elements towards the achievement of SCR and the characteristics of HROs?*

Q4. *From the analysis of the data, what lesson(s) can be learned from HROs to ensure and/or improve SCR?*

Locating Studies

A broad range of online academic database sources were used for this research to reduce bias and to provide a comprehensive list of major contributions to the themes in the research questions (Denyer and Tranfield, 2009). These included EBSCO, Emerald, Taylor and Francis and Wiley online Library as primary sources while Science Direct and Google Scholar were supplementary. These databases were selected because they are considered to have some of the largest repositories of business research and have also been used for similar studies (e.g. Wong et al., 2012; Pereira et al., 2014; Hohenstein et al., 2015; Durach et al., 2015; Harrison et al., 2016; Ali et al., 2017; Banomyong et al., 2017; Datta, 2017; Nurmala et al., 2017). The following keywords and search strings (shown in Table 1) which were identified at the scoping and research formulation stage were used to identify studies.

Insert Table 1

To further identify additional relevant literature, the references in the initially identified papers were used to find other works of interest relative to the research topics in the supplementary databases.

Study selection and evaluation

For the purpose of accuracy, objectivity and reliability, inclusion-exclusion criteria were established; and this is illustrated as follows:

Type

Only articles in Association of Business Schools (ABS) ranked journals were included. This was to ensure reliability, higher quality of the research and help produce better results (Light and Pillemer, 1984; Morris et. al, 2009; Harvey et al., 2011). Non-academic journals, articles in languages other than English, conference proceedings, editorial opinions and book chapters were excluded from this study.

Time

The time span considered for SCR is between 1997 and 2017 while for HROs it was 1987 to 2017. Even though it is generally accepted that SCR research began to emerge from the year 2000 (Zsidisin et al., 2000; Svensson, 2000; Sheffi, 2001), it was identified at the scoping stage that a few articles addressed aspects of resilience before the year 2000 and setting the starting year at 1997 made room for such articles to be considered. For example, Bandyopadhyay et al. (1999) identify measures such as disaster recovery planning, backing up of computer files, employee education and patent protection by focus organisations and others in their networks to reduce the likelihood of disruptions as well as to increase the ability to recover quickly from unavoidable risks such as natural disasters. Srivastava et al. (1999) also prescribe flexibility in manufacturing and order delivery systems as well as the integration of suppliers through the use of Vendor Managed Inventory to reduce the exposure of supply chains to cash flow risks and to ensure sustainable competitive advantages. The timespan for the HROs was extended to begin from 1987 primarily because the seminal articles on the theory were before 1997.

Subject (Relevance)

Only articles relevant to the subject under review were included in the selection phase. This was determined by reading the titles and abstracts for some of the articles while others required reading in depth to affirm relevance. Some articles only mentioned "supply chains" a couple of times as part of the business functions or "resilience" with respect to an organisation or an individual and not the supply chain. Thus, such articles were excluded.

Initially, a total of 887 hits were produced for SCR while that of HROs produced 301 articles from searching EBSCO (Business Source Complete), Emerald (articles and chapters), Taylor and Francis and Wiley online Library (Journals) databases for keywords using the search strings specified in Table 1. However, after excluding duplicates and articles which did not meet the criteria indicated under *Type*, there remained 386 articles in all. Upon applying the specified time spans, the SCR articles reduced to 218. That for HROs reduced to 33 when articles in journals not ABS-ranked were excluded and timespan was applied. After reading of abstracts, the count reduced to 165 SCR articles and 24 HRO articles. However, 21 new SCR articles were identified from citations and bibliographies and six were found for HROs. These new articles were searched in Google Scholar and Science direct. This therefore resulted in 186 and 30 articles for SCR and HRO respectively at this stage. Full reading of all these articles to identify relevance and also the exclusion of the some of the new articles which were not in ABS-ranked journals produced the final number of articles with SCR having 107 while that for HROs was 18 (See Figure 1 for process summary). The search was concluded on 15th May 2018.

Insert Figure 1

Analysis and Synthesis

After the selection of the final documents, a systematic review catalogue which served as the data extraction form (Denyer and Tranfield, 2009) was prepared with Microsoft Excel to facilitate the analysis process. Two different sheets were used for the two areas of study under review. On the sheet for SCR, the major columns were Authors, Journal, Title of article, Year, Supply chain focus, formative elements identified, identified research methods and additional notes. On that for HROs, the main columns were Authors, Journal, Title of article, Year, identified HROs, Characteristics, adopted research methods and additional notes. The indicated sections were derived by answering the 12 questions proposed by Denyer and Tranfield (2009, p.685). This was to facilitate the dissection of the various studies into their constitutive components and to help describe the relationships between them.

A synthesis of this data subsequently followed where linkages within and between studies are highlighted and patterns exposed. Here, the various perspectives on identified characteristics, formative elements and characteristics are compared to make apparent the information that may not be readily obvious from isolated individual studies.

Proposed Formative Elements for SCR

In suggesting ways of achieving supply chain resilience, many authors (e.g. Christopher and Peck, 2004; Sheffi, 2005a, b; Ponomarov and Holcomb, 2009; Lengnick-Hall et al., 2011; Klibi and Martel, 2013) have touched on various formative elements, some of which were already existent but not necessarily

considered as a means of building resilience. From the SLR, several formative elements of resilience were identified, and these along with the number of articles that cited them are indicated in Table 2.

Insert Table 2

Of all the identified formative elements, the most posited as critical resilience elements were supply chain collaboration and flexibility appearing 74 and 73 times respectively. Following closely behind was redundancy after which was agility, with sustainability and logistics capability being the least cited by authors.

Table A1 in the Appendix provides all the 107 reviewed articles on SCR and the corresponding formative elements identified in each.

HRO Characteristics

Not too many organisations have been identified as HROs. From the on-set of the theory, the three organisations originally identified were the US air traffic control system, an electricity company operating both a nuclear power station (Diablo Canyon) and an electricity distribution system and the US Navy nuclear aircraft carrier operations. Most literature on HROs are derived from these (Hopkins, 2007). The frequency of citations for the top 6 organisations identified as HROs in literature is provided in Table 3.

Insert Table 3

A few other organisations such as the nuclear submarines and firefighting have been cited sparingly.

In identifying the attributes and manner of operations of HROs, a total of 14 were found in the literature reviewed. Decision making was the most highlighted dynamic which was closely followed by various ideas of culture (including just culture, learning culture, respectful interaction and/or heedful interrelation). Awareness was the least cited characteristic which was surprising because many of the other characteristics are facilitated by having awareness and/or visibility. However, this may be because in most of the literature, awareness was implied implicitly but not explicitly identified as a characteristic. Bierly and Spender (1995, p. 655) for instance acknowledges this when it points out from the seminal research in the field that, members of HROs submit to a "higher level body of knowledge and experience" without being fully conscious of it. Weick and Roberts (1993, p. 357) describes the concept of a "collective mind" as "a pattern of heedful interrelations of actions" and proceeds to posit that organisational errors decrease as heedful interrelations and mindful comprehension increase. Yet, the paper failed to acknowledge how the awareness of employees is fundamental to the attainment of this "collective mind" and did not therefore identify it as a distinctive characteristic of the HRO they studied. The various characteristics identified, and their citations are presented in Table 4.

Insert Table 4

In the 18 studies reviewed, there was significant consistency in the characteristics identified; nine papers identified at least nine out of the 14 characteristics. This may be attributable to the relatively small number of organisations studied under this theory and the narrow nature of its research stream. Details of each HRO reviewed paper and the corresponding characteristics identified are provided in the Appendix in Table A2.

Similarities in SCR formative elements and HRO characteristics and Lessons from HRO

A careful comparison between the proposed formative elements for SCR and the characteristics of HROs reveal that significant similarities exist between the approaches towards attaining SCR and those for high reliability – even though the difference in conceptualising these elements are very obvious. Out of the 13 formative elements identified in the studies, five had no parallels in the characteristics of HROs. Therefore, considering the aim of this research is to identify similarities and transferable lessons from HROs, these are not discussed. Further reading however are suggested as follows: integration (See Ali et al., 2017; Brusset and Teller, 2017; Datta, 2017), robustness (See Brandon-Jones et al., 2014; Durach et al., 2015; Hasani and Khosrojerdi, 2016), logistics capability (See Urciuoli et. al, 2014; Ho et al.; 2015 and Tukamuhabwa et al., 2015), security (See Bandyopadhyay et al., 1999; Datta, 2017) and sustainability (Fahimnia and Jabbarzadeh, 2016).

Before discussing the similarities, the most unique characteristic of HROs that barely features in any of the prescribed SCR formative elements is the strong commitment from top management towards reliability. This is captured as 'collective mindfulness' (Weick et al., 1999) or 'mindful leadership' (Lekki, 2011). Management exhibits this commitment through fiscal commitment to safety, support of a conscious creation of an improvisation culture when the situation demands and an environment where incident reporting is made easy and also rewarded rather than punished (Weick et al., 1999; Cooke, 2003; Lekka and Sugden, 2011; Lekki, 2011; Linnenluecke, 2017). Further, there is the willingness to engage in experiments aimed at enhancing learning and readiness for the unexpected (Fiol and O'Connor, 2003). Despite featuring prominently in the SCR literature as a requirement for formative elements such as collaboration (Ponomarov, 2012), culture (Christopher and Peck, 2004; Tukamuhabwa et al., 2015; Kamalahmadi and Parast, 2016), flexibility (Skipper and Hanna 2009; Spiegler et al., 2012), redundancy (Christopher and Peck, 2003), logistics capability (Ponomarov and Holcomb, 2009), sustainability (Seuring and Beske, 2014) and also risk management (Giunipero and Aly Eltantawy, 2004; Ponomarov and Holcomb, 2009), support from top management has not been explicitly identified as a SCR formative element. Considering that it is antecedent to so many formative elements and that it is cited as a prominent HRO characteristic, it is proposed that top managerial support has to be researched as a SCR formative element. In practice, strategic level managers must be willing to invest in training and simulation sections that will better prepare their employees and players in their supply chains for disruptions. Recalling Christopher and Peck's (2004) finding that some companies do not have supply chain representation in their boardrooms, it is argued that for an organisation to have a resilient supply chain, genuine commitment including the needed appropriation of resources from top management is required. A commitment to ensure continuous improvement by pushing for ways to improve their network design and risk management strategies should be encouraged.

Human Resource Management

Moving on to the themes that are common to the two streams of literature, we start with approach to human resource management. As a formative element of SCR, Human Resource Management (HRM) involves the development of the human resources and knowledge management (Blackhurst et al., 2011; Pettit et al., 2013; Kamalahmadi and Parast, 2016; Ali et al., 2017). Human resource development can be pursued through the education and training programmes targeted at improving employees' understanding of the supply chain (Kern et al., 2012; Hohenstein et al., 2015). Further, the use of supply chain drills, simulations and exercises, inter-organisational learning and the creation of a risk management culture have been identified to nurture the technical, cognitive, behavioural and

contextual elements required by the human resources in pursuit of SCR (Rice and Caniato, 2003; Finch, 2004; Norrman and Jansson, 2004; Lengnick-Hall et al., 2011; Ali et al., 2017). Training programmes are also required to facilitate knowledge management (Jüttner and Maklan, 2011; Ali et al., 2017) but more significantly, documentation of critical processes and access to such documents (Sheffi, 2001). The use of cross training to improve the flexibility of employees as well as the establishment of cross-functional teams (Sheffi, 2001; Hohenstein et al., 2015) have been prescribed to facilitate resilience in supply chains. Though management of human resources does not feature as a highly cited formative element, encouraging of teamwork, continuous training and cross-training of staff is highlighted as critical in both HRO literature (Roberts, 1990; Bierly and Spender, 1995; Vogus and Welbourne, 2003) and SCR literature (Finch, 2004; Norrman and Jansson, 2004; Blackhurst et al., 2011; Lengnick-Hall et al., 2011).

HROs acknowledge the critical role their employees play in helping them achieve their high levels of reliability and are hence noted to spend disproportionately more money than other organisations in training their staff (Roberts et al., 2001). They pursue careful recruitment (La Porte, 1996; Ericksen and Dyer, 2005), are committed to the provision of staff incentives and also put in measures to ensure staff retention (Roberts et al., 2001; Vogus and Welbourne, 2003). Lessons here are that these efforts must be crucial for the human resource managers in supply chains and they must be included to the varied approaches already indicated in SCR literature. Focus companies must especially be willing to invest in and retain core staff including senior management whose decisions affect the status of their supply chains. This will ensure that employees have the right frame of mind, capabilities and individual resilience to make the right decisions in or out of crisis. The criticality of HRM cannot be overemphasised as it plays a role in the attainment of the heightened look out for risks to facilitate risk avoidance, the institution of decision redundancy, fostering trust and openness for enhanced collaboration, instilling a resilience culture and the pursuit of flexible decision-making – some lessons in the subsequent sections.

Avoidance

19 out of the 107 papers reviewed on SCR suggest an organisation's ability to identify risks early and avoid them in time is crucial for attaining resilience (See Table 2 and Table A1). This involves being able to avoid risks by dropping products with uncertain demands, avoiding specific markets in certain geographical locations and avoiding suppliers with high risk profiles (Jüttner et al., 2003; Klibi et al., 2010; Thun and Hoenig, 2011; Grötsch et al., 2013; Tukamuhabwa et al., 2015). It also includes avoiding extreme leaning and efficiency (Kleindorfer and Saad, 2005) and avoiding risks through visibility (Kleindorfer and Saad, 2005; Manuj and Mentzer, 2008; Colicchia and Strozzi, 2012; Grötsch et al., 2013; Kamalahmadi and Parast, 2016; Ali et al., 2017).

A similar prescription in HRO literature is ‘preoccupation with failure’ where there is a constant look out for indications for larger failures by hunting for lapses and errors in order to gain insight into the strengths and weaknesses of their systems (Rochlin, 1993; Bierly and Spender, 1995; La Porte, 1996; Schulman, 2004; Hopkins, 2007). All failures – irrespective of how small, are viewed as being indicative of the overall reliability of the system. Near failures are thoroughly analysed and the liabilities associated with success are focused on in order to avoid complacency (Wieck et al., 1999). The goal is to anticipate and mitigate accidents before they occur or at the least, to detect, locate and contain them before escalation (Eriksen and Dyers, 2005). To achieve this, HROs have well-developed reporting systems which allow for lessons to be drawn from these events and a realistic view of their operations to be obtained for consequent improvement.

Here the lesson is a relatively more heightened look out for risks facilitated by collaboration and a reporting culture so that there is an incessant identification of processes that must necessarily go right, processes that can suffer disruptions, how disruptions can occur and what disruptions have occurred in the supply chain (Sutcliffe, 2011).

Redundancy

It is a well-established and widely prescribed formative element for SCR. Prescriptions for redundancy in SCR literature can be captured under tangible and intangible redundancy. Tangible redundancy includes low capacity utilisation or excess capacity (Sheffi, 2001; Jüttner, 2005), employees (Sheffi, 2005a), facilities (Sheffi and Rice Jr., 2005; Knemeyer et al., 2009), transport modes (Linnenluecke, 2017) and additional inventory (Sheffi, 2001; Chopra and Sodhi, 2004; Sheffi and Rice Jr., 2005; Priya Datta et al., 2007; Pereira et al., 2014; Ali et al., 2017). Others are the use of multiple suppliers (Sheffi, 2001; Chopra and Sodhi, 2004; Kleindorfer and Saad, 2005; Hohenstein et al., 2015), ICT backup equipment – physical or virtual backup (Sheffi, 2001; Kleindorfer and Saad, 2005; Petit et al., 2013) and power equipment (Petit et al., 2010). Intangible redundancy may be pursued through supplier relationships (Zsidisin and Wagner, 2010; Jüttner and Maklan, 2011), multi-skilled staff achieved through cross training (Sheffi, 2001), having continuity plans in place (Zsidisin and Wagner, 2010) and using multiple processes (Jüttner, 2005; Johnson et al., 2013).

Redundancy in HROs involves the ability to provide for task execution in the event of a failed or faulty primary unit (Rochlin et al., 1987). This is achieved through technical redundancy which involves back up of all critical operational components (Rochlin et al., 1987; Weick, 1987; Hofmann et al., 1995; Saleh et al., 2010) as well as redundancy in skills set or expertise of staff which is achieved through systematic rotation. This involves monitoring of each other's work as well (Weick and Roberts, 1993; Bierly and Spender, 1995; La Porte, 1996; Roberts et al., 2001). There is also decision/management redundancy which is achieved through organisational strategies to ensure that critical decisions are timely and correct. This is achieved by using redundant control and information systems (Rochlin et al., 1987; Roberts and Rousseau, 1989; Weick and Roberts, 1993; Hofmann et al., 1995).

Considering the significant overlap in prescriptions for redundancy, the most obvious lesson for practitioners from HROs is decision redundancy and even though this may not be strictly applicable in some organisations, it is herein argued that critical decisions made and communicated verbally should be backed with emails to all stakeholders; firstly to ensure the content does not change through grapevine (Mishra, 1990), secondly to permit for monitoring of decisions during disruptions and lastly to help evaluate the impact and effectiveness of decisions in order to inform future direction. This will alleviate the effects of staff turnover or absenteeism since records of the decisions taken and their effectiveness will be available for other decision makers. For researchers, questions bothering on how decisions are recorded and monitored, how multiple decisions makers are used to deal with the same disruptions in a supply chain (either simultaneously or sequentially), and the impact of these on a supply chain's resilience present an interesting avenue for empirical research.

Collaboration

This is the most cited formative element for SCR (Refer to Table 2) and this may be attributable to how it facilitates many other formative elements such as visibility, awareness, avoidance, decision-making and integration. Cooperation between supply chain players is prescribed to enhance risk reduction and supply chain recovery capability (Lee, 2002; Norrman and Jansson, 2004; Craighead et al., 2007; Bode et al., 2011; Kamalahmadi and Parast, 2016) and facilitate supply chain intelligence which then brings the awareness to avoid escalation of disruptions (Kleindorfer and Saad, 2005; Craighead et al.,

2007; Brandon-Jones et al., 2014). It boosts confidence and decision making in the supply chain (Christopher and Lee, 2004; Christopher and Peck, 2004; Brandon-Jones et al., 2014; Hohenstein et al., 2015) and enhances control and closer monitoring of suppliers for the purpose of risk avoidance (Christopher and Lee, 2004; Blome and Schoenherr, 2011; Sáenz and Revilla, 2014; Datta, 2017).

Similarly, HROs put a lot of emphasis on situational awareness (La Porte, 1996; Weick et al, 1999; Fiol and O'Connor, 2003; Vogus and Welbourne, 2003; Hopkins, 2007), teamwork (Weick, 1987) and trust (La Porte et al., 1991; Weick et al., 1999; Sutcliffe and Vogus, 2003; Sutcliffe, 2011). Here, the most significant lesson is on how team members in HROs monitor each other, without the "counterproductive loss of operator confidence, autonomy and trust" (La Porte and Consolini, 1991, p.64). Therefore, it can be said that players in a supply chain must have the trust of fellow players in their ability to execute their functions competently while there is yet the openness to monitor each other including the focus organisation in the supply chain.

Managers may achieve this by ensuring that organisations within the supply chain have all requisite certifications in their field of expertise, are enlisted on reputable stock markets and their financial health statuses are publicly available. Even though the role of trust in facilitating collaboration for SCR is acknowledged in the literature (e.g. Kleindorfer et al., 2005; Braunscheidel, 2009; Pereira, 2009; Grötsch et al., 2013; Beske and Seuring, 2014; Ho, 2015; Kamalahmadi and Parast, 2016; Datta, 2017), very few (such as Laeequddin et al., 2009 and Johnson et al., 2013) have explored how trust is built among supply chain partners and how this improves SCR in practice. Further research here is therefore required.

Culture

A culture that helps foster SCR can be identified in literature. It is captured variously as learning-oriented culture (Sheffi and Rice Jr., 2005; Braunscheidel and Suresh, 2009; Lengnick-Hall et al., 2011), information sharing or a reporting culture (Sheffi and Rice Jr., 2005; Lengnick-Hall et al., 2011; Datta, 2017) and risk management culture (Christopher and Peck, 2004; Pettit et al., 2010; Urciuoli et al., 2014; Hohenstein et al., 2015; Tukamuhabwa et al., 2015; Kamalahmadi and Parast, 2016; Ali et al., 2017).

These align almost perfectly with the learning culture (Weick et al., 1999; Lekki, 2011), open and reporting culture (La Porte and Consolini, 1991; Bierly and Spender, 1995; Lekka and Sugden, 2011; Lekki, 2011), and the safety culture (Weick, 1987; Bierly and Spender, 1995; Saleh et al., 2010; Lekki, 2011; Sutcliffe, 2011) of HROs respectively. The difference however is that culture within HROs is oriented against ineffectiveness rather than towards effectiveness (Weick et al., 1999) and hence provides the foundation of high reliability which stems from their preoccupation with failure. It is therefore unsurprising that culture is the second most cited characteristic of HROs while only 21.5% of SCR literature reviewed identified culture.

The lesson for practitioners therefore is that a resilience-seeking culture may have to feature prominently in the focus organisation since this is the way by which a flexible decision-making structure that allows for effective decision making by experts during crisis while maintaining a structured organisational hierarchy is achievable (Weick, 1987). This will then dictate the culture of the rest of the supply chain. This resilience culture will further provide the basis for the operationalisation of the proposed decision-making framework (see Figure 2) where decision makers are presented with "categories, routines and examples of good and poor solutions" (Bierly III and Spender, 1995 p. 643). Within SCR literature where culture is identified as a formative element, a risk management culture is strongly highlighted but there is almost none that proposes a culture that goes

beyond just seeking to manage risks to one that pursues resilience across the supply chain. Further, there is not much literature on practical ways to change the culture within organisations to enable resilience throughout the supply chains. Expanding research on these could perhaps cement culture as a fundamental formative element based on which others may be attained.

Agility

Agility in SCR literature refers to a supply chain's responsiveness to both internal and external unforeseen changes (Christopher and Peck, 2004; Ponomarov and Holcomb, 2009). It is attained by quick reactionary time made possible by early detection of risks and the consequent triggering of response processes (Braunscheidel and Suresh, 2009; Hohenstein et al., 2015; Ali et al., 2017), and accelerated adaptability through rapid supply chain redesign (Swafford et al., 2006; Petit et al., 2010; Blackhurst et al., 2011; Ivanov and Sokolov, 2013; Wieland and Wallenburg, 2013; Hohenstein et al., 2015; Tukamuhabwa et al., 2015; Kamalahmadi and Parast, 2016). These work to minimise impact of disruptions and to facilitate fast recovery. Agility is enhanced through visibility (Christopher and Peck, 2004; Wieland and Wallenburg, 2013; Scholten et al., 2014; Hohenstein et al., 2015), velocity (Christopher and Peck, 2004; Jüttner and Maklan, 2011; Wieland, 2013; Tukamuhabwa et al., 2015), integration (Braunscheidel and Suresh, 2009; Pereira et al., 2014) and flexibility (Swafford et al., 2006; Tang and Tomlin, 2008; Braunscheidel and Suresh, 2009; Ponis and Koronis, 2012).

Agility in HROs is a bit more complex because it is facilitated by an amalgamation of various competences and characteristics rather than a uniquely identified organisational characteristic. To achieve the responsiveness to accidents that HROs are well-known for, the reinforcement of values such as credibility, trust and attentiveness to design and procedures are prioritised. Moreover, organisational culture which ensures a broad vigilance towards potential disruptions through redundancy, continuous training particularly through simulation, strategic prioritisation of safety as well as encouraging improvisation and flexible responses by staff is vigorously pursued (Schulman, 1993; Weick et al., 1999; Fiol and O'Connor, 2003).

Thus, preparedness, awareness and flexibility are common to both SCR and HRO in the pursuit of agility. However, in the case of HROs, their flexible decision-making structure and their mindful staff are central to their adaptive response to changes in their environment (Fiol and O'Connor, 2003). Transferrable practical lessons from HROs for agility in supply chains will be the use of a combination of well-planned and practised response tactics as well as the use of improvisations depending on context.

Flexibility

This features prominently in both streams of literature (See Table 2 and Figure 2). However, the approach to flexibility differs quite significantly. In SCR literature, flexibility is typically to be pursued through operational or sourcing flexibility. Operational flexibility is seen in product flexibility (Sheffi and Rice Jr., 2005; Tang, 2006; Yang and Yang, 2010; Blackhurst et al., 2011; Colicchia and Strozzi, 2012; Sáenz and Revilla, 2014), process flexibility (Colicchia and Strozzi, 2012), transportation flexibility (Tang, 2006; Spiegler et al., 2012; Hohenstein et al., 2015), postponement (Lee, 2002; Jüttner et al., 2003; Christopher and Lee, 2004; Yang and Yang, 2010; Ali et al., 2017; Govindan et al., 2017) and order fulfilment flexibility (Petit et al., 2010; Petit et al., 2013; Ali et al., 2017). Sourcing flexibility is also seen in flexible supplier contracts (Tang, 2006; Petit et al., 2010, 2013; Tukamuhabwa et al., 2015; Datta, 2017), backup suppliers (Hohenstein et al., 2015) and multiple sourcing including sourcing from both local and overseas suppliers (Jüttner et al., 2003; Pereira et al., 2014; Tukamuhabwa et al., 2015).

However, with respect to HROs, flexibility is viewed from an organisational authority structure and decentralisation perspective (Rochlin et al., 1987; Bierly and Spender, 1995; Hofmann et al., 1995; La Porte, 1996), individual flexibility (thinking and decision making) in their response to new challenges and task execution (Rochlin et al., 1987; Weick and Roberts, 1993; Bierly and Spender, 1995; Roberts et al., 2001) and human resource flexibility such as the use of temporary employees (Vogus and Welbourne, 2003). These forms of flexibility allow HROs access to more skills and expertise and enable them to deal with inevitable uncertainties and imperfect knowledge (Sutcliffe and Vogus, 2003; Sutcliffe, 2011).

The lesson from a research perspective is that, there is the need to delve into the role of the flexibility of employees in their thinking and response to disruptions since SCR literature is by and large silent on this. In terms of practice, the idea of flexibility in pursuing SCR has to reflect in the organisation's approach to recruitment and training as was pointed out under human resource management, but more significantly to the structure of the organisation when it comes to decision making under crises or emergency situations. This thus leads to the final lesson to be learned from HROs within this study.

Decision making

Even though it is not shown by the number of citations of decision making in SCR literature, discussions therein show decision making as a critical formative element right from the design of the network to its operations and maintenance (Jüttner, 2005; Tang, 2006; Klibi, 2010; Jabbarzadeh et al., 2016; Ali et al., 2017; Fattahi et al., 2017; Govindan et al., 2017). In order to craft a procurement strategy that allows flexible sourcing but balances the need for resilience and efficiency, critical decisions have to be made (Datta, 2017). When it comes to risk avoidance, managers must be able to decide which products are too risky to maintain in particular geographical locations, which suppliers are deemed risky and must be avoided as well as the extreme supply chain practices that need avoiding. In a similar sense, choice of warehouse locations, distribution centres, manufacturing facilities and similar supply chain design decisions impact the resilience of a supply chain (Jabbarzadeh et al., 2016). All these accentuate the criticality of decision making in the pursuance of resilience in the supply chain. Despite this criticality, only 38.32% of the reviewed SCR literature point to decision making as a formative element.

Decision making in HROs however is the most cited characteristic. Its centrality in their operations is shown in how it features in the other characteristics such as flexibility, redundancy, deference to expertise, reluctance to simplify, awareness, trust and organisational structure. Their organisational authority structure and decentralisation is set up in such a way to facilitate quick and accurate decision making in times of crisis by the most competent staff regardless of their position in the organisation while maintaining a good level of accountability (Roberts and Rousseau, 1989; Roberts et al., 1994; Bierly and Spender, 1995; Waller and Roberts, 2003). This is what is referred to as ‘deference to expertise’ (Roberts et al., 1994; Hopkins, 2007; Saleh et al., 2010; Sutcliffe, 2011). HROs exhibit great expertise when it comes to quick decision making based on limited data and knowing when to abandon routines for improvisation (Weick, 1987; Roberts and Rousseau, 1989). Furthermore, the characteristic referred to as ‘reluctance to simplify’ captures the deliberate effort to get a clearer picture of situations so as to ensure accurate decision making. This they do by taking cognisance of bias in problem diagnosis, prevention of ending causal investigations too early and avoidance of assigning a single cause to errors and incidents (Weick et al., 1999; Weick and Sutcliffe, 2001; Hopkins, 2007; Dekker, 2008).

Even though decision making for resilience occurs in and out of crisis, there are invaluable lessons to be learnt from HROs for SCR especially when the supply chains suffer crisis. Before decisions are made,

the supply chain manager must actively probe received data and verify with other sources to ascertain full authenticity and usefulness. This is useful whether or not the disruption has resulted in a crisis, but it is most crucial under crisis conditions. Further, managers may have to incorporate the needed flexibility in their organisational structure and risk management protocol during crisis that allows employees with the requisite knowledge for making the right decisions and/or problem resolution the authority to do so, irrespective of their hierarchical position in the focus organisation or supply chain. A decision-making framework adopted from HRO literature to provide this flexibility in decision making under crisis situations is presented in Figure 2.

Decision making framework under crisis situations

A decision-making structure may either be over-specified with a predefined approach to decision making or could be a 'mindfulness' structure which encourages flexibility (Fiol and O'Connor, 2003). Therefore, in order to attain the needed flexibility for various kinds of crisis, a mindfulness structure is conflated with three of the four categories in the Cynefin framework to provide the proposed decision-making framework during crisis. Cynefin is a conceptual framework developed by David Snowden which, among other things, offers a categorisation of decision contexts under four categories namely: simple, complicated, complex and chaotic (Snowden and Boone, 2007). The classification of a crisis situation is thus reviewed under the complicated, complex and chaotic contexts.

Insert Figure 2

Complicated Crisis

In complicated crisis, risks are known but outcomes may be ambiguous or contain several right answers; there may also be the potential for catastrophic mistakes (Snowden and Boone, 2007). Even though there is a clear relationship between cause and effect, it is not readily apparent to all and hence often requires expertise. In order to make decisions under this domain, there is the need to create visibility through information sharing on the disruption that has occurred. This is achieved by collaborating with partners particularly at the point of disruption (Roberts et al., 1994) in the supply chain. Once there is sufficient information it must be analysed to identify the appropriate expertise and resources required for response through pre-planned procedures. When decisions require higher accountability or are political in nature, responsibility must shift higher the organisational hierarchy within the supply chain firm addressing the disruption or towards the focus organisation.

Considering that it is the state of knowledge about disruptions that determine which of the crisis domains they may fall under, it is desirable that there is significant knowledge about as many possible disruptions as is possible so that cause and effect relationships are known and forecastable. To achieve this, sufficient investment must be made in risk management in order to identify risks and prescribe appropriate mitigative actions and protocols. This requires commitment from top management to ensure the institution of a risk management culture and to provide appropriate training programmes, contingency planning, simulation exercises and drills that will equip employees with the necessary skills to respond to such disruptions.

Another crucial formative element required to facilitate decision making under the complicated domain is collaboration; it helps create the needed awareness and visibility. Further, it is also expected that the needed investments to provide redundancy or flexibility to address identified risks will be provided accordingly so that uncertainties in decision making are significantly reduced and options available to decision makers are clear and obvious.

Complex Crisis

Unlike in a complicated context where at least one right answer exists, in a complex context, it is extremely difficult to ferret right answers out (Snowden and Boone, 2007); there is a lot of uncertainties. Here, cause and effect relationships become apparent only in retrospect. Therefore, to facilitate decision making, there is the immediate need to create visibility across the supply chain through collaboration within the focus organisation and also within the supply chain partner who has experienced the disruption. This is extremely critical because at the time of such disruptions, the lack of clarity on cause and effect relationships means that predetermined course of action is not useful here – unlike in the complicated domain. Useful information in this case can be obtained from employees as well as public persons who witnessed the disruption. With significant insight gained within the shortest possible time, a cross-sectional team of experts may be assembled to respond as required.

When dealing with complex technological or technical issues where available information has made required actions fairly clear, decisions need to be made by experts right where the action is occurring (Roberts et al., 1994). Complex managerial problems however require a more experimental mode of management (Snowden and Boone, 2007). Top management (particularly of focus organisation) must maintain visibility always to ensure responsive decision making in the face of new information and/or changing circumstances.

In the aftermath of complex crisis, behavioural patterns may emerge and be discernible but there are no perfect repetitions. Thus, in order to learn and be in a better position to avoid or respond to similar disruptions in the future, alternative scenarios can be tested using simulation and discussions within cross-sectional and inter-organisational teams. The aim is to try and move future occurrences as much as possible into the complicated domain where pre-planned procedures and protocols may prove useful. A learning and reporting culture engendered through supply chain collaboration is critical since teams need every available useful information to update contingency plans that may be useful in case such disruptions occur.

Chaotic Crisis

In chaotic crisis, cause and effect relationships are indiscernible (Snowden and Boone, 2007). Here, there is the need to establish order first and make meaning before rational decision making can proceed (Weick, 1987; Snowden and Boone, 2007). Immediately such disruptions occur, there is the need for top management to be informed immediately. Once informed, top management needs to attempt taking some form of action in order to determine the better options for response from the outcome(s) of their initial action. Such actions may include the quick creation of a team of experts from across the supply chain who may be able to attempt initial firefighting, isolation of point of disruption to see if order may be restored to the rest of the supply chain, and evacuation of personnel where there are high risks to human life. Documentation and tracking of decisions and their effects may prove useful at this stage.

Even though things might be chaotic, there is also an opportunity for innovation from multi-skilled or highly experienced personnel within organisations; thus, the utility of training of staff for multiple competencies becomes obvious here since chaotic disruptions are often multi-layered. Human resource managers must ensure that such skilled personnel are given the needed incentives to remain in the organisation. There must also be mentorship programmes for skills transfer to ensure that the potential adverse impact of the departure or retirement of such personnel are somewhat mitigated.

However, when lower-level expertise at the point of disruption is not enough to appropriately respond or there is high responsibility associated with required decisions, decision making must move up organisational hierarchy. There may be the need to engage the services of external expertise immediately some order is restored or when it is realised that in-house expertise is not enough. In such cases, agile and flexible contracting procedures are critical for timely response.

Overall, the main thrust of this framework is that an enabling environment is created for individuals with higher experience and competence to be more likely the source of decisions and to be at the centre of decision networks (Roberts et al., 1994) especially in times of crisis. Further, application of this framework will ensure that most of the possible disruptions in a supply chain are moved into the complicated domain through forecasting and preplanning so that the occurrences of complex and chaotic crisis are extremely rare.

Implications for practice and research

This study has discussed the similarities in the formative elements of SCR and the characteristics of HROs and from this, the following implications for both practice and theory emerge.

Practical Implications

There is the need for context-specific interventions in SCR studies (Datta, 2017) so as to facilitate the successful implementation of proposed formative elements. The adoption of the Cynefin framework to define disruptions under the three crisis contexts in the decision-making framework of this study provides an appropriate contextualisation of crisis and the necessary actions to take to facilitate timely decision making. The findings indicate that commitment from top management is essential in the pursuit of SCR, particularly when it comes to making decisions under crisis. Managers have to understand that without their full commitment, it may be very difficult for their supply chains to attain any level of useful resilience. Investment of resources towards resilience must be viewed as securing business continuity and hence profitability rather than depleting profitability margins.

Further, propositions on a HRO-type approach to risk avoidance for supply chains, how to foster trust for collaboration while maintaining openness with supply chain partners, documentation of critical decisions and their associated benefits have been made. Management can embrace the idea of a flexible organisational structure especially under crisis conditions to ensure that the most competent individual is in a position to take the critical decisions. This will mean that there may be instances where major technical decisions will be taken by experts who may be at lower hierarchical levels while top management focuses on creating order and facilitating these decisions through collaborations with supply chain partners. This can ensure flexible decision-making processes within the supply chains, which is critical for its resilience (Hohenstein et al., 2015; Tukamuhabwa et al., 2015; Ali et al., 2017).

In all three crisis contexts in the proposed decision-making framework, collaboration with supply chain partners in the event of a disruption is among the initial requisite actions. This is needed to create visibility and awareness so that decision makers are equipped adequately to make the most appropriate decisions (Kamalahmadi and Parast, 2016). This therefore establishes collaboration as a crucial formative element which must be prioritised by managers particularly during crisis. In addition to managerial commitment and collaboration, the formative elements of human resource management and culture (risk managing, learning and reporting) have been shown as necessary facilitators of good decisions towards resilience during crisis. Therefore, managers have been put in a

position to optimise these within their organisations to create the most appropriate decision-making enabling environment in case of disruptions.

Research implications

This study has brought to fore the usefulness of High reliability theory in broadening the understanding of resilience in supply chains (Ali et al., 2017; Linnenluecke, 2017) and has shown that current knowledge, conceptualisation and application of known formative elements of SCR can be expanded through transferrable lessons from HROs. For example, it has pointed out the need to explore the ideas of a resilience culture and decision redundancy as well as the need to address the current gaps in the literature on how trust is built between supply chain partners to improve collaboration for SCR. It has also pointed out how individual flexibility in thinking and the disaster response of employees in a given supply chain influence its resilience. By this use of HRT, this paper has contributed to meeting the need for theoretical application to ground the usefulness of SCR in the management of supply chains (Pereira et al., 2014; Tukamuhabwa et al., 2015). The utility of the Cynefin framework in categorising different crisis situations has been highlighted and this can prove helpful in contextualising specific interventions targeted at improving SCR (Datta, 2017).

This study has shown that beyond its practical implication, the commitment of top management must also be considered as a SCR formative element. This can be seen in its utility in both HROs and SCR, especially how it facilitates many of the other characteristics and formative elements respectively. Beyond the likelihood of poor decisions by managers compounding the vulnerability of supply chains to exogenous threats (Christopher and Peck, 2004; Tukamuhabwa et al., 2015), management's commitment shown through resource investment and the creation of an enabling environment, can be seen as a vehicle through which supply chains can organise for resilience.

Finally, this paper indicates by its discussion of decision making in HRO and SCR literature and the consequent proposed framework that decision making strategies can be a useful area to explore for additional ways to build SCR beyond the highly proposed formative elements of flexibility, redundancy, agility and collaboration (Tukamuhabwa et al., 2015). By being the first SLR of HROs in SCR studies, this paper shows the widespread acknowledgement in the HRT literature of the centrality of decision making in the ability of HROs to achieve and maintain their high levels of reliability.

Limitations and Future research

A limitation of this research as is with all others that adopt SLR is the imperfect nature of the judgement of articles and the selection. Furthermore, the analysis of the information and synthesis are influenced by the research background and social constructs of the researchers (Datta, 2017) and these biases are herein acknowledged albeit sufficient efforts were invested to neutralise them. Also, the restriction of the articles to be included for the SLR to only ABS-ranked journals and the time span used may have prevented the inclusion of some articles which could have provided useful information. For instance, articles on HROs from the health sciences (such as Baker et al., 2006; Christianson et al., 2011 and Lekka, 2011) could not be included in the SLR. Lastly, because the paper focused on identifying the similarities in SCR formative elements and the characteristics of HROs, it failed to provide in-depth discussions on the other formative elements which were not relevant to it.

Regardless of these limitations, insights from this study reveal a number of gaps that hold exciting prospects for future research. The first is that there is the need to further explore the role that decision-making plays in the creation of SCR. Current research (such as Fahimnia and Jabbarzadeh,

2016; Hasani and Khosrojerdi, 2016; Jabbarzadeh et al., 2016; Fattahi et al., 2017 and Govindan et al., 2017) have largely focused on proposing quantitative models to guide network design decision-making for resilience. However, there is the need to go beyond network design and look at decision making in other aspects of the management of supply chain for resilience including operations, distribution and procurement decisions. Attention must be given to the qualitative aspects of decision making such as providing empirical data on the enablers of decision-making during crisis. The testing of the proposed framework of this study could be a great starting point. Secondly, having pointed out the need to identify managerial commitment as a formative element, research into the role that managers' perception of resilience, their individual resilience and their risk personalities play in their approach to SCR will be useful.

As changes in climate are becoming more obvious and the population of the world also increases, the occurrences and impacts of both slow-onset disasters (such as famines, drought, political crises) and sudden-onset disasters (such as flooding, earthquakes, hurricanes, coup d'états) are on the ascendency in the past couple of decades compared to previous decades (Guha-Sapir et al., 2016). It is therefore important to investigate further the need for resilient supply chains for the future, not only in the commercial ones but quite significantly in humanitarian supply chains as well and the impact these recent trends have on global sourcing and distribution. Moreover, a research into how the sustainability of supply chain partners can affect an organisation's SCR may provide useful insight into the kind of attention organisations need to give to their suppliers and distributors in the areas of employee remuneration, sources of raw material, green production and fair trade.

Finally, in terms of the transferability of HRO lessons into other fields of study and practice, the health and medical sciences have led the way in exploring and implementing HRT concepts in hospitals and care centres over the past two decades. Examples of such studies include Knox et al. (1999), Roberts et al. (2005), Carroll and Rudolph (2006), Pronovost et al. (2006), Bagnara et al. (2010), Chassin and Loeb (2013), Provost et al. (2015), Lane et al. (2016), Aboumatar et al. (2017), Padgett et al. (2017) and Sutcliffe et al. (2017). With this study being the first to introduce HRT principles into SCR, there is the need for further studies into the usefulness and applicability of these in creating more resilient supply chains.

Conclusion

The increasing spate of the frequency of disasters and their consequences on supply chains globally reinforce the need for resilient supply chains capable of avoiding, enduring or recovering from the aftermath of disasters as well as disruptions either within an organisation or its supply chain. Considering that HRT research has shown organisations that have the ability to avoid accidents and operate at very high levels of safety, this research has systematically reviewed its literature to identify HRO characteristics and SCR literature to identify proposed formative elements. These answered the first two research questions of this research. Then similarities between the characteristics and formative elements are discussed under human management resources, avoidance, redundancy, flexibility, culture, agility, collaboration and decision making where useful lessons from HROs that can aid in the development of resilient supply chains are pointed out.

Findings have indicated that despite the significant similarities in the characteristics of HROs and the proposed SCR formative elements, the approach and applications are quite different. It is from these that the lessons are largely pointed out. However, it establishes that commitment from top management is deemed critical in HROs whereas it receives no such attention in SCR literature. This

is therefore strongly posited as something worth pursuing towards attaining resilience in supply chains. However, the major lesson identified from this research is the centrality of flexible decision-making structures in HROs and how this underpins their success in the attainment of high reliability. To this end, a flexible decision-making framework which is adapted from a combination of Roberts et al.'s (1994) model of flexible decision making in HROs and three of the four domains of the Cynefin framework (Snowden and Boone, 2007) is presented. This framework is to help contextualise different types of disruptions and the actions required to facilitate effective decision making by the most competent persons regardless of their hierarchical position in the organisation(s) involved.

This research has significant implications for practitioners and SCR research. It amplifies the role of management in the pursuance of SCR and provides managers with lessons and a guiding framework for decision making by which major strides towards the attainment of resilience in their supply chains can be pursued.

References

Abidi, H., de Leeuw, S. and Klumpp, M. (2014), “Humanitarian supply chain performance management: a systematic literature review”, *Supply Chain Management: An International Journal*, Vol. 19 No. 5/6, pp. 592-608.

Aboumatar, H. J., Weaver, S. J., Rees, D., Rosen, M. A., Sawyer, M. D. and Pronovost, P. J. (2017), "Towards high-reliability organising in healthcare: a strategy for building organisational capacity", *BMJ Quality Safety*, Vol. 26 No. 8, pp. 663-670.

Albino, V., Garavelli, A.C. and Okogbaa, O.G. (1998). “Vulnerability of production systems with multi-supplier network: A case study”, *International Journal of Production Research*, Vol. 36 No. 11, pp. 3055-3066.

Alexander, A., Walker, H., Naim, M. (2014), "Decision theory in sustainable supply chain management: a literature review", *Supply Chain Management: An International Journal*, Vol. 19 No. 5/6, pp. 504-522.

Ali, A., Mahfouz, A. and Arisha, A. (2017), “Analysing supply chain resilience: integrating the constructs in a concept mapping framework via a systematic literature review”, *Supply Chain Management: An International Journal*, Vol. 22 No. 1, pp. 16-39.

Ambulkar, S., Blackhurst, J. and Grawe, S. (2015), “Firm's resilience to supply chain disruptions: Scale development and empirical examination”, *Journal of Operations Management*, Vol. 33-34 No. 2015, pp. 111-122.

Anderson, N., Herriot, P. and Hodgkinson, G. P. (2001), “The practitioner-researcher divide in industrial, work and organizational (IWO) psychology: where are we now, and where do we go from here?”, *Journal of Occupational & Organizational Psychology*, Vol. 74 No. 4, pp. 391-411.

Bag, S. (2016), “Humanitarian supply chain management: a bibliometric analysis of the literature”, *AIMS International Journal of Management*, Vol. 10 No. 3, pp. 175-202.

Bagnara, S., Parlangeli, O. and Tartaglia, R. (2010), "Are hospitals becoming high reliability organizations?", *Applied ergonomics*, Vol. 41 No. 5, pp. 713-718.

Baker, D. P., Day, R., and Salas, E., (2006), “Teamwork as an essential component of high-reliability organizations.” *Health Services Research*, Vol. 41 No. 4 pt. 2, pp. 1576-1598.

Bakshi, N. and Kleindorfer, P. (2009), “Co-opetition and investment for supply-chain resilience”, *Production and Operations Management*, Vol. 18 No. 6, pp. 583-603.

Bandyopadhyay, K., Mykytyn, P.P. and Mykytyn, K. (1999), “A framework for integrated risk management in information technology”, *Management Decision*, Vol. 37 No. 5, pp. 437-445.

Banomyong, R., Varadejsatitwong, P. and Oloruntoba, R. (2017), “A systematic review of humanitarian operations, humanitarian logistics and humanitarian supply chain performance literature 2005 to 2016”, *Annals of Operations Research*, pp. 1-16.

Baumeister, R. F., and Leary, M. R. (1997), “Writing narrative literature reviews”, *Review of General Psychology*, Vol. 1 No. 3, pp. 311–320.

Bell, M. A. (2002), *The Five Principles of Organizational Resilience*, Gartner Newsletter.

Beske, P., and Seuring, S. (2014), “Putting sustainability into supply chain management”, *Supply Chain Management: An International Journal*, Vol. 19 No. 3, pp. 322-331.

Bierly III, P. E. and Spender, J.-C. (1995), "Culture and high reliability organizations: the case of the nuclear submarine", *Journal of Management*, Vol. 21 No. 4, pp. 639-656.

Blome, C., and Schoenherr, T. (2011), “Supply chain risk management in financial crises—A multiple case-study approach”, *International Journal of Production Economics*, Vol. 134 No. 1, pp. 43-57.

Bode, C., Wagner, S. M., Petersen, K. J. and Ellram, L. M. (2011), “Understanding responses to supply chain disruptions: insights from information processing and resource dependency perspectives”, *Academy of Management Journal*, Vol. 54 No. 4, pp. 833-856.

Boin, A. and McConnell, A. (2007), “Preparing for critical infrastructure breakdowns: the limits of crisis management and the need for resilience”, *Journal of Contingencies & Crisis Management*, Vol. 15 No. 1, pp. 50-59.

Boin, A. and Schulman, P. (2008), “Assessing NASA’s safety culture: the limits and possibilities of high-reliability theory”, *Public Administration Review*, Vol. 68 No. 6, pp. 1050-1062.

Boin, A., and 't Hart, P. (2010), “Organising for effective emergency management: Lessons from research 1”, *Australian Journal of Public Administration*, Vol. 69 No. 4, pp. 357-371.

Booth, A., Papaioannou, D. and Sutton, A. (2012), *Systematic Approaches to a Successful Literature Review*, Sage Publications, Thousand Oaks, CA.

Bourrier, M. (2011), “The legacy of the high reliability organization project”, *Journal of Contingencies & Crisis Management*, Vol. 19 No. 1, pp. 9-13.

Brand, F. S. and Jax, K. (2007), “Focusing the meaning(s) of resilience: resilience as a descriptive concept and a boundary object”, *Ecology & Society,* Vol. 12 No. 1, pp. 1-16.

Brandon-Jones, E., Squire, B., Autry, C. W. and Petersen, K. J. (2014), “A contingent resource-based perspective of supply chain resilience and robustness”, *Journal of Supply Chain Management,* Vol. 50 No. 3, pp. 55-73.

Braunscheidel, M. J. and Suresh, N. C. (2009), “The organizational antecedents of a firm’s supply chain agility for risk mitigation and response”, *Journal of Operations Management,* Vol. 27 No. 2, pp. 119-140.

Brusset, X. and Teller, C. (2017), “Supply chain capabilities, risks, and resilience”, *International Journal of Production Economics*, Vol. 184 No. 2017, pp. 59-68.

Cabral, I., Grilo, A. and Cruz-Machado, V. (2012), “A decision-making model for lean, agile, resilient and green supply chain management”, *International Journal of Production Research*, Vol. 50 No. 17, pp. 4830-4845.

Carroll, J. S. and Rudolph, J. W. (2006), "Design of high reliability organizations in health care", *BMJ Quality & Safety*, Vol. 15 No. 1, pp. i4-i9.

Carvalho, H., Barroso, A. P., Machado, V. H., Azevedo, S. and Cruz-Machado, V. (2012), “Supply chain redesign for resilience using simulation”, *Computers & Industrial Engineering,* Vol. 62 No 1, pp. 329-341.

Chassin, M. R. and Loeb, J. M. (2013), "High-reliability health care: getting there from here", *The Milbank Quarterly*, Vol. 91 No. 3, pp. 459-490.

Chopra, S. and Sodhi, M. (2004), "Managing risk to avoid supply chain breakdown [J]", *MIT Sloan Management Review*, Vol. 46 No. 1, pp. 53-61.

Christianson, M. K., Sutcliffe, K. M., Miller, M. A., and Iwashyna, T. J. (2011), "Becoming a high reliability organization", *Critical Care*, Vol. 15 No. 6, p. 314

Christopher, M. and Holweg, M. (2011), "Supply chain 2.0: managing supply chains in the era of turbulence", *International Journal of Physical Distribution & Logistics Management*, Vol. 41 No. 1, pp. 63-82.

Christopher, M. and Peck, H. (2003), "Creating resilient supply chains: A practical guide", *Cranfield University School of Management*.

Christopher, M. and Peck, H. (2004), "Building the resilient supply chain", *The International Journal of Logistics Management*, Vol. 15 No. 2, pp. 1-13.

Christopher, M., and Lee, H. (2004), "Mitigating supply chain risk through improved confidence", *International Journal of Physical Distribution & Logistics Management*, Vol. 34 No. 5, pp. 388-396.

Colicchia, C. and Strozzi, F. (2012), "Supply chain risk management: a new methodology for a systematic literature review", *Supply Chain Management: An International Journal*, Vol. 17 No. 4, pp. 403-418.

Colicchia, C., Dallari, F. and Melacini, M. (2010), "Increasing supply chain resilience in a global sourcing context", *Production Planning & Control*, Vol. 21 No. 7, pp. 680-694.

Cooke, D. L. (2003), *Learning from Incidents*. In 21st System Dynamics Conference, NYC, New York.

Cooper, H. M. and Hedges, L. V. (1994), *The Handbook of Research Synthesis*, Russell: Sage Foundation.

Cooper, M. C., Lambert, D. M. and Pagh, J. D. (1997), "Supply chain management: more than a new name for logistics", *The International Journal of Logistics Management*, Vol. 8 No. 1, pp. 1-14.

Counsell, C. (1997), "Formulating questions and locating primary studies for inclusion in systematic reviews", *Annals of Internal Medicine*, Vol. 127 No. 5, pp. 380-387.

Coutu, D. L. (2002), "How resilience works", *Harvard Business Review*, May, pp. 47-55.

Craighead, C. W., Blackhurst, J., Rungtusanatham, M. J. and Handfield, R. B. (2007), "The severity of supply chain disruptions: design characteristics and mitigation capabilities", *Decision Sciences*, Vol. 38 No. 1, pp. 131-156.

Datta, P. (2017), "Supply network resilience: a systematic literature review and future research", *International Journal of Logistics Management,* Vol. 28 No. 4, pp. 1387-1424.

Dekker, S., Hollnagel, E., Woods, D., and Cook, R. (2008), "Resilience engineering: new directions for measuring and maintaining safety in complex systems", *The Second Progress Report.*

Denyer, D, and Tranfield, D. (2009), "Producing a systematic review", In: Buchanan, D. A. and Bryman, A. (Eds). *The Sage handbook of organizational research methods*. (pp. 671-689). Thousand Oaks, CA: Sage Publications Ltd, xxxvi.

Dubey, R. and Gunasekaran, A. (2016), "The sustainable humanitarian supply chain design: agility, adaptability and alignment", *International Journal of Logistics Research & Applications*, Vol. 19 No. 1, pp. 62-82.

Durach, C. F., Wieland, A. and Machuca, J.A. (2015), "Antecedents and dimensions of supply chain robustness: a systematic literature review", *International Journal of Physical Distribution & Logistics Management*, Vol. 45 No. 1/2, pp. 118-137.

Ericksen, J., and Dyer, L. (2005), "Toward a strategic human resource management model of high reliability organization performance", *The International Journal of Human Resource Management*, Vol. 16 No. 6, pp. 907-928.

Fahimnia, B. and Jabbarzadeh, A. (2016), "Marrying supply chain sustainability and resilience: a match made in heaven", *Transportation Research Part E: Logistics & Transportation Review*, Vol. 91 No. 2016, pp. 306-324.

Fattahi, M., Govindan, K. and Keyvanshokooh, E. (2017), "Responsive and resilient supply chain network design under operational and disruption risks with delivery lead-time sensitive customers", *Transportation Research Part E: Logistics & Transportation Review*, Vol. 101 No. 2017, pp. 176-200.

Finch, P. (2004), "Supply chain risk management." *Supply Chain Management: An International Journal*, Vol. 9 No. 2, pp. 183-196.

Fiol, C. M. and O'Connor, E. J. (2003), "Waking up! Mindfulness in the face of bandwagons." *Academy of Management Review,* Vol. 28 No. 1, pp. 54-70.

Fisher, M., Hammond, J., Obermeyer, W. and Raman, A. (1997), "Configuring a supply chain to reduce the cost of demand uncertainty", *Production & Operations Management*, Vol. 6 No. 3, pp. 211-225.

Folke, C**.** (2006), "Resilience: the emergence of a perspective for social-ecological system analyses", *Global Environmental Change,* Vol 16 No. 3, pp. 253-267.

Frederickson, H. G. and LaPorte, T. R. (2002), "Airport security, high reliability, and the problem of rationality", *Public Administration Review*, Vol. 62 No. 2002, pp. 33-43.

Gimenez, C. and Tachizawa, E. M. (2012), "Extending sustainability to suppliers: a systematic literature review", *Supply Chain Management: An International Journal*, Vol. 17 No. 5 pp. 531-543.

Giunipero, L. C. and Eltantawy, R. A. (2004), "Securing the upstream supply chain: a risk management approach", *International Journal of Physical Distribution & Logistics Management*, Vol. 34 No. 9, pp. 698-713.

Gligor, D. M. and Holcomb, M. C. (2012), "Understanding the role of logistics capabilities in achieving supply chain agility: a systematic literature review", *Supply Chain Management: An International Journal*, Vol. 17 No. 4, pp. 438-453.

Govindan, K., Fattahi, M. and Keyvanshokooh, E. (2017), "Supply chain network design under uncertainty: A comprehensive review and future research directions", *European Journal of Operational Research*, Vol. 263 No. 1, pp. 108-141.

Grötsch, V.M., Blome, C. and Schleper, M.C. (2013), "Antecedents of proactive supply chain risk management – a contingency theory perspective", *International Journal of Production Research*, Vol. 51 No. 10, pp. 2842-2867.

Guha-Sapir, D., Hoyois, P. and Below, R. (2016), *Annual Disaster Statistical Review 2016: The Numbers and Trends,* Brussels.

Hall, R. (1999), "Rearranging risks and rewards in a supply chain", *Journal of General Management*, Vol. 24 No. 3, pp. 22-32.

Hamel, G. and Valikangas, L. (2003), "The quest for resilience", *Harvard Business Review*, Vol. 81 No. 9, pp. 52-65.

Harrison, C., Paul, S. and Burnard, K. (2016), "Entrepreneurial leadership: a systematic literature review", *International Review of Entrepreneurship*, Vol. 14 No. 2, pp. 235-264.

Hart, C. (1998), *Doing a Literature Review: Releasing the Social Science Research Imagination.* Thousand Oaks, CA: Sage Publications.

Harvey, C., Kelly, A., Morris, H. and Rowlinson, M. (2011), *ABS Journal Quality Guide*, The Association of Business Schools, London.

Hasani, A. and Khosrojerdi, A. (2016), "Robust global supply chain network design under disruption and uncertainty considering resilience strategies: A parallel memetic algorithm for a real-life case study", *Transportation Research Part E: Logistics & Transportation Review*, Vol. 87 No. 2016 pp. 20-52.

Hearnshaw, E. J. S. and Wilson, M. M. J. (2013), "A complex network approach to supply chain network theory", *International Journal of Operations & Production Management*, Vol. 33 No. 4, pp. 442-469.

Heimann, L. (2005), "Repeated failures in the management of high-risk technologies", *European Management Journal*, Vol. 23 No. 1, pp. 105-117.

Ho, W., Zheng, T., Yildiz, H. and Talluri, S. (2015), "Supply chain risk management: a literature review", *International Journal of Production Research*, Vol. 53 No. 16, pp. 5031-5069.

Hofmann, D. A., Jacobs, R., and Landy, F. (1995), "High reliability process industries: Individual, micro and macro organisational influences on safety performance." *Journal of Safety Research*, Vol. 26 No. 3, pp. 131-149.

Hohenstein, N.-O., Feisel, E., Hartmann, E., Giunipero, L. (2015), "Research on the phenomenon of supply chain resilience", *International Journal of Physical Distribution & Logistics Management*, Vol. 45 No. 1/2, pp. 90-117.

Holling, C. S. (1973), "Resilience and stability of ecological systems", *Annual Review of Ecology & Systematics,* Vol. 4 No. 1, pp. 1-23.

Hopkins, A. (2007), "The problem of defining high reliability organisations", *National Research Center for Occupational Safety and Health Regulation*. January.

Ishfaq, R. (2012), "Resilience through flexibility in transportation operations", *International Journal of Logistics: Research & Applications*, Vol. 15 No. 4, pp. 215-229.

Ivanov, D., and Sokolov, B. (2013), "Control and system-theoretic identification of the supply chain dynamics domain for planning, analysis and adaptation of performance under uncertainty", *European Journal of Operational Research*, Vol. 224 No. 2, pp. 313-323.

Jabbarzadeh, A., Fahimnia, B., Sheu, J. B. and Moghadam, H. S. (2016), “Designing a supply chain resilient to major disruptions and supply/demand interruptions”, *Transportation Research Part B: Methodological*, Vol. 94 No. 2016, pp. 121-149.

Johnson, N., Elliott, D. and Drake, P. (2013), “Exploring the role of social capital in facilitating supply chain resilience”, *Supply Chain Management: An International Journal*, Vol. 18 No. 3, pp. 324-336.

Jüttner, U., (2005), “Supply chain risk management – understanding the business requirements from a practitioner perspective”, *The International Journal of Logistics Management*, Vol. 16 No. 1, pp. 120-141.

Jüttner, U., and Maklan, S. (2011), "Supply chain resilience in the global financial crisis: an empirical study", *Supply Chain Management: An International Journal,* Vol. 16 No. 4, pp. 246-259.

Jüttner, U., Peck, H., and Christopher, M. (2003), “Supply chain risk management: outlining an agenda for future research”, *International Journal of Logistics: Research & Applications*, Vol. 6 No. 4, pp. 197-210.

Kamalahmadi, M. and Parast, M. M. (2016), “A review of the literature on the principles of enterprise and supply chain resilience: major findings and directions for future research”, *International Journal of Production Economics,* Vol. 171 No. 1, pp. 116-133.

Kern, D., Moser, R., Hartmann, E. and Moder, M. (2012), “Supply risk management: model development and empirical analysis”, *International Journal of Physical Distribution & Logistics Managemen*t, Vol. 42 No. 1, pp. 60-82.

Klein, R. L., Bigley, G. A. and Roberts, K. H. (1995), “Organizational culture in high reliability organizations: an extension”, *Human relations*, Vol. 48 No. 7, pp. 771-793.

Kleindorfer, P. R. and Saad, G. H. (2005), “Managing disruption risks in supply chains”, *Production & Operations Management*, Vol. 14 No. 1, pp. 53-68.

Klibi, W. and Martel, A. (2012), “Modeling approaches for the design of resilient supply networks under disruptions”, *International Journal of Production Economics*, Vol. 135 No. 2, pp. 882-898.

Klibi, W., and Martel, A. (2013), “The design of robust value-creating supply chain networks”, *OR Spectrum*, Vol. 35 No. 4, pp. 867-903.

Klibi, W., Martel, A. and Guitouni, A. (2010), “The design of robust value-creating supply chain networks: a critical review”, *European Journal of Operational Research,* Vol. 203 No. 2, pp. 283-293.

Knemeyer, A. M., Zinn, W. and Eroglu, C., (2009), “Proactive planning for catastrophic events in supply chains”, *Journal of Operations Management*, Vol. 27 No. 2, pp. 141-153.

Knox, G. E., Simpson, K. R. and Garite, T. J. (1999), "High reliability perinatal units: an approach to the prevention of patient injury and medical malpractice claims", *Journal of Healthcare Risk Management*, Vol. 19 No. 2, pp. 24-32.

La Porte, T. R. (1996), “High reliability organizations: unlikely, demanding and at risk”, *Journal of Contingencies & Crisis Management*, Vol 4 No. 2, pp. 60-71.

La Porte, T. R. and Consolini, P. M. (1991), “Working in practice but not in theory: Theoretical challenges of 'high reliability organizations”, *Journal of Public Administration Research & Theory,* Vol. 1 No. 1, pp. 19-47.

La Porte, T.R. (1994), “A strawman speaks up: comments on the limits of safety”, *Journal of Contingencies & Crisis Management,* Vol. 2 No. 4, pp. 207-211.

Laeequddin, M., Sardana, G. D., Sahay, B. S., Waheed, K. A. and Sahay, V. (2009), “Supply Chain Partners’ Trust Building Process through Risk Evaluation: The Perspectives of UAE Packaged Food Industry”, *Supply Chain Management: An International Journal*, Vol. 14 No 4, pp. 280-290.

Laios, L. and Moschuris, S. (1999), “An empirical investigation of outsourcing decisions”, *Journal of Supply Chain Management*, Vol. 35 No. 4, pp. 33-41.

Lane, R. D., Funai, T., Reeder, R. and Larsen, G. Y. (2016), "High reliability pediatric septic shock quality improvement initiative and decreasing mortality", *Pediatrics*, Vol. 138 No. 4, pp. e1-e9.

Lee, H. L. (2002), “Aligning supply chain strategies with product uncertainties,” *California Management Review*, Vol. 44 No. 3, pp. 105-119.

Lee, H. L. and Tang, C. S. (1997), “Modelling the costs and benefits of delayed product differentiation”, *Management Science*, Vol. 43 No. 1, pp. 40-53.

Lee, H. L., Padmanabhan, V. and Whang, S. (1997), “Information distortion in a supply chain: the bullwhip effect”, *Management Science*, Vol. 43 No. 4, pp. 546-558.

Lekka, C. (2011), “High reliability organisations: A review of the literature” *Health and Safety Executive*, 2011 Research Report, RR899. United Kingdom.

Lekka, C., and Sugden, C. (2011), “The successes and challenges of implementing high reliability principles: A case study of a UK oil refinery”, *Process Safety & Environmental Protection,* Vol. 89 No. 6, pp. 443-451.

Lengnick-Hall, C. A., Beck, T. E. and Lengnick-Hall, M. L. (2011), "Developing a capacity for organizational resilience through strategic human resource management." *Human Resource Management Review,* Vol. 21 No. 3, pp. 243-255.

Leveson, N., Dulac, N., Marais, K., and Carroll, J. (2009), “Moving beyond normal accidents and high reliability organizations: a systems approach to safety in complex systems”, *Organization Studies*, Vol 30 No. 2-3, pp. 227-249.

Light, R. J. and Pillemer, D. B. (1984), *Summing Up: The Science of Reviewing Research*, Harvard, MA: Harvard University Press.

Linnenluecke, M. K. (2017), “Resilience in business and management research: A review of influential publications and a research agenda”, *International Journal of Management Reviews*, Vol. 19 No. 1, pp. 4-30.

Mabert, V. A. and Venkataramanan, M. A. (1998), “Special research focus on supply chain linkages: challenges for design and management in the 21st century”, *Decision Sciences*, Vol. 29 No. 3, pp. 537-552.

Manuj, I. and Mentzer, J. T. (2008), "Global supply chain risk management", *Journal of Business Logistics*, Vol. 29 No. 1, pp. 133-156.

Manuj, I., and Sahin, F. (2011), "A model of supply chain and supply chain decision-making complexity", *International Journal of Physical Distribution & Logistics Management*, Vol. 41 No. 5, pp. 511-549.

Marais, K., Dulac, N. and Leveson N. (2004), “Beyond normal accidents and high reliability organisations: The need for an alternative approach to safety in complex systems”, paper presented to *Engineering Systems Division Symposium*, MIT, Cambridge, Mass.

McClelland, R. (2009), *Check Against Delivery*, Speech to Australian Security Industry Association, Security 2009 Conference, 24 August 2009, Sydney. Australian Security Industry Association. Available at: <http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22media%2Fpressrel%2FPIHU6%22>

Melnyk, S. A., Closs, D. J., Griffis, S. E., Zobel, C. W. and Macdonald, J. R. (2014), “Understanding supply chain resilience”, *Supply Chain Management Review*, Vol. 18 No. 1, pp. 34-41.

Melnyk, S. A., Davis, E. W., Spekman, R. E. and Sandor, J. (2010), “Outcome-driven supply chains”, *MIT Sloan Management Review*, Vol. 51 No. 2, pp. 32-38.

Mishra, J. (1990), “Managing the grapevine”, *Public Personnel Management*, Vol. 19 No. 2, pp. 213-228.

Morris, H., Harvey, C. and Kelly, A. (2009), “Journal rankings and the ABS journal quality guide”, *Management Decision*, Vol. 47 No. 9, pp. 1441-1451.

Nooraie, S. V. and Parast, M. M. (2016), “Mitigating supply chain disruptions through the assessment of trade-offs among risks, costs and investments in capabilities”, *International Journal of Production Economics*, Vol. 171 No. 1, pp. 8-21.

Norrman, A., and Jansson, U. (2004), “Ericsson's proactive supply chain risk management approach after a serious sub-supplier accident”, *International Journal of Physical Distribution & Logistics Management*, Vol. 34 No. 5, pp. 434-456.

Nurmala, N., de Leeuw, S., and Dullaert, W. (2017), "Humanitarian–business partnerships in managing humanitarian logistics", *Supply Chain Management: An International Journal*, Vol. 22 No. 1, pp. 82-94.

Oke, A., and Gopalakrishnan, M., (2009), “Managing disruptions in supply chains: a case study of a retail supply chain”, *International Journal of Production Economics*, Vol. 118 No. 1, pp. 168-174.

Padgett, J., Gossett, K., Mayer, R., Chien, W. W. and Turner, F. (2017), "Improving patient safety through high reliability organizations", *The Qualitative Report*, Vol. 22 No. 2, pp. 410-425.

Peck, H. (2005), “Drivers of supply chain vulnerability: an integrated framework”, *International Journal of Physical Distribution & Logistics Management*, Vol. 35 No. 4, pp. 210-232.

Pereira, C. R., Christopher, M., and Da Silva, A. L., (2014), "Achieving supply chain resilience: the role of procurement", *Supply Chain Management: An International Journal*, Vol. 19 No. 5/6, pp. 626-642.

Pereira, J. V. (2009), “The new supply chain’s frontier: information management”, *International Journal of Information Management*, Vol. 29 No. 5, pp. 372-379.

Perrow, C. (1984), *Normal Accidents: Living with High-risk Technologies*. New York, NY: Basic Books.

Petticrew, M., and Helen, R. (2006), *Systematic Reviews in the Social Sciences: A Practical Guide*. Malden, MA: Blackwell.

Pettit, T. J., Fiksel, J. and Croxton, K. L. (2010), “Ensuring supply chain resilience: development of a conceptual framework”, *Journal of Business Logistics*, Vol. 31 No. 1, pp. 1-21.

Pettit, T. J., Croxton, K. L. and Fiksel, J. (2013), “Ensuring supply chain resilience: development and implementation of an assessment tool”, *Journal of Business Logistics*, Vol. 34 No. 1, pp. 46-76.

Pilbeam, C., Alvarez, G. and Wilson, H. (2012), “The governance of supply networks: a systematic literature review”, *Supply Chain Management: An International Journal*, Vol. 17 No. 4, pp. 358-376.

Ponis, S. T. and Koronis, E. (2012), “Supply chain resilience: definition of concept and its formative elements”, *Journal of Applied Business Research.* Vol. 28 No. 5, pp. 921-935.

Ponomarov, Y. S. and Holcomb, M. C. (2009), “Understanding the concept of supply chain resilience”, *The International Journal of Logistics Management*, Vol. 20 No. 1, pp. 124-143.

Priya Datta, P., Christopher, M. and Allen, P. (2007), “Agent-based modelling of complex production/distribution systems to improve resilience”, *International Journal of Logistics: Research & Applications,* Vol. 10 No. 3, pp. 187-203.

Pronovost, P. J., Berenholtz, S. M., Goeschel, C. A., Needham, D. M., Sexton, J. B., Thompson, D. A., Lubomski, L. H., Marsteller, J. A., Makary, M. A. and Hunt, E. (2006), "Creating high reliability in health care organizations", *Health services research*, Vol 41 No. 4p2, pp. 1599-1617.

Provost, S. M., Lanham, H. J., Leykum, L. K., McDaniel Jr, R. R. and Pugh, J. (2015), "Health care huddles: Managing complexity to achieve high reliability", *Health Care Management Review*, Vol. 40, No. 1, pp. 2-12.

Revilla E. and Sáenz, M.J., (2014), “Supply chain disruption management: global convergence vs national specificity”, *Journal of Business Research*, Vol. 67 No. 6, pp. 1123-1135.

Roberts, K. H. (1990), "Some characteristics of one type of high reliability organization", *Organization Science,* Vol. 1 No. 2, pp. 160-176.

Roberts, K. H. (1991), “Structuring to facilitate migrating decisions in reliability enhancing organizations”, pp. 171-191 in Gomez-Meija, L. and Lawless, M. W. (Eds.), *Top management and effective readership in high technology firms*. Greenwich, CT: JAI Press.

Roberts, K. H., & Rousseau, D. M. (1989), “Research in nearly failure-free, high-reliability organizations: having the bubble”, *Engineering Management, IEEE Transactions*, Vol. 36 No. 2, pp. 132-139.

Roberts, K. H., Bea, R., and Bartles, D. L. (2001). “Must accidents happen? Lessons from high-reliability organizations”, *The Academy of Management Executive*, Vol. 15 No. 3, pp. 70-78.

Roberts, K. H., Madsen, P., Desai, V. and Van Stralen, D. (2005), "A case of the birth and death of a high reliability healthcare organisation", *BMJ Quality and Safety*, Vol. 14 No. 3, pp. 216-220.

Roberts, K. H., Stout, S. K. and Halpern, J. T. (1994), “Decision dynamics in two high reliability military organizations.” *Management Science,* Vol. 40 No. 5, pp. 614-624.

Rocco, T. S., and Plakhotnik, M. S. (2008), “Literature reviews, conceptual frameworks, and theoretical frameworks: Terms, functions, and distinctions”, *Human Resource Development Review*, Vol. 8 No. 1, pp. 120-130.

Rochlin, G. (1993), “Defining “high reliability” organisations in practice: a taxonomic prologue”, pp. 11-32. In: Roberts, K. (Ed) *New Challenges to Understanding Organisations*, Macmillan, New York.

Rochlin, G. I. (1996), “Reliable organizations: present research and future directions.” *Journal of Contingencies & Crisis Management*, Vol. 4 No. 2, pp. 55-59.

Rochlin, G. I., La Porte, T. R., and Roberts, K. H. (1987) “The self-designing high-reliability organization: Aircraft carrier flight operations at sea”, *Naval War College Review*, Vol. 40 No. 4, pp. 76-90.

Rousseau, D. M., Manning, J. and Denyer, D. (2008), “Evidence in management and organizational science: assembling the field’s full weight of scientific knowledge through syntheses”, *The Academy of Management Annals*, Vol. 2 No. 1, pp. 475-515.

Sadghiani, N.S., Torabi, S.A. and Sahebjamnia, N. (2015), “Retail supply chain network design under operational and disruption risks” *Transportation Research Part E: Logistics & Transportation Review*, Vol. 75 No. 2015, pp. 95-114.

Sáenz, M.J. and Revilla E. (2014), “Creating more resilient supply chains”, *MIT Sloan Management Review*, Vol. 55 No. 4, pp. 22-24.

Sagan, S.D. (1993), *The Limits of Safety: Organizations, Accidents and Nuclear Weapons*. Princeton University Press, New Jersey.

Saleh, J. H., Marais, K. B., Bakolas, E., and Cowlagi, R. V. (2010), “Highlights from the literature on accident causation and system safety: review of major ideas, recent contributions, and challenges”, *Reliability Engineering & System Safety*, Vol. 95 No. 11, pp. 1105-1116.

Schmitt, A.J. and Singh, M. (2012), “A quantitative analysis of disruption risk in a multi-echelon supply chain”, *International Journal of Production Economics*, Vol. 139 No. 1, pp. 22-32.

Scholten, K. and Schilder, S. (2015), “The role of collaboration in supply chain resilience”, *Supply Chain Management: An International Journal*, Vol. 20 No. 4, pp. 471-484.

Scholten, K., Sharkey Scott, P., and Fynes, B. (2014), “Mitigation processes–antecedents for building supply chain resilience”, S*upply Chain Management: An International Journal*, Vol. 19 No. 2, pp. 211-228.

Schulman P. R. (2004), “General attributes of safe organizations”, *Quality & Safety in Health Care 2004,* Vol 13 No. 2, pp. 39-44.

Schulman, P. R. (1993), “The negotiated order of organizational reliability”, *Administration & Society,* Vol. 25 No. 3, pp. 353-372.

Seville, E., Brunsdon, D., Dantas, A., Le Masurier, J., Wilkinson, S., and Vargo, J. (2006), Building Organisational Resilience: A New Zealand Approach, *Resilient Organisations Research Programme.* Disponível em: www.resorgs.org.nz.

Shapiro, M. J. and Jay, G. D. (2003), High reliability organizational change for hospitals: translating tenets for medical professionals, pp. 238-239.

Sheffi, Y and Rice Jr. J. B. (2005), “A supply chain view of the resilient enterprise”, *MIT Sloan Management Review*, Vol. 47 No. 1, pp. 41-48.

Sheffi, Y. (2001) “Supply chain management under the threat of international terrorism”, *The International Journal of Logistics Management*, Vol. 12 No. 2, pp. 1-11.

Sheffi, Y. (2005a), "Building a resilient supply chain", *Harvard Business Review,* Vol. 1 No. 8, pp. 1-4.

Sheffi, Y. (2005b), *The Resilient Enterprise: Overcoming Vulnerability for Competitive Advantage*. MIT Press, Cambridge.

Singh, K. (1997), “The impact of technological complexity and interfirm cooperation on business survival”, *Academy of Management Journal*, Vol. 40 No. 2, pp. 339-367.

Skipper, J. B. and Hanna, J. B. (2009), "Minimizing supply chain disruption risk through enhanced flexibility", *International Journal of Physical Distribution and Logistics Management*, Vol. 39 No. 5, pp. 404-427.

Smart, P. K., Tranfield, D., Deasley, P., Levene, R., Rowe, A. and Corley, J. (2003), “Integrating ‘lean’and ‘high reliability’ thinking”, *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture*, Vol. 217 No. 5, pp. 733-739.

Smeltzer, L. R. and Siferd, S. P. (1998), “Proactive supply management: the management of risk” *International Journal of Purchasing & Materials Management*, Vol. 34 No. 4, pp. 38-45.

Snowden, D. J., and Boone, M. E. (2007), “A leader's framework for decision making”, *Harvard Business Review*, Vol. 85 No. 11, pp. 1-9.

Soni, U., Jain, V. and Kumar, S. (2014), “Measuring supply chain resilience using a deterministic modelling approach” *Computers & Industrial Engineering*, Vol. 74 No. 2014, pp. 11-25.

Spiegler, V. L., Mohamed, M. N. and Wikner J. (2012), “A control engineering approach to the assessment of supply chain resilience”, *International Journal of Production Research*, Vol. 50 No. 21, pp. 6162-6187.

Spiegler, V. L., Potter, A. T., Naim, M. M. and Towill, D. R. (2016), “The value of nonlinear control theory in investigating the underlying dynamics and resilience of a grocery supply chain”, *International Journal of Production Research*, Vol. 54 No. 1, pp. 265-286.

Srivastava, R.K., Shervani, T.A. and Fahey, L. (1999), “Marketing, business processes, and shareholder value: An organizationally embedded view of marketing activities and the discipline of marketing”, *The Journal of Marketing*, Vol. 63 No. 1999 pp. 168-179.

Stoltz, P. G. (2004), *Building Resilience for Uncertain Times*, Wiley, Hoboken, NJ.

Sutcliffe, K. M. (2011), “High reliability organizations (HROs)”, *Best Practice & Research Clinical Anaesthesiology*, Vol 25 No. 2, pp. 133-144.

Sutcliffe, K. M., Paine, L. and Pronovost, P. J. (2017), "Re-examining high reliability: actively organising for safety", *BMJ Quality and Safety*, Vol. 26 No. 3, pp. 248-251.

Sutcliffe, K.M. and Vogus, T.J. (2003), “Organizing for resilience.” In: K.S. Cameron, J.E. Dutton and R.E. Quinn, (Eds). *Positive organizational scholarship: foundations of a new discipline*. San Francisco: Berrett-Koehler, pp. 94-110.

Sutton, A. (2016), *Systematic Approaches to a Successful Literature Review*. Los Angeles, CA: Sage Publications.

Swafford, P.M., Ghosh, S. and Murthy, N. (2006), “The antecedents of supply chain agility of a firm: scale development and model testing”, *Journal of Operations Management*, Vol. 24 No. 2, pp. 170-188.

Tang, C. S. (2006), “Robust strategies for mitigating supply chain disruptions.” *International Journal of Logistics: Research & Applications*, Vol. 9 No. 1, pp. 33-45.

Tang, O., and Musa, S. N. (2011), “Identifying risk issues and research advancements in supply chain risk management.” *International Journal of Production Economics*, Vol. 133 No. 1, pp. 25-34.

Thomé, A. M. T., Scavarda, L. F., Scavarda, A. and de Souza Thomé, F. E. S. (2016), “Similarities and contrasts of complexity, uncertainty, risks, and resilience in supply chains and temporary multi-organization projects”, *International Journal of Project Management*, Vol. 34 No. 7, pp. 1328-1346.

Thun, J. H., and Hoenig, D. (2011), “An empirical analysis of supply chain risk management in the German automotive industry”, *International Journal of Production Economics*, Vol. 131 No. 1, pp. 242-249.

Tomlin, B., 2006. “On the value of mitigation and contingency strategies for managing supply chain disruption risks”, *Management Science*, Vol. 52 No. 5, pp. 639-657.

Torabi, S. A., Baghersad, M. and Mansouri, S. A. (2015), “Resilient supplier selection and order allocation under operational and disruption risks”, *Transportation Research Part E: Logistics & Transportation Review*, Vol. 79 No. 2015, pp. 22-48.

Torracro, R. (2005), “Writing integrative literature reviews: guidelines and examples”, *Human Resource Development Review*, Vol. 4 No. 3, pp. 356–367.

Tranfield, D., Denyer, D. and Smart, P. (2003), "Towards a methodology for developing evidence-informed management knowledge by means of systematic review", *British Journal of Management*, Vol. 14 No. 3, pp. 207-222.

Trkman, P., and McCormack, K. (2009), “Supply chain risk in turbulent environments—A conceptual model for managing supply chain network risk.” *International Journal of Production Economics,* Vol. 119 No. 2, pp. 247-258.

Tukamuhabwa, B. R., Stevenson, M., Busby, J. and Zorzini, M. (2015), “Supply chain resilience: definition, review and theoretical foundations for further study”, *International Journal of Production Research*, Vol. 53 No. 18, pp. 5592-5623.

Urciuoli, L., Mohanty, S., Hintsa, J., and Gerine Boekesteijn, E. (2014), “The resilience of energy supply chains: a multiple case study approach on oil and gas supply chains to Europe”, *Supply Chain Management: An International Journal*, Vol. 19 No. 1, pp. 46-63.

Van der Vorst, J. G., and Beulens, A. J. (2002), “Identifying sources of uncertainty to generate supply chain redesign strategies”, *International Journal of Physical Distribution & Logistics Management,* Vol. 32 No. 6, pp. 409-430.

Van der Vorst, J. G., Beulens, A.J., De Wit, W. and Van Beek, P. (1998), “Supply chain management in food chains: Improving performance by reducing uncertainty”, *International Transactions in Operational Research*, Vol. 5 No. 6, pp. 487-499.

Vogus, T., and Welbourne, T. M. (2003), "Structuring for high reliability: HR practices and mindful processes in reliability-seeking organizations", *Journal of Organizational Behavior,* Vol. 24 No. 7, pp. 887-903.

Wagner, S. M., and Bode, C. (2006), "An empirical investigation into supply chain vulnerability", *Journal of Purchasing & Supply Management*, Vol. 12 No. 6, pp. 301-312.

Waller, M. J., and Roberts, K. H. (2003), "High reliability and organizational behaviour: finally, the twain must meet", *Journal of Organizational Behavior*, Vol. 24 No. 7, pp. 813-814.

Wang, J., Muddada, R.R., Wang, H., Ding, J., Lin, Y., Liu, C. and Zhang, W. (2016), "Toward a resilient holistic supply chain network system: Concept, review and future direction" *IEEE Systems Journal*, Vol. 10 No. 2, pp. 410-421.

Weick, K. E. (1987), "Organizational culture as a source of high reliability", *California Management Review*, Vol. 29 No. 2, pp. 112-127.

Weick, K. E. and Roberts, K. H. (1993), "Collective mind in organizations: Heedful interrelating on flight decks", *Administrative Science Quarterly*, Vol. 38 No. 3, pp. 357-381.

Weick, K. E. and Sutcliffe, K. M., (2001), *Managing the Unexpected: Assuring High Performance in an Age of Complexity*. Jossey-Bass, San Francisco.

Weick, K. E., Sutcliffe, K. M. and Obstfeld, D. (1999), "Organizing for high reliability: processes of collective mindfulness" In: Staw, B. M. and Cummings, L. L. (Eds.), *Resilient Organizational Behaviour*, Greenwich (CT): JAI Press, pp. 81-123.

Wieland, A. (2013), "Selecting the right supply chain based on risks", *Journal of Manufacturing Technology Management*, Vol. 24 No. 5, pp. 652-668.

Wieland, A. and Wallenburg, C. M. (2012), "Dealing with supply chain risks: linking risk management practices and strategies to performance", *International Journal of Physical Distribution & Logistics Management*, Vol. 42 No. 10, pp. 887-905.

Wieland, A. and Wallenburg, C.M. (2013), "The influence of relational competencies on supply chain resilience: a relational view", *International Journal of Physical Distribution & Logistics Management*, Vol. 43 No. 4, pp. 300-320.

Wieland, A., Handfield, R.B. and Durach, C.F. (2016), "Mapping the landscape of future research themes in supply chain management", *Journal of Business Logistics*, Vol. 37 No. 3, pp. 205-212.

Wilding, R. (1998), "The supply chain complexity triangle: uncertainty generation in the supply chain", *International Journal of Physical Distribution & Logistics Management*, Vol. 28 No. 8, pp. 599-616.

Wilding, R. and Wagner, B. (2014), "Special issue: building theory in supply chain management through "systematic reviews" of the literature", *Supply Chain Management: An International Journal,* Vol. 19 No. 5/6, https://doi.org/10.1108/SCM-08-2014-0275

Wong, C., Skipworth, H., Godsell, J. and Achimugu, N. (2012), "Towards a theory of supply chain alignment enablers: a systematic literature review", *Supply Chain Management: An International Journal*, Vol. 17 No. 4, pp. 419-437.

Yang, B. and Yang Y. (2010), “Postponement in supply chain risk management: a complexity perspective”, *International Journal of Production Research*, Vol. 48 No. 7, pp. 1901-1912.

Zsidisin, G.A. and Hendrick, T.E. (1998), “Purchasing’s involvement in environmental issues: a multi-country perspective”, *Industrial Management & Data Systems*, Vol. 98 No. 7, pp. 313-320.

Zsidisin, G.A. and Wagner, S.M. (2010), “Do perceptions become reality? The moderating role of supply chain resiliency on disruption occurrence”, *Journal of Business Logistics*, Vol. 31 No. 2, pp. 1-20.

Zsidisin, G.A., Panelli, A. and Upton, R. (2000), “Purchasing organization involvement in risk assessments, contingency plans, and risk management: an exploratory study”, *Supply Chain Management: An International Journal*, Vol. 5 No. 4, pp. 187-198.

FIGURES

Figure 1 Summary of review process for study selection

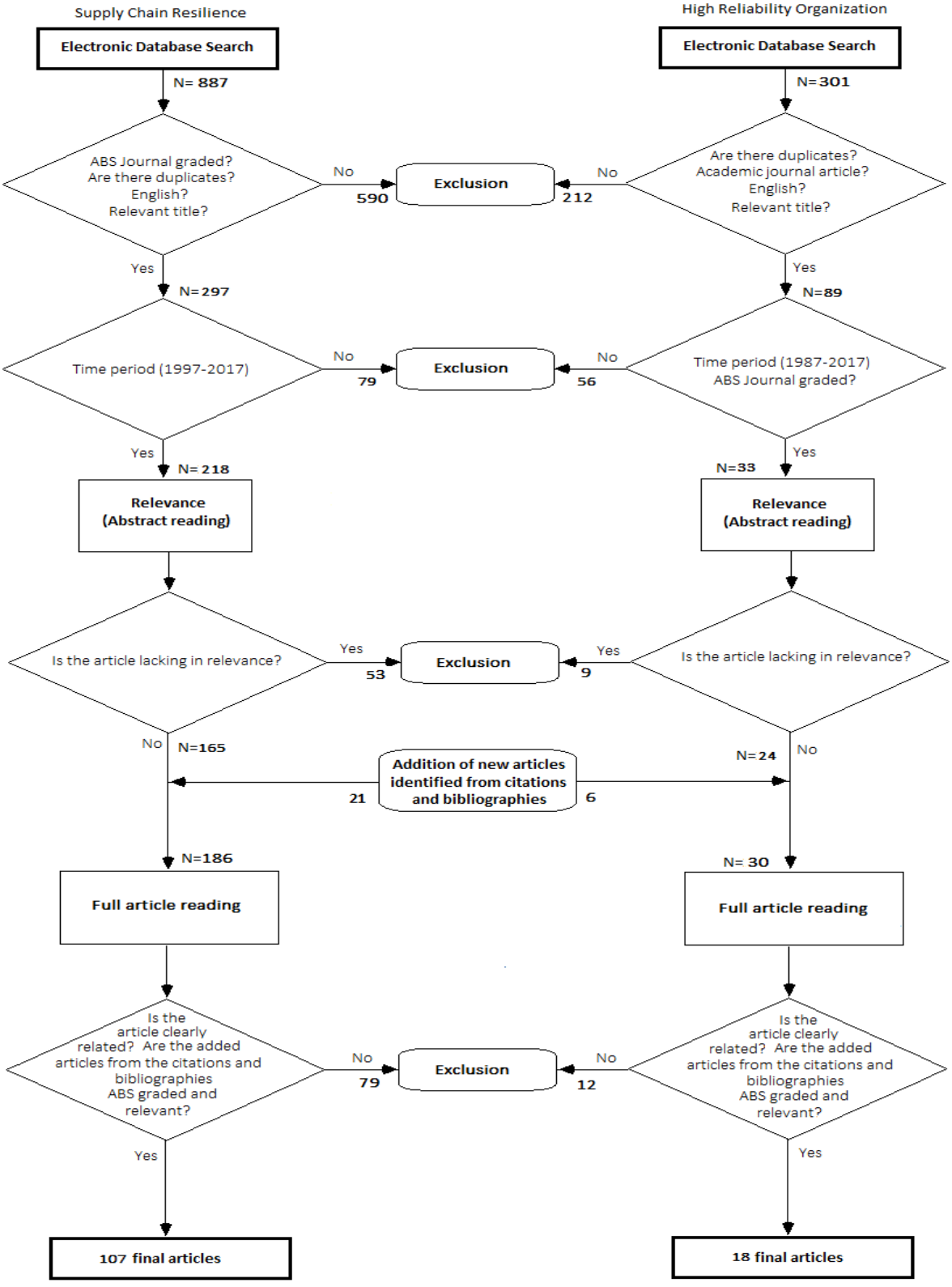
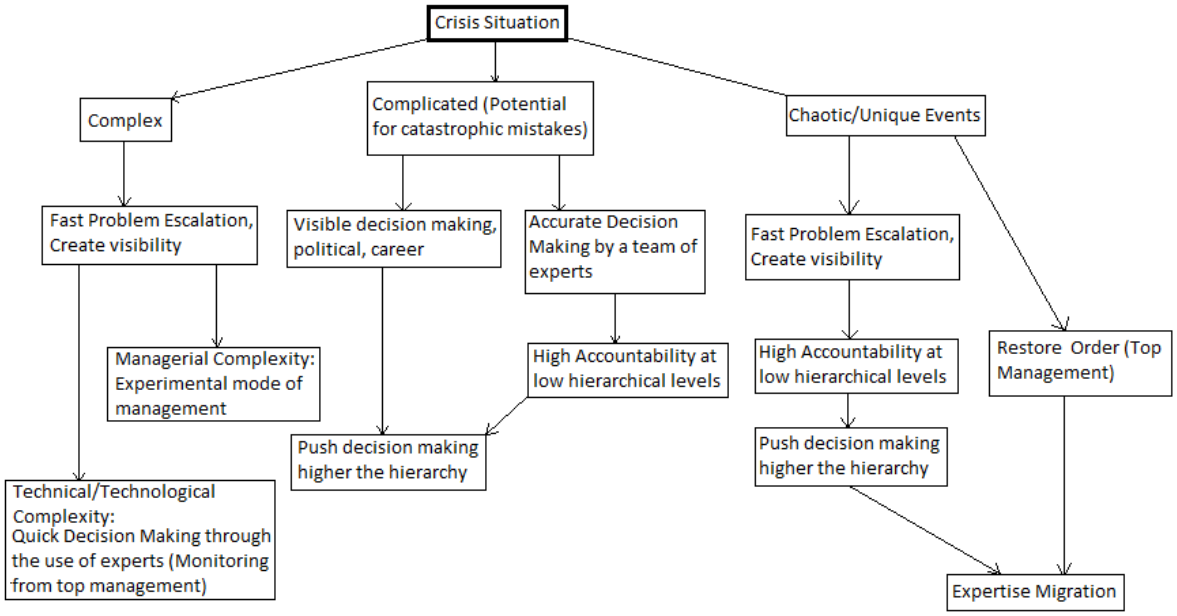


Figure 2 A framework for flexible decision making under crisis situations in supply chain networks (Adapted from Roberts et al., 1994 with inputs from Snowden and Boone, 2007)



TABLES

Table 1 Keywords used to identify papers on SCR and HROs

	Keywords	Search strings	Databases (hits)
Supply Chain Resilience	supply chain resilience	supply chain resilien* OR supply chain vulnerab* OR supply chain risk*	EBSCO (272)
	resilient supply chain		Emerald (233)
	supply chain risks		Taylor and Francis (218)
	supply chain disruptions		Wiley online Library (164)
	supply chain vulnerability		
High Reliability Organisations	High reliability organisations	high* reliab*	EBSCO (107)
	High reliability theory		Emerald (27)
	High reliability		Taylor and Francis (77)
	highly reliable		Wiley online Library (90)
	reliable organisations		

Table 2 Formative elements of SCR and the frequency of citations

SCR Formative element	Number of Articles	Percentage
Collaboration	74	69.16%
Flexibility	73	68.22%
Redundancy	64	59.81%
Agility	53	49.53%
Decision making	41	38.32%
Security (IT, Insurance)	31	28.97%
Culture	23	21.50%
Robustness	21	19.63%
Integration	20	18.69%
Avoidance	19	17.76%
HRM	18	16.82%
Sustainability	8	7.48%
Logistics capability	8	7.48%

Table 3 Number of citations of HROs in literature

Examples of HROs	Number of citations	Percentage
Air Traffic Control	14	77.78%
US navy Aircraft carrier	13	72.22%
Nuclear Plant	11	61.11%
Electricity Distributing Company	6	33.33%
Nuclear Submarine	3	16.67%
Firefighting	2	11.11%

Table 4 Citations of HRO characteristics

HRO Characteristics	Number of articles	Percentage
Decision making	16	88.89%
Culture	15	83.33%
Flexibility	12	66.67%
Preoccupation with failure	12	66.67%
Deference to expertise	11	61.11%
Redundancy	10	55.56%
Teamwork	10	55.56%
Organizational structure	9	50.00%
Reluctance to simplify	8	44.44%
Management commitment	7	38.89%
Human Resource Management	6	33.33%
Risk Management	4	22.22%
Trust	4	22.22%
Awareness	3	16.67%

APPENDIX:

Table A1 Formative elements prescribed for achieving SCR

Author(s)	**Year**	Sustainability	HRM	Security (IT, Insurance)	Integration	Avoidance	Robustness	Agility	Logistics capability	Flexibility	Redundancy	Culture	Collaboration	Decision making
Cooper et al.	1997				✓								✓	
Fisher et al.	1997									✓	✓		✓	
Lee et al. (a)	1997												✓	
Lee et al. (b)	1997									✓			✓	
Singh	1997					✓							✓	
Albino et al.	1998										✓			✓
Mabert and Venkataramanan	1998				✓								✓	
Smeltzer and Siferd	1998		✓											
Vorst et al.	1998										✓		✓	✓
Wilding	1998							✓		✓	✓			✓
Zsidisin and Hendrick	1998	✓												
Bandyopadhyay et al.	1999		✓	✓✓							✓			
Hall	1999											✓	✓	
Laios and Moschuris	1999													✓✓
Srivastava et al.	1999	✓			✓	✓				✓	✓		✓	✓
Zsidisin et al.	2000		✓		✓					✓	✓		✓	
Sheffi	2001			✓						✓	✓		✓	
Lee	2002							✓		✓	✓		✓	
Van der Vorst et al.	2002		✓		✓			✓		✓			✓	✓

Jüttner et al.	2003				✓	✓				✓	✓		✓	
Chopra and Sodhi	2004							✓		✓	✓			
Christopher and Lee	2004							✓		✓			✓✓	
Christopher and Peck	2004							✓		✓	✓	✓	✓	✓
Finch	2004		✓	✓								✓		✓
Giunipero and Aly Eltantawy	2004			✓	✓								✓	
Norrman and Jansson	2004		✓										✓	
Jüttner	2005										✓	✓	✓	✓
Kleindorfer and Saad	2005			✓		✓	✓	✓		✓	✓		✓	
Sheffi	2005									✓	✓	✓		
Sheffi and Rice Jr.	2005									✓	✓	✓	✓	
Helen	2006			✓										
Swafford et al.	2006							✓✓	✓	✓				
Tang	2006			✓		✓	✓	✓		✓			✓	
Tomlin	2006			✓						✓✓	✓			✓
Craighead et al.	2007												✓	✓
Datta et al.	2007				✓	✓		✓		✓	✓		✓	
Manuj and Mentzer	2008			✓	✓	✓				✓				
Bakshi and Kleindorfer	2009			✓									✓	
Braunscheidel and Suresh	2009				✓			✓✓		✓		✓	✓	
Knemeyer et al.	2009									✓	✓		✓	✓
Oke and Gopalakrishnan	2009			✓						✓	✓		✓	
Pereira	2009						✓	✓		✓			✓	✓
Ponomarov and Holcomb	2009			✓	✓			✓	✓	✓	✓		✓	✓
Trkman and McCormack	2009									✓	✓			✓
Colicchia et al.	2010		✓	✓		✓				✓			✓	
Klibi et al.	2010				✓	✓	✓			✓	✓			✓
Melnyk et al.	2010			✓		✓		✓			✓	✓	✓	
Pettit et al.	2010		✓	✓	✓			✓		✓	✓	✓	✓	

Yang and Yang	2010									✓	✓		✓	
Zsidisin. and Wagner	2010									✓	✓		✓	
Blackhurst et al.	2011		✓	✓				✓		✓	✓		✓	✓
Blome and Schoenherr	2011	✓				✓				✓			✓	
Bode et al.	2011							✓		✓	✓		✓	
Christopher and Holweg	2011							✓		✓	✓		✓	
Jüttner and Maklan	2011		✓				✓			✓	✓		✓	✓
Lengnick-Hall et al.	2011		✓✓					✓		✓		✓		✓
Manuj and Sahin	2011		✓		✓					✓		✓	✓	✓✓
Tang and Musa	2011			✓		✓	✓	✓	✓	✓	✓		✓	✓
Thun and Hoenig	2011			✓		✓				✓	✓		✓	
Cabral et al.	2012				✓			✓			✓			✓
Carvalho et al.	2012							✓		✓	✓		✓	
Colicchia and Strozzi	2012			✓		✓				✓			✓	✓
Ishfaq	2012								✓	✓				
Kern et al.	2012												✓	✓
Klibi and Martel	2012					✓	✓			✓	✓			✓
Schmitt and Singh	2012							✓		✓	✓			
Spiegler et al.	2012			✓			✓	✓		✓	✓	✓	✓	
Wieland and Wallenburg	2012						✓							
Golgeci and Ponomarov	2013							✓		✓				
Grötsch et al.	2013					✓		✓					✓	✓
Hearnshaw and Wilson	2013			✓				✓		✓	✓		✓	
Ivanov and Sokolov	2013			✓			✓	✓		✓	✓		✓	
Johnson et al.	2013		✓					✓		✓	✓		✓	
Pettit et al.	2013		✓	✓				✓		✓	✓		✓	
Wieland	2013						✓	✓		✓	✓			✓
Wieland and Wallenburg	2013						✓	✓					✓	
Beske and Seuring	2014	✓		✓	✓				✓				✓	

Brandon-Jones et al.	2014			✓			✓✓			✓			✓	
Chopra and Sodhi	2014							✓		✓	✓	✓		✓
Pereira et al.	2014				✓			✓		✓	✓		✓	
Revilla and Sáenz	2014											✓		
Sáenz and Revilla	2014					✓						✓	✓	✓
Scholten et al.	2014						✓	✓		✓	✓		✓	✓
Soni et al.	2014	✓		✓				✓				✓	✓	✓
Urciuoli et al.	2014			✓					✓	✓	✓	✓	✓	
Ambulkar et al.	2015							✓			✓		✓	
Durach et al.	2015		✓			✓	✓✓	✓				✓	✓	
Ho et al.	2015						✓	✓	✓	✓	✓		✓	✓
Hohenstein et al.	2015		✓					✓		✓	✓	✓	✓	✓
Sadghiani et al.	2015										✓			✓
Scholten and Schilder	2015							✓		✓			✓✓	
Torabi et al.	2015							✓		✓	✓		✓	✓
Tukamuhabwa et al.	2015	✓		✓				✓	✓	✓	✓	✓	✓	
Fahimnia and Jabbarzadeh	2016	✓✓						✓		✓				✓
Hasani and Khosrojerdi	2016						✓✓	✓		✓	✓			✓
Jabbarzadeh et al.	2016													✓✓
Kamalahmadi and Parast	2016						✓	✓		✓	✓	✓	✓	
Nooraie and Parast	2016							✓			✓			
Spiegler et al.	2016									✓	✓		✓	
Thomé et al.	2016							✓		✓	✓		✓	
Wieland et al.	2016										✓			
Ali et al.	2017	✓		✓	✓		✓	✓		✓	✓	✓	✓	
Brusset and Teller	2017				✓	✓				✓	✓		✓	
Datta	2017		✓	✓	✓			✓		✓	✓	✓	✓	✓
Fattahi et al.	2017						✓	✓		✓				✓
Govindan et al.	2017			✓			✓	✓		✓	✓			✓✓

Linnenluecke	2017		✓					✓		✓	✓		✓	

NB. '✓✓' implies this formative element formed the core of the cited study.

Table A2 HRO characteristics and cited HROs

Author(s)	**Year**	**Cited HROs**						**HRO Characteristics**													
		Nuclear Plant	Electricity Distributing Company	Air Traffic Control	US navy Aircraft carrier	Firefighting	Nuclear Submarine	Risk Management	Organizational structure	Management commitment	Flexibility	Redundancy	Teamwork	Deference to expertise	Preoccupation with failure	Reluctance to simplify	Human Resource Management	Trust	Decision making	Culture	Awareness
Roberts	1990		✓	✓	✓✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Schulman	1993	✓✓						✓		✓	✓	✓	✓		✓	✓		✓	✓	✓	
Weick and Roberts	1993			✓	✓						✓	✓	✓✓					✓	✓		
Roberts et al.	1994			✓✓					✓		✓	✓	✓	✓	✓	✓			✓✓		
Klein et al.	1995	✓✓		✓✓	✓								✓		✓				✓	✓✓	
Bierly and Spender	1995		✓	✓	✓		✓				✓	✓	✓		✓		✓	✓		✓✓	✓
Frederickson and LaPorte	2002	✓	✓	✓	✓		✓		✓	✓	✓	✓		✓	✓		✓		✓	✓	✓
Shapiro and Jay	2003									✓			✓	✓	✓	✓			✓	✓	
Smart et al.	2003	✓		✓	✓				✓			✓		✓			✓		✓	✓	
Fiol and O'Connor	2003	✓		✓							✓			✓	✓	✓			✓✓	✓	
Waller and Roberts	2003										✓								✓		
Vogus and Welbourne	2003	✓		✓	✓					✓	✓			✓	✓	✓	✓✓		✓	✓	
Heimann	2005			✓	✓				✓	✓	✓	✓								✓	

Boin and Schulman	2008	✓		✓	✓			✓	✓				✓	✓	✓	✓	✓		✓	✓	
Leveson et al.	2009	✓	✓	✓	✓	✓			✓		✓	✓		✓					✓	✓	
Saleh et al.	2010	✓	✓		✓	✓		✓	✓	✓	✓	✓		✓	✓				✓	✓	
Bourrier	2011	✓	✓	✓	✓								✓						✓	✓	
Linnenluecke	2017	✓		✓	✓				✓	✓			✓	✓	✓	✓			✓	✓	

NB. '✓✓' implies this characteristic was central to the cited study