Supply Chain Resilience: Mapping the Knowledge Domains through a Bibliometric Approach

E.M.A.C. Ekanayake

17902595r@connect.polyu.hk

PhD Candidate, ZN710, Block Z, Department of Building and Real Estate, Faculty of Construction and Environment. The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong

Geoffrey Q.P. Shen – Corresponding Author

geoffrey.shen@polyu.edu.hk

Chair Professor of Construction Management, Department of Building and Real Estate, Faculty of Construction and Environment. The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong

Mohan M. Kumaraswamy

mohan@hku.hk

Honorary Professor, Department of Civil Engineering, Faculty of Engineering, The Hong Kong University, Hong Kong

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Abstract

Purpose: This paper aims to review the state-of-the-art of literature of Supply Chain Resilience (SCR) and to map the SCR domain, so as to provide a launchpad for further knowledge development and dissemination.

Design: Citespace as a bibliometric analysis software was used to systematically, comprehensively and accurately review the SCR related literature and to then develop an SCR research map.

Findings: The results revealed the existing SCR publication base, domains, highly contributed publications, research hotspots, key milestones of SCR research development and a dynamic platform to integrate future research and developments of SCR.

Originality/value: The scientific contribution to SCR knowledge is an accurate and quantitative SCR research map, including the related SCR publication base, domains, pillars, hotspots, evolution, and future trends. The methodology and the findings can be generalised to many other fields. Besides, the proposed SCR research map could be frequently updated by injecting future findings from similar studies to fill any residual or newly emerging research gaps. Moreover, the results could inspire further new knowledge creation in the SCR domain, identify future research demands in this field, and ultimately boost the performance of global SCs by triggering smart and sustainable practices.

Keywords: Supply Chain Resilience (SCR); Literature review; Bibliometric analysis; CiteSpace

Paper type: Literature review

Introduction

Disruption risk management has gained growing attention over the last decade since global supply chains are susceptible to a long array of disruptions, which create both long-term and short-term impacts on the Supply Chain (SC) (Parast and Shekarian, 2019). Although traditional SC Risk Management (RM) practices are applied to cope with disruptions, their application to each link in global SCs to handle every probable impact

is difficult (Kochan and Nowicki, 2018). As a solution to address these difficulties arising from the insufficiency of traditional RM practices, the emerging attention of practitioners is now shifting to building Supply Chain Resilience (SCR). This evolving research area comes under the increasingly prominent concept of resilience that has been widely applied in many research fields. SCR goes beyond identifying, monitoring and reducing SC disruptions, but also enables withstanding them swiftly and cost-effectively (Melnyk et al., 2009). It is the ability of an organisation to recover from a large disruption or a supply chain's ability to react to unexpected disruptions and restore quickly to normal supply network operations (Sheffi and Rice, 2005; Christopher and Peck, 2004). Further, SCR provides a balance between the associated vulnerabilities and the counteractive capabilities in the SCs (Pettit et al., 2013).

Over the previous years, the SCR research domain was enriched with numerous scientific studies (Bevilacqua et al., 2018) by highlighting its importance in applications. For instance, Ponis and Koronis (2012) studied the interaction between SC capabilities and the disruptions under the concept of SCR. Zavala et al. (2018) proposed quantitative metrics to analyse SCR while Bevilacqua et al. (2018) conducted a modular analysis of the SCR triangle (a theorised tool to shape the behaviour of a SC during disruption and during a simulation session of a disruption). Developing an assessment tool to measure SCR (Pettit et al., 2013) was another significant contribution to the SCR knowledge domain. Zainal and Ingirige (2018) proposed an SCR based approach to Malaysian public construction projects. Researching of SCR in prefabricated construction (Ekanayake et al., 2020a) is another ongoing initiative to enhance project performance in this domain. These studies facilitate the development of an SCR research base.

Apart from the above publications, there have been a few attempts to manually and systematically review the historical development of SCR and to present agendas for future

research (Kochan and Nowicki, 2018). For instance, manual and systematic literature reviews by Ponomarov and Holcomb (2009), Christopher and Peck (2004), Hohenstein et al. (2015), Ali et al. (2017), Elleuch et al. (2016), Tukamuhabwa et al. (2015), and Kochan and Nowicki (2018) have made useful contributions. However, all these studies are manual reviews of literature, hence, subject to being somewhat distorted by the unavoidable subjectivity based on personal scrutiny, lack of quantitative analysis, and inability to cover the entire literature sources. Also, these studies do not appear to integrate the past knowledge of SCR with the fast-developing new knowledge.

In response, many structured research tools have been developed recently to overcome the above-stated weaknesses in literature analysis (Wei et al., 2015). These tools reveal the hidden connections of the literature, such as cited and co-cited references of the knowledge domains, which is not possible in the manual reviewing process (Li et al., 2017). Citespace is an example of such a powerful bibliometric analysis tool which enables the visualisation of informative conceptualisation of literature (Cobo et al., 2011). For instance, Ekanayake et al. (2019), Olawumi and Chan (2018), Wei et al. (2015) used Citespace to map Value Management, sustainability, and GIS knowledge domains respectively by facilitating objective, accurate, and quantitative reviews of the entire published literature. However, these may not replace the manual review process, which is still beneficial for in-depth understanding and interpreting a complicated subject, along with its critical factors (Ekanayake et al., 2019). Besides, Citespace combines quantitative analysis of the literature and visualisation, enabling improved understanding of a knowledge domain, including the important dynamics of underlying themes (Chen et al., 2010). However, there is a dearth of literature on such a bibliometric review of the SCR knowledge domain.

‘Knowledge is belief arising out of acts of intellectual virtue’ (Zagzebski, 2017) and SCR knowledge domain consists of all the theoretical and practical knowledge developed on SCR. Further, it is needed to objectively and algorithmically investigate the previous literature, visualise them clearly and fill the existing theory-practice gap by synthesising new research domains of SCR. Bibliometric evaluation of research outcomes, their impact, and study of the field’s development together, with research limitations, enables overcoming the aforementioned research lacuna while proposing potential research opportunities. Hence, this study traces the development of SCR throughout the past few decades and explores the future demand by analysing the SCR publication base, research clusters, key contributors (through citation counts), research hotspots (through keyword analysis), and research evolution (citation bursts) using bibliometric analysis. Finally, the results are condensed to an SCR research map which presents a state-of-the-art quantitative summary of the SCR knowledge domain.

Research Methodology of Literature Review

Drawing on the successful approach in the methodology employed in the study of Ekanayake et al. (2019) albeit in a different domain, this study developed an SCR research map by integrating the findings generated from the bibliometric analysis of SCR related literature. In this study, Citespace.5.3.R11 software was used to map the current SCR publication base to fill the identified research gaps. Citespace is a more balanced and powerful software compared to the other visual analytic tools (Wei et al., 2015) and useful in determining an intellectual base, landmark publications, research trends, and hotspots by generating visualisations that vividly unveil interesting patterns in the literature (Ekanayake et al., 2019). Indeed Ekanayake et al. (2019) followed the common methodology used in other Citespace analysis-based publications and has developed a more dynamic and rigorous research map as the key research output. Hence, this study

followed the same proven methodology as it was now required and targeted to develop such a rigorous and dynamic SCR research map by addressing the long-neglected research gap in the SCR research field.

Data collection

In this study, the dataset of bibliometric records on SCR was retrieved from the Web of Science (WoS) database using a topic search including title/abstract/keyword search of 'Supply Chain Resilience' and 'Resilient Supply Chains'. Each bibliometric record included author details, abstract, and the full details of the cited references in the article. Thereby, a core data set comprising of 664 publications: 461 articles, 163 conference proceedings, and 40 review papers were retrieved through WoS (a reputable database of high-quality publications) without restricting to a specific year of publication. The retrieved data were used to determine the research clusters, citation bursts and the research hotspots of the SCR.

Data Analysis

Citespace encourages several types of analysis using the retrieved bibliographic records (Li et al. 2017). This study focused on the document co-citation network analysis, keyword co-occurrence network analysis, and Citation bursts analysis to generate the study findings. Since these techniques provide a more extensive and diverse range of topic investigation, this method has an advantage over the manual review method (Li et al., 2017). Also, this method allows for frequent review and easy updating of the literature.

A merged network of nodes and links highlighting the significant publications on SCR over the years was first identified and then visualised via document co-citation network analysis. These highlighted publications are the landmark publications within the SCR

research domain. Each dot of the visualisation demarcates a node, which is a cited reference. Each link conveys the cited frequency of two articles together in another article within the data set. It can identify prominent research groups in a data set, namely the clusters in the analysis. Each cluster is a distinct research domain (Li et al., 2017) of SCR. Cluster properties are defined using the modularity, and the mean silhouette scores and higher modularity indicates that the network is divided into loosely coupled clusters (Ekanayake et al., 2019). The higher the mean silhouette scores, the higher is the cluster homogeneity (Ping et al., 2017). Furthermore, research hotspots of SCR were discovered through keyword co-occurrence network analysis. Citation bursts analysis was employed to trace the evolution of the SCR research along with the research milestones by identifying a sharp increase of citation counts of an article.

Results and Discussion

Based on the results generated from document co-citation network analysis, cluster analysis, keyword co-occurrence network analysis, and analysis of citation bursts, this study developed an SCR research map (Figure 1) and explicated further as follows.

(Insert Figure 1 here)

SCR Research Map

The need for a comprehensive review of SCR related literature has been identified by several studies, including Tukamuhabwa et al. (2015), Ali et al. (2017). However, all these studies were manual reviews based on desk studies and did not determine the SCR research base, clusters, hotspots, and the research evolution through citation bursts. Therefore, following on from the methodology employed in the study of Ekanayake et al. (2019), this study developed an SCR research map by integrating the findings generated from the bibliometric analysis of SCR related literature. According to Figure 1, the SCR

research map comprises six key-constructs, namely, the SCR publication base, the body of research knowledge, research hotspots, the pattern of research evolution and the future.

SCR publication base

The SCR publication base consists of all the 664 publications on SCR retrieved from the WoS database. These are the research outputs that link directly to the SCR research field and are therefore considered as the basis of the study by providing the foundation level in the research map.

Research pillars

Research pillars are the supporting structures that strengthen SCR research development. Therefore, highly contributed publications to SCR, identified from the document co-citation analysis were considered as the key pillars of the research map. Following the document co-citation network analysis, Citespace enabled dividing the timeline of the publications into a series of time slices in a way that each slice equals one year. Thereby, the top 50 citations in each year were taken into the analysis. Figure 2 shows the generated results: a co-citation network with 268 nodes and 1387 links. Modularity Q of the network is 0.5249 and, the mean silhouette value is 0.4263, confirming that the network is reasonably divided into tightly coupled clusters, and the homogeneity of the clusters is fair. Further, citations with large nodes represent the highly cited publications of SCR. For instance, the results indicate that Pettit et al. (2010) have contributed substantially to the SCR research base.

(Insert Figure 2 here)

Table 1 presents the details of the most cited ten publications as derived from the analysis. All these publications are peer-reviewed journal articles and published in the highly indexed journals. The most cited article is Pettit et al. (2010). This publication has

received the highest citation frequency with 129 citation counts. Apart from proposing SCR best practices, the authors importantly differentiate the SC-RM from resilience and develop a conceptual framework with postulates and propositions to enhance SCR. Besides, the authors developed an assessment tool to ensure SCR by enabling firms to evaluate their level of resilience (Pettit et al. 2013). This study was the first initiative to evaluate firms' SCR via an assessment tool, and this methodology was further followed by Zainal and Ingirige (2018) to evaluate and enhance SCR in construction projects. Also, the authors first proved the interdependency between SCR, capabilities and vulnerabilities: SCR increases when capabilities increase, and vulnerabilities decrease; hence, SCR indicates the level of balance or equilibrium achieved between the capabilities and the vulnerabilities.

Therefore, these articles have contributed significantly to knowledge creation and development in SCR research field. Without just focusing on the popularity of a publication, co-citation analysis enabled measuring 'prestige' of a paper by calculating the number of times a publication is cited by other highly cited papers. Accordingly, Pettit et al. (2010) has received higher popularity and prestige ratings compared to the other related publications, since accounting for the largest node in Figure 2.

Ponomarov and Holcomb (2009), as the 2nd highest cited article, has contributed to the knowledge domain by conducting an integrative literature review. Notably, the study has attempted to define the concept of resilience from different perspectives, including ecological, organisational, social, psychological, and economical. It has linked the logistics capabilities with SCR and highlighted the adverse effect of SC disruptions on both revenue and costs, suggesting the future need of event readiness, efficient responsiveness and successful recovery at a disruption. It is not surprising that the study of Jüttner and Maklan (2011) ranked as the 3rd most cited article since the study

conceptualises the SCR concept by supporting strong empirical justifications and explores the concept under a disruptive global event for the first time. Accordingly, knowledge management has a positive impact on SCR, together with improved flexibility, velocity, visibility, and collaboration capabilities.

The study of Wieland and Wallenburg (2013) widens the conceptual understanding of resilience and improves the knowledge on relational competencies (robustness, agility) recommended for risky SC environment. Carvalho et al. (2011) evaluated alternative SC scenarios based on a simulation study for the first time and promoted an understanding of how mitigation strategies affect each SC's performance. Bhamra et al. (2011) and Hohenstein et al. (2015) are review-based studies which identify a number of areas for advancing resilience research. These studies have gained close attention of relevant researchers and readers since these provide an in-depth investigation of the concept.

Blackhurst et al. (2011) describe a multi-industry empirical investigation that culminates in a framework to assess resilience in a supply base. Brandon-Jones et al. (2014) discuss the relationship between specific resources, capabilities, and performance in terms of SCR and robustness, where the latter is taken as a separate phenomenon. The study of Craighead et al. (2007) is also significant since it took the first initiative to understand the severity of SC disruptions and propose two SC capabilities, namely recovery and warning. All these articles have received significant attention from researchers and have become significant publications in this field.

(Insert Table 1 here)

The façade

The façade of the SCR research map replicates the research clusters of SCR. They are the structured subsets of the SCR body of knowledge that can promote the understanding of SCR and its implementation. Hence, the research clusters were investigated to identify

the SCR research outliers. Cluster labels were created from the top-ranked title terms in each cluster, and these title terms were extracted from titles, abstracts, and the keywords of the publications. Log-Likelihood Ratio (LLR), Latent Semantic Index (LSI) and the Mutual Information (MI) tests were used to identify the most significant clusters and their most significant terms. The LLR test detects the distinctiveness of a term to a specific cluster, whereas LSI and MI tests separately distinguish the most representative words in each dimension and the most salient aspect of the clusters (Chen et al., 2010). Figure 3 denotes SCR clusters created in this study with their cluster labels. The largest cluster received #0, and other clusters were named accordingly. Silhouette value of all the clusters ranging from 0.7-1.0 indicates meaningful and robust results.

Clusters of 'SCR' and 'increasing SCR' are well connected and linked by the publication nodes. The most important cluster is the SCR (#0), symbolising the original research domain as it is and including 55 articles with 0.838 silhouette value. Articles within the cluster 0 consist of the research of systematic reviews of SCR (Ali et al., 2017; Hohenstein et al., 2015; Tukamuhabwa et al., 2015; Durach et al., 2015), empirical studies of SCR (Jüttner and Maklan, 2011), case studies of SCR (Tukamuhabwa et al., 2017), and modelling and simulation methods of SCR (Pournader et al., 2016). The most active citer of the cluster is (0.16) Ali et al. (2017) analysing SCR. All the articles within the cluster deeply investigate the research domain and further facilitates future research directions by associating with the primary domain: SCR.

The second most significant cluster is increasing SCR (#1). Being the most active citer (0.32) of the cluster, Colicchia et al. (2010) researched on increasing SCR in a global context. Further, the articles in this cluster present details about enhancing SCR under the worldwide context. Scholten et al. (2014) suggest a mitigation process to enhance SCR, whereas Pettit et al. (2010) propose a framework to ensure SCR. Pereira et al. (2014)

cover another vital area of improving SCR by determining the requirements of the procurement stage. Therefore, this research cluster is very important to practitioners since it suggests approaches to ensure and enhance SCR in a global context.

The third-ranked cluster (#2) focuses on SC and proposes initiatives to enhance SC performance. Jabbarzadeh et al. (2018) incorporated resilience and sustainability into the SC design to enable SCs to withstand disruption risks effectively. This cluster includes 36 articles published ranging from 2013-2018. Therefore, the cluster reveals the recent research trend and establish resilience as a SC performance enhancement criterion. Especially Ivanov (2017), Dolgui et al. (2018) researched on the ripple effect of SCs and suggested efficient, resilient trade-offs to optimise SC performance. Ripple effect explicates situations in which one event produces impacts which spread and produce further effects. Most of the SC disruptions emerged as a set of joint circumstances and generated cascading impacts with a ripple impact, which are hard to anticipate and predict (Van Der Vegt et al., 2015). Moreover, bringing a new initiative to the SCR knowledge domain, Pavlov et al. (2018) proposed a hybrid fuzzy-probabilistic approach to assess the SCR and therefore, this paper is clustered in the cluster (#2).

(Insert Figure 3 here)

In addition, all the other main clusters explicate the significant research sub-domains related to the SCR knowledge domain, e.g., sustainable SC management [environmental-friendly practices the global firms look for] (Ahi and Searcy, 2013), digging into SC risks (Fischl et al., 2014), SC disruption mitigation (Scholten et al., 2014) to name a few. In summary, all these clusters explore SCR as a performance-enhancing method for SCs that can be used to pursue specific research objectives in physical or social environments irrespective of the area of research.

The façade is divided into three sections based on their relevance to each section. Section 1 presents the clusters related to the concept of SCR, namely: SCR and the system-theoretic identification. SCR is derived from the multidisciplinary and multidimensional concept of 'Resilience' and nurtured in supply chain management and RM disciplines (Ponomarov & Holcomb, 2009). Since the concept of resilience is still under development, the SCR concept is also being reinforced with theoretical underpinnings of both resilience and supply chain knowledge revision and development. However, the concept can be studied using the dynamic capability theory (Chowdhury & Quaddus, 2017). Accordingly, SCR can be defined as the dynamic capability of SCs to withstand the influential SC vulnerabilities under tumultuous SC environment by developing and deploying appropriate SC capabilities.

In section 2, allied management clusters such as SC, sustainable SC management and the price risk are included. This cluster provides alerts to the development of the sustainable capacity of resilient SCs. Ponomorov and Holcomb (2009) probe the economic and social aspects of resilience. However, the interconnection with the environmental aspect is not explored, hence suggesting a new area of search. Although the findings reveal that SCR should withstand SC price risk, a suitable mechanism is lacking, hence, pointing to another research area.

Section 3 is allocated for describing practice related clusters, including increasing SCR, mitigation processes, low carbon energy system, achieving SCR, the failure mode of SCR and SCR in a waterway port. These clusters help to identify the current practice in mitigating SC disruptions, hence explore the dynamic capabilities and their failure modes specific to the case studies. Accordingly, moving from manufacturing and automobile industry practices of SCR, Hosseini and Barker (2016), studied how resilience affects infrastructure using a case study of an inland waterway port. Also, these authors have

identified that the Bayesian network modelling is an effective tool to quantify resilience capacities through forward and backwards propagation. Further, the results suggest improving absorptive, adaptive and restorative capacities of resilience by creating new knowledge in this domain. Identified cluster (#10) combines such interesting findings of resilience related to infrastructure systems such as ports. Thereby, the entire body of SCR research was divided into meaningful subsets and tied together within this integrated SCR research map.

The windows-research hotspots

As keywords are related to the core content of the publications, keyword co-occurrence network analysis was beneficial in exploring the critical research topics (Li et al., 2017). Keywords indicate the research hotspots of the SCR by meaningfully tracking the threads in the evolutionary trajectory of topics. Further, these research hotspots facilitate insights into the SCR research domain. Therefore, the window level is allocated for the keywords. Figure 4 shows the keyword co-occurrence network with mostly cited terms generated, including 175 nodes and 1,111 links. A node denotes one keyword determined from the publications where node size is proportionate to the co-occurrence frequency of the related keywords. The most frequently used term in the SCR domain is ‘resilience’ with 288 citation frequencies. Resilience straddles diverse disciplines due to the wider adoption of the context around different research domains (Ali et al., 2017), and SCR is also one of the clusters researched under the same umbrella (Bevilacqua et al., 2018). The second-largest count of keyword co-citation is 134 for ‘management’. New management initiatives have been launched to overcome the allied weaknesses of SC management, beginning in 1980 (Akintoye and Main, 2007). For instance, SCR itself has appeared in recent years to aid managers to strategically design resilient SCs (Bevilacqua et al., 2018). Therefore, SCR is found in the management related research studies over the years.

However, resilient practices in the construction SC management are ad-hoc and scattered and reveals another research area to explore (Ekanayake et al., 2020a). At the infancy stage of SCR concept, the studies were limited to the state-of-the-art reviews and the empirical studies. Later, the interests have broadened towards fuzzy evaluation, graph theory, structural equation modelling, quality function deployment and system dynamics modelling (Ekanayake et al., 2020a). Therefore, these mathematical modelling and simulation tools and techniques enabled analysing SC performance under controlled environments and also enabled investigating possible mechanism for the optimised performance.

The 3rd largest hotspot in the SCR research domain is performance. As explained above in this research, it is not surprising that this term was selected as a research hotspot since the key objective of achieving SCR is to enhance the performance of SCs. There are many simulations (Ivanov, 2017) and modelling approaches (Brusset and Teller, 2017) used in the research field to optimise SCR targeting the enhanced performance of SCs. Further, it is essential to develop counteractive capabilities to effectively withstand SC vulnerabilities to boost SC performance (Pettit et al., 2013). Organisational performance in SCR can be evaluated using assessment tools and resilience can be better achieved when the appropriate balance between SC vulnerabilities and SC capabilities obtained (Pettit et al., 2013). 'Framework' was identified as the fifth-largest hotspot since the researchers have established several research frameworks to address SCR. These include conceptual frameworks (Pettit et al., 2010; Peck, 2005; Ponomarov and Holcomb, 2009) and the case-study based research frameworks (Scholten et al., 2014). 'Risk management' is the eighth-ranked term with 97 counts. SCR goes beyond the traditional RM practices and provides the required protection against potential risks (Fiksel, 2015), which cannot

be handled within the conventional RM framework (Van Der Vegt et al., 2015), hence, establishing its significance towards the SC performance.

(Insert Figure 4 here)

The identified keywords of resilience, SCR and framework are allied with theory; hence, placed within the theory section. Management, SC and RM are relevant to the management, so they are appropriately placed in the management section and performance, and disruptions are located within the practice category since SC performance and disruptions come along with its practice.

Upper roof tie-beam-research evolution

The upper roof tie-beam of the SCR research map is allocated for the evolution of SCR research. Citation bursts reflect a stepwise evolution trajectory, emerging from the dynamics of SCR research field by denoting the publications which received a sharp increase of citations. Figure 5 shows the top 25 references with the most robust citation bursts in the field of SCR. The earliest citation burst began in 2005 and was consistent with the rapid development of SCR throughout 2008-2013.

(Insert Figure 5 here)

Building resilient SCs received significant consideration at the beginning of 2008 (Christopher and Peck, 2004), and this was followed by an early citation burst of the SCR related literature. There are many publications urging the need for resilient SCs, e.g., including Sheffi and Rice (2005) and Bevilacqua et al. (2018). However, the research focus was shifted to the disruptions/vulnerabilities studies in 2009 since they are the events which suggest the emergence of SCR. SCs are exposed to the increased level of disruptions/vulnerabilities such as political, social, and economic disorders (Snyder and Shen 2007), and these vulnerabilities are unanticipated and unplanned events which beset

the normal flow (Zavala et al., 2018). Studies of Blackhurst et al. (2005) and Jüttner (2005) contributed to appropriate knowledge development by demarcating a citation burst relevant to the disruptions/vulnerabilities studies. Therefore, the burst was unsurprisingly created on mitigating disruptions after 2010. Firms must adopt appropriate procedures to identify and withstand the vulnerabilities to realise enhanced resilience in the SCs (Christopher and Peck, 2004; Surjan et al., 2016). In these circumstances, mitigating the disruptions have attracted the researchers' focus by establishing its vital significance that can be achieved by developing counteractive capabilities in a SC (Pettit et al., 2013). Therefore, the research focus shifted to the emergence of SC capabilities later in 2011. For instance, Tomlin (2006) suggested flexibility as a SC capability to deal with disruptions, and Pettit et al. (2013) developed a 13-factor capability assessment tool. Mostly, these findings were related to the SCs of manufacturing and service firms. However, the application of SCR also appeared in the automotive industry (Thun and Hoenig, 2011) and more recently in the construction industry (Zainal and Ingirige, 2018, Ekanayake et al., 2020b) by expanding prevailing horizons.

Future research trend and implications

The future trend of SCR is forecasted to have wider applications in the global SCs and also promote new initiatives to achieve SCR better, as found in this study. This future perspective is presented at the roof level of the SCR research map by highlighting the importance of resilient SCs.

According to the findings of citation bursts analysis, future studies may target evolutionary approaches in assessing SCR and proposing new dynamic capabilities as appropriate to the distinct industries. Without just considering the absorptive, adaptive and, restorative capacities separately, it would be beneficial to find out their

interconnections and dynamics through case studies and propose robust methods to enhance SCR.

Since the basic theory is growing in several SC management disciplines by expanding its horizons, further studies of infrastructure SCs (as derived from the cluster analysis results) and construction-related SCs can add value. For instance, the vulnerability of a dry port due to SC disruptions may lead to significant economic losses since ports are the crucial nodes of intermodal transportation and do experience an escalating number of disruptions (Hosseini et al., 2020). Hence, deeper infrastructure and transportation-related research may provide domain-specific insights into the SCR practice.

SCR findings in the construction industry can be further focused on the prefabricated construction process as industrialised construction is nurtured and developed using advanced manufacturing and installation principles, such as modular units. Prefabricated construction SCs are affected by additional SC vulnerabilities of SC fragmentation, necessitating fresh SC capabilities to withstand these disruptive causes. Also, industry practitioners will benefit from identifying SCR as a proactive method to withstand supply chain vulnerabilities. Therefore, industry leaders should be willing to incorporate SCR in their new policies.

In addition, as a new initiative, the industries may consider 'blockchain' and 'SCR' integrated platforms for value-enhanced SCs in times of increased risks and uncertainty (Min, 2019). As identified from the cluster analysis, modelling of blockchain integrated SCR case studies may lead to useful research agendas. The results may further encourage a search for synergies in integrated blockchain, artificial intelligence, and SCR practices. Exploring the interconnections between SCR and sustainability concepts also provides a pointer to new research direction, since the findings still lack an environmental sustainability emphasis, in the context of the three pillars of sustainability (economic,

social and environmental). Identifying stakeholder influence in resilient SCs using social network analysis theory and agent-based modelling will not only enable identifying the stakeholder roles in SCR as a new research agenda but also will facilitate the application of new research methods in this domain. Thus, these emerging technological improvements have great potential for knowledge creation.

These new research directions could inform policymakers to develop appropriate frameworks to encourage resilient, smart, and sustainable contributions to the built environment. Therefore, an initiative to develop policies and strategies that facilitate SC capability improvements could be supported through such research outcomes. Finally, the established SCR research map denotes the state-of-the-art of SCR knowledge and, provides a dynamic platform to integrate future changes.

Conclusion

SCR is an emerging research area which has to be explored widely and in-depth. This study applied bibliometric analysis research techniques to analyse the SCR research domain and used Citespace software due to its advantages over the manual reviewing process. The 664 publications retrieved from WoS were analysed, enabling the identification of highly contributed articles, research clusters, hotspots, and the critical milestones of evolution. Future SCR developments are projected to rely upon expanding its applications in the global SCs, in-depth findings on SC capabilities to enhance resilience, sustainability aspects, methodology improvements, and policy implementation. The scientific contribution of this study is an accurate and quantitative SCR research map, including the SCR research base, domains, pillars, hotspots, evolution, and future trends. The methodology and the findings can be generalised to any specific field of study. Besides, the proposed SCR research map could be frequently

updated by injecting future findings from similar studies to fill the future gap of research. However, it is necessary to declare the research assumptions and limitations faced. The data set was collected entirely from WoS to match the requirements of Citespace. This may exclude some other relevant items that may only be within other data sources, and the results may highly depend upon WoS data source. Hence, a broader-based exercise may be considered to expand the datasets and using other bibliometric analysis tools to expand the 'data catchment area' and refine the results. Also, these refined results can be underpinned by further empirical studies or manual reviews of the literature to inject any useful expert insights. Moreover, the findings create new knowledge in the SCR domain, that also help to identify corresponding future demands of the research field, and ultimately contribute to performance-enhanced, resilient global SCs by accelerating better structured and balanced development of smart and sustainable practices.

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Table 1: Most cited publications in the discipline of SCR

Author	Title	Year	Published in	Frequency
Pettit, T. J., Fiksel, J. & Croxton, K. L. J. J. O. B. L.	Ensuring supply chain resilience: development of a conceptual framework.	2010	Journal of Business Logistics	129
Ponomarov, S. Y. & Holcomb, M. C.	Understanding the concept of supply chain resilience	2009	The International Journal of Logistics Management	116
Jüttner, U. & Maklan, S.	Supply chain resilience in the global financial crisis: An empirical study	2011	Supply Chain Management	98
Pettit, T. J., Croxton, K. L. & Fiksel, J.	Ensuring supply chain resilience: Development and implementation of an assessment tool.	2013	Journal of Business Logistics	69
Wieland, A. & Wallenburg, C. M.	The influence of relational competencies on supply chain resilience: A relational view	2013	International Journal of Physical Distribution and Logistics Management	66
Carvalho, H., Barroso, A. P., Machado, V. H., Azevedo, S. & Cruz-Machado, V.	Supply chain redesign for resilience using simulation	2012	Computers and Industrial Engineering	64
Bhamra, R., Dani, S. & Burnard, K.	Resilience: the concept, a literature review and future directions.	2011	International Journal of Production Research	58
Blackhurst, J., Dunn, K. S. & Craighead, C. W.	An empirically derived framework of global supply resiliency	2011	Journal of Business Logistics	56
Brandon-Jones, E., Squire, B., Autry, C. W. & Petersen, K. J.	A Contingent Resource-Based Perspective of Supply Chain Resilience and Robustness.	2014	Supply Chain Management	52
Craighead, C. W., Blackhurst, J., Rungtusanatham, M. J. & Handfield, R. B.	The severity of supply chain disruptions: Design characteristics and mitigation capabilities	2007	Decision Sciences	51
Hohenstein, N. O., Feise, E., Hartmann, E. & Giunipero, L.	Research on the phenomenon of supply chain resilience: A systematic review and	2015	International Journal of Physical Distribution and	51

	paths for further investigation	Logistics Management

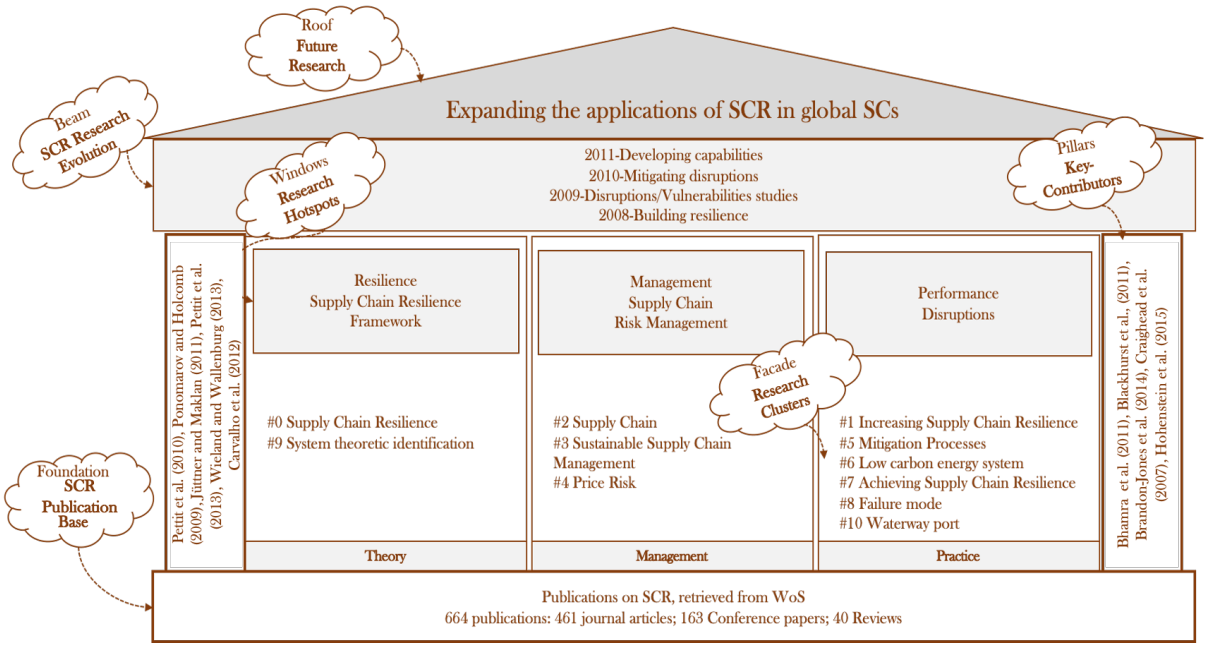

Figure 1: SCR Research Map

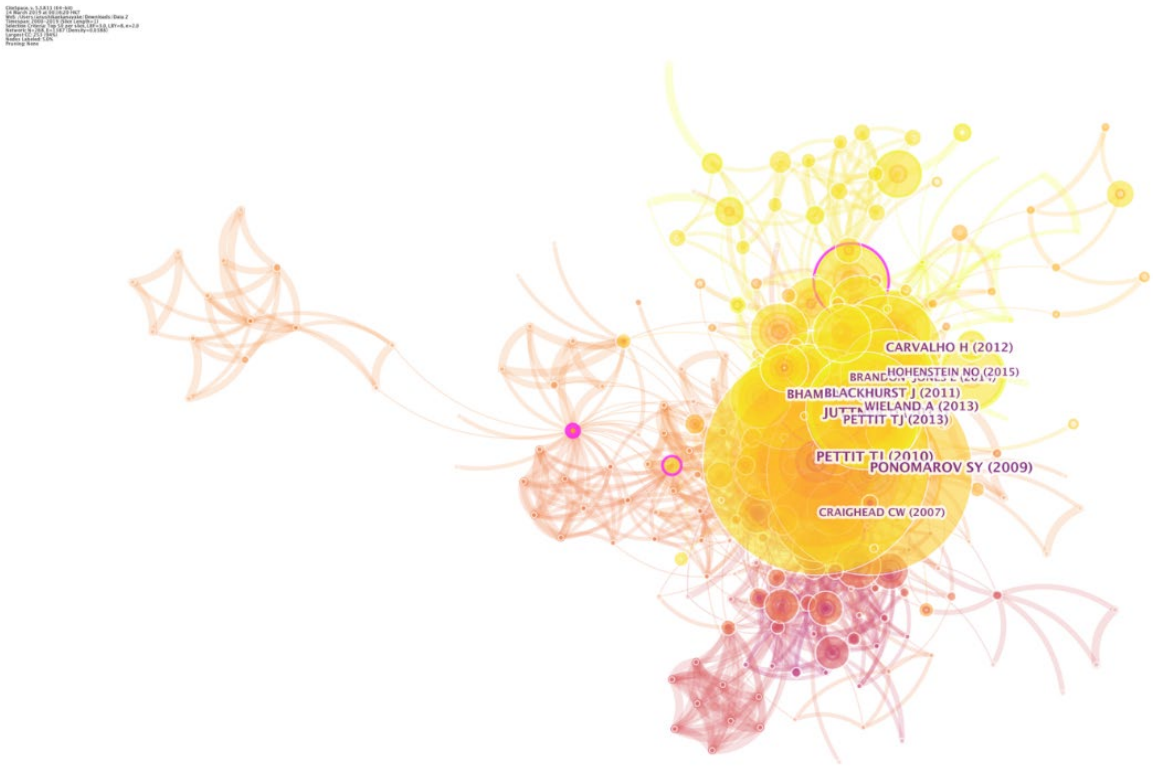

Figure 2: Document co-citation network of SCR

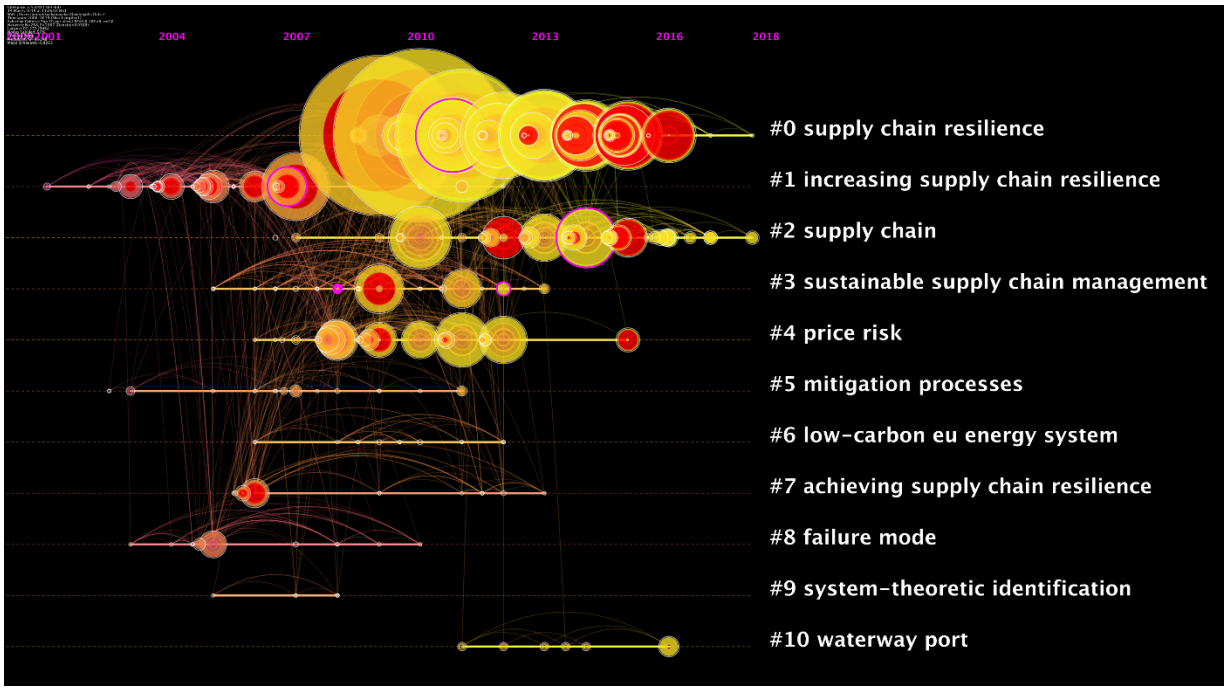

Figure 3: Clusters of research domains within the SCR discipline

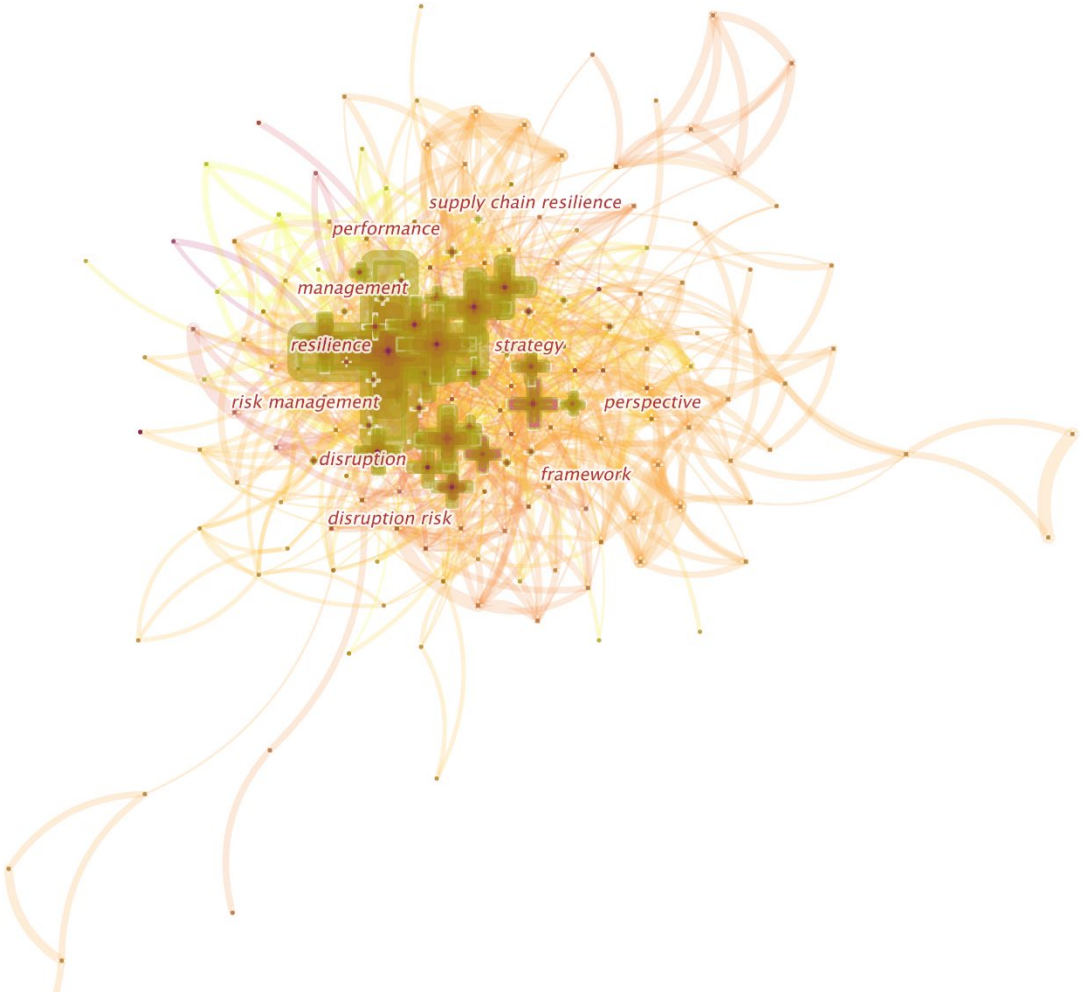

Figure 4: Keyword co-occurrence network with mostly cited terms

Top 25 References with the Strongest Citation Bursts

References	Year	Strength	Begin	End	2000 - 2019
SHEFFI Y, 2005, RESILIENT ENTERPRISE, V0, P0	2005	10.9747	**2008**	2013	
SHEFFI Y, 2005, MIT SLOAN MANAGE REV, V47, P41	2005	13.6202	**2008**	2013	
CHRISTOPHER M, 2004, INT J LOGIST MANAG, V15, P1, DOI	2004	11.8108	**2008**	2012	
SHEFFI Y, 2001, INT J LOGIST MANAG, V12, P1	2001	3.4176	**2008**	2009	
RICE J, 2003, SUPPLY CHAIN MANAG, V7, P22	2003	11.1364	**2009**	2011	
BLACKHURST J, 2005, INT J PROD RES, V43, P4067, DOI	2005	5.2288	**2009**	2013	
JIITTNER U, 2005, INT J LOGIST MANAG, V16, P120, DOI	2005	6.8071	**2009**	2013	
PECK H, 2005, INTERNATIONAL JOURNAL OF PHYSICAL DISTRIBUTION & LOGISTICS MANAGEMENT, V35, P210, DOI	2005	7.8618	**2009**	2013	
NORRMAN A, 2004, INTERNATIONAL JOURNAL OF PHYSICAL DISTRIBUTION & LOGISTICS MANAGEMENT, V34, P434, DOI	2004	4.7213	**2009**	2012	
LEE HL, 2004, HARVARD BUS REV, V82, P102	2004	4.3662	**2010**	2011	
TOMLIN B, 2006, MANAGE SCI, V52, P639, DOI	2006	10.0528	**2010**	2014	
WILSON MC, 2007, TRANSPORT RES E-LOG, V43, P295, DOI	2007	3.117	**2010**	2015	
CHOPRA S, 2004, MIT SLOAN MANAGE REV, V46, P53	2004	5.3887	**2010**	2012	
TANG CS, 2006, INT J PROD ECON, V103, P451, DOI	2006	10.0528	**2010**	2014	
HENDRICKS KB, 2005, MANAGE SCI, V51, P695, DOI	2005	3.1811	**2010**	2013	
JUTTNER U, 2003, INT J LOGIST-RES APP, V6, P197, DOI	2003	4.3662	**2010**	2011	
TANG CS, 2007, INT J LOGIST-RES APP, V9, P33, DOI	2007	9.4372	**2010**	2015	
HENDRICKS KB, 2005, PROD OPER MANAG, V14, P35	2005	4.3997	**2011**	2013	
TANG C, 2008, INT J PROD ECON, V116, P12, DOI	2008	5.0992	**2011**	2015	
WAGNER SM, 2006, JOURNAL OF PURCHASING AND SUPPLY MANAGEMENT, V12, P301, DOI	2006	4.9931	**2011**	2014	
WAGNER SM, 2008, J BUS LOGIST, V29, P307, DOI	2008	3.8196	**2011**	2015	
CRAIGHEAD CW, 2007, DECISION SCI, V38, P131, DOI	2007	17.2044	**2011**	2015	
MANUJ I, 2008, INT J PHYS DISTR LOG, V38, P192, DOI	2008	6.3437	**2013**	2016	
BRAUNSCHEIDEL MJ, 2009, J OPER MANAG, V27, P119, DOI	2009	3.4223	**2014**	2017	
THUN JH, 2011, INT J PROD ECON, V131, P242, DOI	2011	3.6959	**2014**	2016	

Figure 5: Top 25 references with the strongest citation bursts