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Demystifying supply chain visibility: A systematic literature review

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Abstract

Supply chain visibility (SCV) has been in trend after the millennium and raised interest of both academics and practitioners. However, there is still an ambiguity on the topic, which hinders a proper SCV application. This study aims to clarify the fuzziness of the area by conducting a systematic literature review. By reviewing 67 articles, we have identified a conceptual model that covers three main roles of information sharing for SCV and their impacts on the positive and negative constructs of SCV. This framework illuminates the inter-construct interactions and, also provides diagnostic insights for the implementation of SCV in the firms.

Keywords: Supply chain visibility, information sharing, systematic literature review

Introduction

SC concept relies on the movement of materials from suppliers to customers and finance and information in the opposite direction (Baihaqi & Beaumont 2006). However, these flows generally go further beyond the horizon that the focal firms see. This situation sometimes creates problems because there is no capability of the focal companies to interfere with the issues beyond their visible boundaries (Carter et al. 2015). Moreover, this has become to be a bigger issue as once unimportant factors that are of no need to trace gain importance with the new requirements of dynamic market conditions (McKinney et al. 2015). For example, some problems related to social governance strategies that mega companies experienced are a result of not being aware of after boundaries. Similarly, being unaware of the processes within the boundary has been turning out as extra costs and problematic relationships. Therefore, as a result of the need to see, supply chain visibility (SCV) has become essential for supply chains, to mitigate the risks and maintain the confidence of supply chains (Fan et al. 2013). Various authors highlighted the importance of SCV (see (Barratt & Oke 2007; Dubey et al. 2017; Sarker et al. 2016; Nooraie & Parast 2015; Musa et al. 2014). Therewithal, practitioners have

also realised that importance (Bartlett et al. 2007). Enslow (2006)'s survey shows that 79% of the respondent companies mention that lack of SCV is one of their top concerns. Another study conducted by Sarker et al. (2016) affirms that results and demonstrate the importance of SCV among practitioners. However, the very same studies and some others also refer to SCV as one of the points that firms are incapable of achieving. Although there are various, contingent reasons for the issue, a dominant school of thought in the field believes that the gap between the targeted and achieved visibility levels can be a result of the ambiguity around the term of SCV (see Williams et al. 2013; Gunasekaran et al. 2017; Barratt & Oke 2007; Basole & Bellamy 2014; Zhang et al. 2011; Wang & Wei 2007) The vagueness starts with the definition of SCV. Since there is no consensus even in the definition, a misunderstanding dominates the topic (Francis 2008). Moving from Dubey et al. (2017)'s study, we suggest that the roots of the problem may be searched in delineating visibility from 'information sharing' term, which is a significant component of visibility and supply chain management (Baihaqi & Beaumont 2006).

Information sharing and SCV has been often used to state the same concept in supply chains: the state of the information prevalence among SC partners. In fact, moving from the previous studies, we can make a basic differentiation between these two terms with a resource-based view. As the visibility is basically accepted as the 'capability of accessing and sharing information', we can see the information as the main resource behind this capability and 'information sharing' as a single activity unit of that resource (Holcomb et al. 2011). However, the interaction between these two terms is not limited to only this. As there are authors that see information as a means of implementing visibility, some others regard it as a consequence of having information. Although all propositions are correct in theory, that situation blurs the field and hinders to constitute an SCV implementation roadmap for practitioners. Lack of a holistic study that will aggregate different schools and organise them into an applicable form motivates this study to construct a conceptual model of for the interactions between information sharing activity and the SCV dynamics.

Thus, this paper targets to investigate different interaction models between information and SCV dynamics and consequently produce a conceptual model. By that framework, the gap between theory and the practice will be narrowed down and the organisations with better SCV understanding will increase their SCV and overall SC performance. In order to achieve these aims, this paper utilises systematic literature review (SLR) methodology. Remainder of the paper will inform about the SLR methodology and the specific process of this paper and then demonstrate the descriptive and thematic findings of the study.

Methodology

A systematic review (or systematic literature review (SLR)) is defined as a review of a clearly formulated question conducted via a set of systematic and clear methods which identify, scope, and evaluate the relevant research in a critical way and then collect and analyse data of included studies (Siddaway 2014). It is adopted by researchers to identify, justify or refine the processes (Mulrow 1994). SLR, being a fundamental scientific activity in its nature, has various reasons to be preferable against traditional literature reviews. Characteristics of SLR compose some of the differences, such as replicability, positivity and transparency (Tranfield et al. 2003). Information overload is another reason to select SLR over traditional review. (Petticrew & Roberts 2006). In order to achieve the aims of this study, it was critical to conduct a holistic research and not to miss any perspective, so systematic literature review (SLR) has been adopted as the research methodology. Figure 1 demonstrates the phases of this SLR:

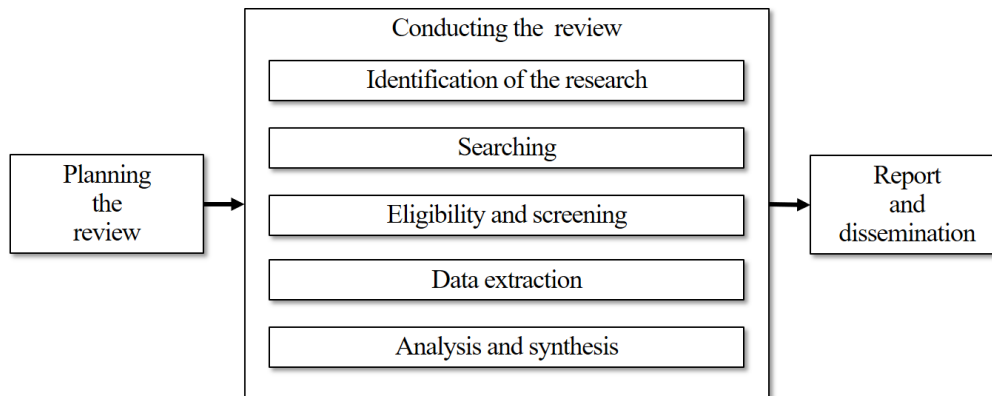


Figure 1 – Phases of SLR process (Adapted from Tranfield et al. (2003))

Denyer & Tranfield (2009) propose that less experienced researchers should tap into a scoping study in the field just ahead of the SLR. It is suggested in order to provide an introductory understanding of the constructs, so that they can conduct a better review with an increased awareness. In the planning step, this process has been achieved by the complete review of 28 papers, which deliver a good amount of background details about the variables. Together with scoping the research area, a review panel and an SLR protocol have been structured. Review panel helps the study increase objectivity by bringing distinct and expert perspectives, while protocol document formally captures the steps of the review and fulfil the transparency and replicability requirements (Tranfield et al. 2003).

Scoping the field and discussions in the review panel help the study to create specific review question or questions. They clearly put forth the variables of the study, which compose the keywords and search terms, and ultimately search strings (Tranfield et al. 2003). In light of this, the following main review question and sub-questions were identified to form the main framework of this research:

- How do supply chain visibility and information sharing interact to improve supply chain performance?
 - What are the enabling and inhibiting factors for SC visibility?
 - What are the benefits (improvements in SC performance) of improved SC visibility?
 - What are the challenges (vulnerabilities) ensued by improved SC visibility?
 - What are the core constructs of information sharing in its interaction with SC visibility?
 - What are the relationship models between information sharing and SC visibility?

In order to be able to find successful and complete answers for these questions, following keywords and search terms were used (Table 1) to the final search string.

Table 1 – Keywords for variables and related search terms

Keywords	Search Terms
Supply	(suppl* OR demand OR value OR logistics)
Chain	(chain OR network OR web OR distribution)
Visibility and Information Sharing	(visib* OR transparen* OR "information shar*" OR "information exchange" OR "information disseminat*")

For searching, three major databases for management and organisations studies have been selected, namely Scopus, EBSCOHost, and Web of Science. Search ended up with 45,296 papers in the aggregate, which then are filtered and evaluated with three sets of results: eligibility filters, focus and relevancy criteria and quality evaluation. Eligibility filters included publication type and quality (only 3-4* journal articles in order to focus only on quality data and to avoid drowning in the excessive and repetitive data), research field (operations research and management, business, management and supply chain management), publication year (all included), and language (English). Filtered papers, then, were checked for their relevancy and focus by a title and abstract review. Next, remainder papers were evaluated according to four criteria: theory, contribution, methodology and results. In total, 54 journal articles were selected for the SLR. Lastly, they were supported with two main cross-referencing techniques (namely, snowballing and citation-tracking) in order to avoid missing essential information that is initially dismissed by the eligibility screening (Greenhalgh et al. 2005). It has brought 13 additional papers and, the study has been constructed on the review of 67 papers in total.

Along the review process, data have been extracted from papers in a systematic way. First, review sub-questions were considered as the main categories. Then, in order to create the granular codes within each category, a repetitive review process has been conducted. The findings of the review were analysed descriptively and thematically. Descriptive analysis demonstrates the trends in the field, in terms of publication year, resource, adopted methodology and theoretical approach. Thematic analysis, on the other hand, presents the context-based findings like state-of-the-art in the field, taxonomy of the constructs and related interrelationship.

Descriptive Analysis

In order to understand the main characteristics of the field, papers have been first analysed descriptively, in terms of their publication year, research methodology, and theory utilisations.

In the eligibility criteria, there was not any limitation for the publication year. However, descriptive analysis shows 2000 as the earliest publication year of 67 paper reviewed. Considering the non-existence of any restriction, we may infer that SCV is a rather new area. Moreover, we have identified that the last decade has an average of 5.7 publication on SCV. It indicates the importance of the area in academia and its need and fruitfulness to be illuminated.

In terms of paper type, we have observed that 15% of the papers (11) provide either conceptual or theoretical contribution to the field. These type of studies help researchers keep up-to-date with the state-of-the-field, and suggest promising directions for further research. On the other hand, the remained 85% (58) utilise empirical research methods, either in order to explain previously asserted conceptual phenomenon or to explore the area further. We suggest that the ratio of 15% to 85% is a good balance for the steady and continuous improvement of the SCV area. Among these 58 papers, 49 use three major research methods: case study (21), survey (17), and modelling (11). These figures tell that academics of SCV 1) are in a search of furthering the area with majorly doing exploratory case studies; 2) are interested in the correlations (of internal SCV constructs or with other SC constructs) related to SCV; 3) and look for creating a universal quantitative measurement for SCV. While these research methods dominate the field, there is a rarity in methodologies like field and laboratory experiments and action studies. These methodologies, comparing the others, give more control to researchers and help them investigate causal relationships. Hence, adopting them more will bring a holistic sharpness to SCV, and lead it to be a well-understood and applicable field.

Another descriptive area we assessed in this study is the theoretical approach of the reviewed papers. Utilising a theory in the research is essential because it defines the boundaries of the study and provides study to stay in that limits, not less or more. Therefore, the research field grows within robust blocks. Lack of theoretical base, on the other hand, ends up with suspending ideas and a fuzzy research field. SCV field also experiences this problem, where only 26 out of 58 papers adopt a theoretical approach. Considering that ambiguity is SCV field's biggest problem, we can assert that this may be one of the reasons. Resource-based view is the most adopted theory, which accepts visibility as a capability for SCs. However, authors look at the phenomena from 18 other perspectives as well (Table 2).

Table 2 – Distribution of theories in SCV field

# of frequencies	Theories
5	Resource-based View (RBV)
2	Contingency Theory, Dynamic Capabilities View, Network Analysis, Organisational Information Processing Theory
1	Transaction Cost Economics, Social Exchange Theory, Systems Theory, Systems Dynamics Approach, Bounded Rationality Theory, IDEF0, Contingent RBV, Social Capital Theory, Process Oriented Approach, Design Theory, Set Theory, Dependency Theory, Technology-Organisation-Economy

Thematic Analysis

Roles of information sharing in SCV

Information sharing is accepted as a vital tool for many supply chain constructs like coordination, integration and flexibility (Baihaqi & Beaumont 2006; Williams et al. 2013). When it comes to visibility, the degree of that importance scales up, as information sharing constructs the core of SCV. This relationship, however, brings some problems as well: interchangeable usage of SCV and information sharing (Swaminathan & Tayur 2003). We believe that this interchangeability underlies the ambiguity of SCV context. Here, we define two main interactions between information sharing and SCV.

The first school of thought accepts information sharing as a source, which results in having visibility capability along the supply chain (Brandon-Jones et al. 2014; Holcomb et al. 2011; Barratt & Oke 2007). This relationship is obvious as the majority of SCV definitions rely on information sharing/accessing capability and information quality attributes. In this concept, we can tap into the resource-based perspective. We can infer that information sharing is only the activity that provides discrete benefits when the resource is used. On the other hand, a continuous information sharing powered by a completely visible supply chain will lead to a holistic set of benefits along the supply chain. The second group of authors, on the other hand, assert that when there is a viable visibility in supply chains, it can ease sharing information and getting benefit from that activity (Yu & Goh 2014; Caridi et al. 2010; Pfahl & Moxham 2014; Brandon-Jones et al. 2015). This relationship may be explained by the facilitating role of visibility, in terms of providing requisite technical and technological infrastructure. When the conditions are

more suitable to share and access information, it will be more possible to have more flow of information among supply chain partners. Other than technical assist, SCV can help construct the right environment for information sharing. The visibility-led higher level of trust between partners will make them more volunteer to share information (Baihaqi & Beaumont 2006).

Therefore, we can see that there is a cycling relationship between information sharing and SCV. While this brings the ambiguity and interchangeability for the field, it also complicates the practical implication of SCV. Since both concepts trigger each other, organisations may be confused about the starting point of visibility process. Somapa et al. (2018) bring an original set of ideas for information sharing and visibility interactions, which can be a solution to the issue. Authors look SCV from a process theory perspective and create three main categories for SCV characteristics. Then, they match the categories with suitable attributes of information: accessibility of information, quality of information and usefulness of information. These categories fit our findings and develop them by highlighting the difference between accessing information and the quality attributes of accessed information like completeness, accuracy, timeliness, usability, and format. Since quality-related information attributes are independent than the state of reaching information, we can accept it as another information sharing-SCV interaction model. Conclusively, we can classify these interaction modes as follows: information as-enabler-of-SCV, information as-means-of SCV, and information as-result-of-SCV. Investigating SCV contributes amongst these interaction modes will increase the robustness of the field and ease the applicability of both concepts.

Positive SCV constructs

Review of 67 papers has provided us to have a comprehensive analysis of SCV constructs with 49 concepts that affect SCV in a positive way. However, without analysing and synthesising them, they were not suitable to use. They were dispersed, in some cases repeating or covering others, in other words, far from creating a systematic tool. After repetitive analysis of the reviews, we have identified two main taxonomies for positive constructs of SCV, namely antecedents, and enablers.

Antecedents represent the prerequisites, of which existence is required for a better or easier setting of an activity. In this context, their impact can be considered as a moderating variable. Literature has provided one tangible and five intangible groups of antecedents. The first antecedent is the *connectivity*, which is the only tangible one (Scholten & Schilder 2015; Hardgrave et al. 2013; Kyu Kim et al. 2011; Chew et al. 2013; Caridi et al. 2014; Pfahl & Moxham 2014; Brusset 2016) It refers to the technological infrastructure readiness for an end-to-end SCV. Many authors consider connectivity as an essential prerequisite, as it provides the technical background for the collection and dissemination of information along supply chains. Hence, we can accept connectivity as a starting point for SCV implementation in the cycling interactions of information sharing and SCV. Other antecedents are related to intangible concepts. The first one is *culture*. It involves the interorganisational culture elements like shared language and narrative (Johnson et al. 2013) or country culture (Dubey et al. 2017) and intraorganisational culture elements like organisational culture (Dubey et al. 2017), knowledge management culture (Busse et al. 2017), joint learning culture (Scholten & Schilder 2015) and risk management culture (Rajagopal 2017). Second intangible concept, *trust* is accepted of a great essence, as it supports SCV and at the same time is supported by SCV (Johnson et al. 2013; Klueber & O'Keefe 2013). *Relationship management* is another antecedent for SCV. It can be assessed as two groups: strategic relationship management, including internal and external SC integration and collaboration (Williams et al. 2013; Rajagopal

2017; Scholten & Schilder 2015; Steinfield et al. 2011), and operational relationship management covering length of relationship, power distribution, enthusiasm, network ties and configurations (Akkermans et al. 2004; Klueber & O’Keefe 2013; Johnson et al. 2013; Scholten & Schilder 2015). Last antecedent group is related to external environment, which is *demand uncertainty* (Yang et al. 2018). It is suggested that visibility is best utilised in a problematic demand profile. It should be remembered that these factors have moderating impacts. In other words, they do not result with a better SCV implementation on their own, instead, their existence plays a supportive role for the initiation of SCV.

Second group of positive constructs of SCV is composed of enablers. Enablers play a role of initiating and driving visibility. Literature provides three main enablers. First and the most important one is *information sharing* and quality of information shared. Since previous section has elaborated this concept, we do not repeat the details here. Second enabler is about *regulatory and contract requirements* (Johnson et al. 2013; Yang et al. 2018). This enabler does not have an incentive role but instead has a directive function. Organisations may need to be more visible according to their industry-specific requirements (e.g. pharmaceuticals, cold-chain food industry). In the other aspect, an SME may be demanded to become more visible in a collaboration with a multinational corporate. The last enabler is about *behavioural norms* (Johnson et al. 2013). Behavioural preferences of managers or operators trigger the implementation of visibility. However, it should be kept in mind that this behavioural propensity can work as an inhibitor as well.

Negative SCV constructs

Similar to the positive constructs, there are negative factors that inhibit a prosper SCV implementation. The review of the literature has demonstrated that these negative factors can be classified into two main groups in order to comprehend them in the best manner: extant challenges, and inhibitors before SCV initiation.

Two main existing challenges hinder companies to consider adopting SCV in strategic perspective. The first one is related to the management of SCs. Lack of alignment among SC partners aggregates the integration. Hence, it turns into an obstacle before companies, and even inhibits them to consider being visible to their partners, which are mentally far to collaborate (Maghsoudi & Pazirandeh 2016; Busse et al. 2017). Second problem arouses from technological reasons. Since the technology plays an important role of reaching data and then disseminating it, adopting the right and integrated technology along SC is regarded as essential for SCV (Maghsoudi & Pazirandeh 2016). However, the short life-time of communication technologies and their increasing infrastructure costs make an end-to-end SCV implementation difficult, especially for SEMs (Steinfield et al. 2011). These two problems are the obstacles that should be solved before creating strategies for implementing a holistic SCV.

Second set of negative constructs appears when firms decide to become visible. The main problem is the ambiguity around the visibility field (Basole & Bellamy 2014; Dubey et al. 2017; Francis 2008). Its interchangeability with information sharing, its deficiency of not having a single definition prevent organisations to have a standard road map for the implementation process. Another setback is about the management of information. The difficulty of data standardisation, having low quality information and the discrepancies in the information sharing process lead firms to unsuccessful SCV initiatives from the beginning (Maghsoudi & Pazirandeh 2016; Steinfield et al. 2011; Williams et al. 2013).

Lastly, behavioural reasons play an important role before SCV applications in negative direction. Biases of managers against the dependability of information, their

underweighting manners against its importance cause reluctance in information sharing (Caridi et al. 2014; Williams et al. 2013). Besides, partners having trust issues have the fear of opportunistic behaviour from opposite side of relationship, when they give access to them for their information (Dubey et al. 2017). These hesitations hinder the relationship and prevent having the full benefit of SCV.

Conceptual Model

Concluding, this study has investigated the different impacts of information sharing roles on SCV. In order to elaborate their interactions, following conceptual model can be a base for future studies in the SCV area (Figure 2).

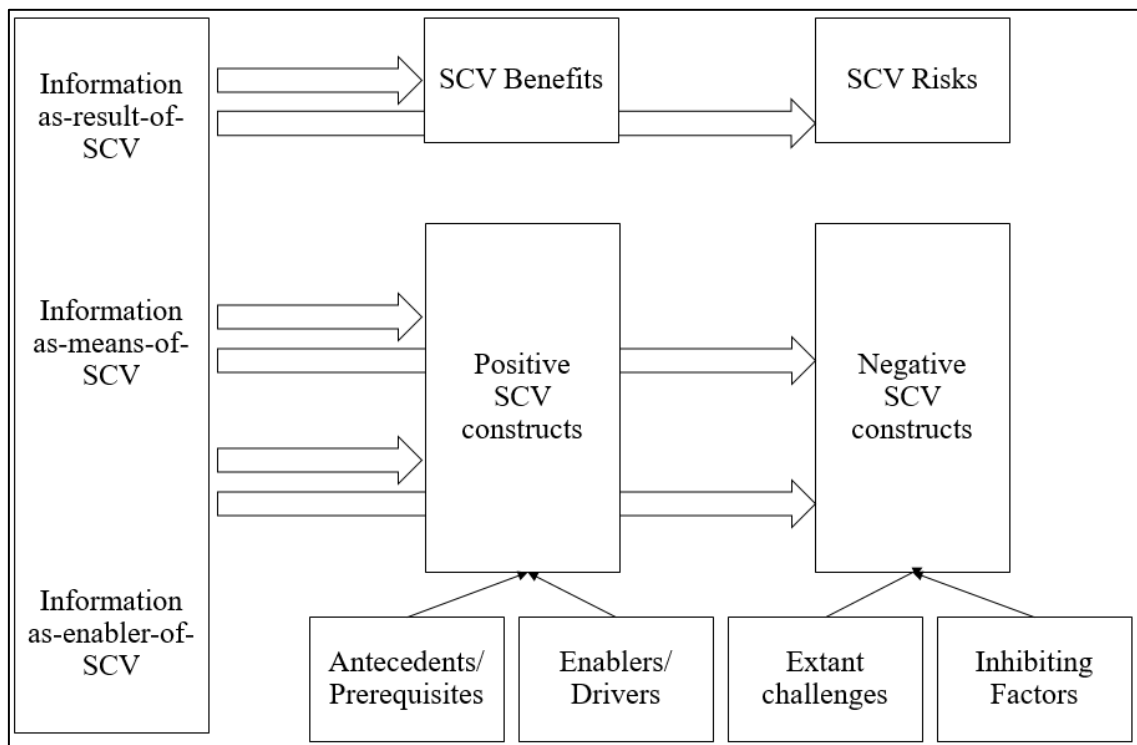


Figure 2 – Conceptual Model

Conclusion

This paper aims to clarify the fuzziness in the supply chain visibility by investigating its interactions with information sharing activity. In order to achieve the aims of the study, SLR methodology has been adopted in this research. Analysing 67 papers, three main roles of information have been found and their impacts have been observed in their interactions with SCV constructs. Two main contributions have been gathered from the study: interaction between information sharing and supply chain visibility has been illuminated in order to abolish the fuzzy nature of the research field. Secondly, positive and negative constructs of SCV have been classified in relations to each other. This helps researchers and practitioners to detect the interactions between constructs and draw their own roadmaps for and end-to-end SCV. We recommend future studies to test the conceptual findings of this study in empirical settings.

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