Antecedents of Supply Chain Information Visibility: The Complementarity Effect of IT Integration Capability and Interpersonal Communication Capability

Abstract

This study contributes to the SCM theoretical field, by focusing on the practical development of information visibility from the standpoint of supply chain professionals. Although prior research has identified the benefits of information visibility, a gap remains in understanding what the antecedents are. This research addresses this gap. The findings suggest that information visibility is a higher-order capability, which encompasses internal and external information visibility. Since internal information visibility has been largely under-researched, here we focus on describing the perception of internal information visibility and its antecedents in this paper. The findings reveal that the complementarity of IT infrastructure integration and interpersonal communication contributes to the achievement of internal information visibility in the supply chain. This finding offers empirical evidence for explaining the IT payoff in terms of IT capabilities development, which indicates that IT capabilities if combined together with complementary capabilities should become more effective in producing business value.

Keywords

Information visibility, IT integration capability, interpersonal communication capability, the resource-based view (RBV), complementary effect.

Introduction

In the context of market globalization, intensified competition and technological breakthrough, businesses have long recognized the critical role of effective supply chain management in achieving competitive advantage (Singh and Benyoucef 2013). Supply chain management (SCM) refers to the management of the external and internal aspects of a firm’s operations including the sourcing, logistics, production, and distribution processes involved in the delivery of goods and services (Chen and Paulraj 2004). Supply chain visibility (SCV), generally defined as the outcome of information sharing between different actors across the supply chain (Barratt and Oke 2007), is an important determinant of successful SCM (Caridi et al. 2014). Previous research has conceptualized SCV as a capability which may generate significant and sustained performance gains (Barratt and Oke 2007; Brandon-Jones et al. 2014). The increased visibility across organizational boundaries is critical for effective supply chain forecasting, planning, scheduling and execution (Kulp et al. 2004). Visibility of information related to supply and demand enables firms to respond in a timely manner to opportunities and challenges (Williams et al. 2013). Seamless information flows within a supply chain help to reduce uncertainty, lowering the incentives of behaving opportunistically, and alleviating the “bullwhip” effect (Lee et al. 2004).
Due to the practical relevance and importance of SCV, supply chains have invested in building chain visibility, yet, it is still far from being fully achieved (KPMG 2016). While SCV has become a popular buzzword in SCM, the concept is largely under-refined within the extant literature (Williams et al. 2013), and much of the prior definitions of SCV are theoretical in nature. Research in SCM often seeks to identify dimensions and antecedents to develop a formal definition of the poorly-understood constructs (Durach et al. 2015). While the benefits of SCV have generally been identified, research is still scarce in terms of identifying what the critical building blocks, or antecedents, of SCV concept are. For further clarification and development of SCV, additional scientific research is called for to better understand the concept and how such capability can be successfully executed (Somapa et al. 2018).

The literature of SCM identifies important flows across the supply chain to include materials, information and finance (Mentzer et al. 2001). This paper uses the term information visibility as an operational concept of SCV to emphasize the study’s focus on the extent to which useful supply chain information is made visible to different actors across the supply chain. Grounded on the resource-based view (RBV), information visibility is conceptualized as the capability in which members within a supply chain (i.e., suppliers, distributors, manufacturers, logistics providers, customers) have access to useful information (Barratt and Oke 2007; Williams et al. 2013). The purpose of the study is two-fold: first, to empirically explore the perception of information visibility from the standpoint of supply chain professionals; second, to identify the antecedents of information visibility. The research preliminary findings suggest that information visibility is a multi-dimensional concept characterized by two elements of internal and external information visibility. Additionally, the findings further elaborate the internal information visibility concept that is under-researched in the extant literature and its antecedents encompassing IT integration and interpersonal communication capabilities. As such, this study highlights theoretical and practical implications for better understanding and development of information visibility in supply chains.

The paper begins with an overview of the existing literature and develops a theoretical framework. Next, it describes the data collection and analysis method employed. The preliminary findings follow to illustrate the perception of information visibility from supply chain professionals’ point of view. Further detailed explanation of internal information visibility and the antecedents of internal information visibility are presented. A discussion of theoretical and practical implications is offered, followed by the conclusion.

**Literature Review**

**Overview of Supply Chain Visibility**

Supply chain visibility (SCV) has been recognized as vital to the theory and practice of SCM. In this section, the authors review the literature to provide a general understanding of SCV. The concept of SCV is defined according to inter-organizational and informational characteristics. However, SCV definitions are varied and there is a lack of an agreement on what constitute the concept.

The inter-organizational characteristic of visibility focuses on the extent to which the relevant information are made accessible between supply chain actors (i.e. suppliers, logistics providers, distributors, and customers). However, different SCV definitions elaborate different attributes of the concept. For example, Kaipia and Hartila (2006, p. 377) define SCV as “the sharing of all relevant information between supply chain partners, also over echelons in the chain.” Barratt and Oke (2007, p. 1230) SCV definition emphasizes on the accessibility and usefulness of information rather than information sharing itself: “the extent to which actors within a supply chain have access to or share information which they consider as key or useful to their operations and which they consider will be of mutual benefit.” Meanwhile, Kim et al. (2011, p. 667) specifically define SCV in terms of information visibility enabled through the inter-organizational information systems (IOIS) as “the extent to which the information and knowledge of partner firms regarding supply chain cooperation is visible to the focal firm through IOIS.”

The informational characteristic refers to the quantity and quality of information that is made available to different parties in the supply chain (Barratt and Oke 2007). Prior studies have identified different information-related dimensions in characterizing the concept. Table 1 illustrates informational dimensions of SCV with the features outlined:
Information quantity features as the breadth (how much) and variety (different types) of information that can be shared across a supply chain. Information breadth refers to how much demand information and supply information can be shared (Williamson et al. 2013). Information variety means sharing different categories of supply and demand information including strategic, tactical and operational information (Patnayakuni et al. 2006). Swaminathan and Tayur (2003, p. 1391) define SCV as “the ability to access information across the supply chain and use it in real time”. Wang and Wei (2007, p. 651) identify SCV as “the degree to which supply chain partners have on-hand information related to demand and supply for planning and control management.”

Information quality refers to the extent to which the shared information meets the needs of the organization (Zhou and Benton Jr 2007). As such, supply chain visibility does not refer to making all information visible to all partners in the supply chain, but rather it is conceptualized as comprised of information with certain required properties. However, there are varied descriptions of information quality criteria. For example, Goswami et al. (2013) specify different criteria of information that is accuracy, timeliness, completeness, and confidentiality. Meanwhile, Barratt and Oke (2007) and Kaipia and Hartiala (2006) assert that information is of high quality if it is relevant and useful.

Table 1: Informational Characteristic of Supply Chain Visibility

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<tr>
<th>Information Quantity</th>
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<td>Operational Information</td>
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<td>Accuracy</td>
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The Resource-based View (RBV) and Theoretical Framework

The RBV has received considerable attention by scholars in the business management literature. The RBV expands the body of knowledge of differential firm performance and elevates the understanding of strategic management (Priem and Butler 2001). While researchers in strategic and general management have mainly utilised the RBV, its popularity has been increasing in the field of SCM and information systems (IS) (Ketchen and Hult 2007).

The RBV is a theoretical perspective that examines how firms achieve sustained competitive advantage through deployment and use of resources and/or capabilities at their disposal (Barney 1991). Firms seek to acquire and combine valuable, rare, imperfectly mobile, non-imitable, and non-substitutable (VRINN) resources and organizational capabilities that can provide sustained competitive advantage over their competitors (Barney 1991). However, the mere possession of such resources does not guarantee the development of competitive advantages or the creation of value under dynamic and uncertain environments (Priem and Butler 2001; Sirmon et al. 2007). The bundling of resources to create unique capabilities is necessary to generate value and are potentially superior to competitors (Sirmon et al. 2007). The utilization of capabilities may help to explain how organizations create sustained competitive advantage (Wu et al. 2006). Further, Grewal and Sloteegraaf (2007) suggest that organizational capabilities can be conceptualized as a hierarchy, with various resources being combined to form lower-order capabilities, which in turn can be integrated to develop higher-order capabilities and impact overall firm performance.

The previous studies in SCV have adopted the RBV to identify its antecedents. Barratt and Oke (2007) identify distinctive visibility as an information-based capability generated from bundling VRINN technological and non-technological resources. Also, Brandon-Jones et al. (2014) described supply chain visibility as a key capability in reducing supply chain risk, which is created through the bundling of two critical resources: supply chain connectivity and information sharing. Accordingly, connectivity relates to the technological infrastructure through which information is conveyed to supply chain partners and information sharing relates to the quality of the information being shared (Brandon-Jones et al. 2014). As such, IT resources are identified as an antecedent of SCV (Barratt and Oke 2007; Brandon-Jones et al. 2014). However, the RBV and information systems research reveal that available IT resources per se cannot create significant gains for a firm because IT has become increasingly standardized and affordable, thus is easily imitable and no-longer-rare resource (Fawcett et al. 2011). Instead, the way IT is exploited (i.e., IT capabilities) can enable unique value-creation opportunities and that, in turn, can render competitive

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differentiation (Fawcett et al. 2011; Wu et al. 2006). Therefore, this study will focus on identifying information visibility’s antecedents according to the notion of capabilities bundling instead of the notion of resource bundling used in the previous SCV studies.

Viewed from the perspective of RBV and a hierarchy of capabilities (Sirmon et al. 2007), we develop our conceptual framework (Figure 1). Antecedents of SCV represents firm’s capabilities that can be bundled to develop the higher-order capability (i.e., information visibility that in turn generates significant performance gains. In this paper, we focus on exploring the antecedents of information visibility.

![Figure 1: Conceptual Framework](image)

**Research Method**

The purpose of this study is to explore the perceptions of information visibility and its antecedents from the viewpoint of supply chain professionals. Thus, we adopted an exploratory qualitative study which is useful when the research problem requires exploring concepts and establishing relationships in raw data and organizing these concepts and relationships into a theoretical explanatory scheme (Strauss and Corbin 1998).

We conducted in-depth, semi-structured interviews ranging between about 60 minutes to 90 minutes with supply chain professionals who have more than five years of experience in SCM, having five of them with more than 15-years of experience. The supply chain professionals hold varying positions (e.g. procurement manager, demand planner, supply chain manager, export manager) in New Zealand-based organizations in the health sector. Three of the participants were male and five of them were female. Given the exploratory nature of this study, this data collection approach is appropriate to capture a wide range of experiences and perspectives (Jüttner et al. 2003). The informants were asked about: their awareness and understanding of information visibility, description of visibility level in the supply chain, the factors that enable the creation and development of information visibility and, how to improve the visibility level. All the interviews were recorded and transcribed verbatim. To identify categories of the collected data, we followed Charmaz (2006), applying the grounded theory coding processes of initial, focused, and axial coding. Categories have been identified and presented using the QSR NVivo 11 software package. As more interviews were conducted and more data were collected and analyzed, the interview guideline was developed further by adding more purposeful sub-questions. The initial and focused coding processes were conducted by the first author, the emerging categories were then discussed and chosen with the other authors. Analysis of the eight interviews was conducted considering two main axes: the perception of supply chain professionals of the information visibility concept, and identification of factors that contribute to the establishment of information visibility.

**Findings and Discussion**

Much of the prior research suggests that SCV has become a “buzzword” both in academia and practice (Francis 2008). However, the participants indicated that the term “visibility” is not widely used in their organizations. However, they supposed that their organizations have in place something that is synonymous with visibility. As illustrated in interview 5:

*I think we have in place something like visibility, although we do not use the same word, they are collaboration or transparency, rather than visibility but the same thing (Interview 5).*

Supply chain professionals perceived information visibility as the extent to which high quality information is shared within and across a firm boundary for supply chain coordination. The main objective of SCM is how to coordinate different parties to work together as a single entity to achieve the common goal of chain profitability in contrast to individually optimized goals (Simatupang et al. 2002). In the supply chain context, coordination can be viewed as a coherent combination (harmony, adjustment, alignment) of a
number of objects (actions, objectives, decisions, information, knowledge, funds) for achieving the shared goal (Simatupang et al. 2002). The importance of effective information sharing to the success of SCM has been emphasized because every party in a supply chain needs timely and accurate information to coordinate business activities for the achievement of operational efficiency and competitive advantages (Wong et al. 2011). Therefore, the discussion with informants revealed that information visibility goes beyond simple sharing or access to certain information. Particularly, information visibility needs to ensure that the shared information creates mutual understanding across a firm’s supply chain to enhance supply chain coordination. As illustrated in interview 3:

I think, it [information visibility] is exactly when the information is available that everybody can see the information, can access the information at any time...And again, if we have the visibility in place, for me, it is a success because everybody is on the same page, and have the same kind of information...And as much alignment every part has, and the more transparency on the information, the more success the business will be (Interview 3).

It is noticeable that the supply chain professionals took a holistic view of the information visibility concept. They considered the various internal functions comprising a firm are as much part of the supply chain as are the firm’s suppliers and customers (Vickery et al. 2003). Thus, their understanding of information visibility encompasses internal information visibility and external information visibility. Internal information visibility refers to the extent to which high quality information is shared within a firm for supply chain coordination. Meanwhile, external information visibility is defined as the extent of sharing high quality information between a firm and its external partners (i.e. suppliers and customers) for supply chain coordination. Also, respondents noted that the levels of internal and external information visibility are different, whereas they have much higher level of visibility within their boundaries than across partners’ boundaries.

...this [visibility] is definitely at different levels, all information is open within internal [company]...we all anytime have visibility of each other, of what we are doing or of the process. But of course to external [partners], it is limited. It is only what they need to know, and that is always not everything (Interview 5).

Since the concept of internal information visibility has been under-researched, we put our focus on elaborating this concept and its antecedents to fill the research gap in the next sections. As figure 2 represents, findings show that IT integration and interpersonal communication capabilities are antecedents of internal information visibility.

Figure 2: Internal Information Visibility Model

**The Internal Information Visibility**

Internal information visibility emphasizes on the elimination of functional silos and making information available to everyone at different levels within a firm. For example, interviewee 2 described internal information visibility as information is shared across business functions that enables coordination between different departments for lead-time reduction.

I suppose, for us, when we talk about supply chain visibility within an organization, we look at the end-to-end, we look at the whole sort of [ummm] what we call lead-time markdown; so we can see all the different areas of the business, and who does what, and we can track all raw materials, all finished
goods, and see through all way from raw material all the way through the point of manufacture (Interview 2).

Further discussion on information visibility within the organization indicated that the internal actors involved might be extended from different departments within a focal firm to its corporate business units who are supposed the firm’s internal suppliers or customers.

A lot of our suppliers are our (corporate) companies...So they are different companies even though we are in the same global company, so for instance haft of our products are supplied by other (corporate) companies and therefore. Because we are all on an integrated system, so I can see what is going on their side, and talk directly to them about what I can see, that’s really good (Interview 1).

The meaning of internal information visibility thus is the extent to which high quality information is shared between various functions at local and global levels within a firm.

The Antecedents of Internal Information Visibility

Information Technology (IT) Integration Capability

Respondents acknowledged that their organizations have developed integrative enterprise systems (ES) within their boundaries. ES is a type of information system in the context of an organization in which the data are captured, processed, stored, and extracted as the output and the basis for analysis (Lech 2014). However, they have not established inter-organization enterprise systems (IOES) or only have partially integrated IOES with external partners. Accordingly, the participants mainly illustrated internal IT integration as the degree to which a firm has established integrative information systems to facilitate the consistent and automated sharing of data/information within its boundary. Internal IT integration mainly involves information systems integration through the use of enterprise resources planning (ERP) systems.

We have SAP to share the information; everything is put in there from production planning to procurement, order, customer service, dispatch of products. All of that we have access to. So we can instantly get the information (Interview 5).

IT integration provides everyone within an organization open and timely accessibility to a variety of information and understand what is happening across the firm. Participant 3 indicated that the information shared through the internal integrative ES is wide ranging - from operational information to strategic information:

The system allows you to have any kind of information. If the information is classified as critical or confidential, you have to sign secrecy agreement to have the access to them. You can have access but you have to sign the secrecy agreement and have your manager to sign to authorize you to have access (Interview 3).

The automation of information sharing improves the speed and amount of information flowing within a firm. Specifically, different internal business functions are updated with changes instantaneously and thus, being able to make relevant and quick responses. As described in the interview 2:

We now have the Change Management System ...that has given us automation and project management. When we have a sourcing project, any change within the organization is managed through the system... every department will have their tasks... If I finished my part, then it will go to next person, and there is email responses automatic, whereas before we used to have project that were paper- based... No one knew where they were, where they are up to, the risk of not knowing, not having, that is whether I still need to order this one, what were the update... What we have now is visibility of projects (Interview 2).

The reach of the integrated information systems is not only limited to the local level but it expands to the global level also. The global reach means the globalized ES facilitates information sharing between a firm and its internal foreign partners in a timely manner. Therefore, globalized ES expand visibility to what is happening in a firm’s internal partners. Interviewee 7 gave an example:

[Company] wants to know where the stock was globally, what the forecast was, what the production requirement was; so they could be as efficient as they possibly could in manufacturing, delivery and stock that was on hand ...At the push of the button, someone is using the globalized IT system could see it (Interview 7).
Interpersonal Communication Capability

The interviewees referred to interpersonal communication as the capability of sharing information and knowledge between members of a firm to obtain reliable information and create mutual understanding for supply chain coordination. For effective communication taking place between different members, it is necessary to build up close relationships and trust between them. Close connection and regular interaction between internal members play an important role in the elimination of functional silos and thus facilitate information sharing internally. It may range from informal communication to formal communication such as formal meetings, personal talks, email, and phones.

Participants discussed that interpersonal communication provides rich information and facilitates mutual understanding within a firm boundary for enhancing internal integration and coordination. In addition, professionals pointed out that they can extract the most updated and valuable market information through talking with people from sales departments or brand managers.

*The personal relationship is what makes the difference. Because if you just trust the systems, press button and send the documents I will not see any success in that because people just receive the document and then say ah ok and it is there. But if you are talking and aligning, explaining the situation then I see more effective (Interview 3).*

Therefore, interpersonal communication facilitates supply chain professionals to capture important and current market information such as competitor information, demand change, etc. since it is not usually captured and shared through IS.

Complementarity of Internal IT Integration and Interpersonal Communication

The discussion with informants revealed that while internal IT integration is useful in enabling the consistent and automated transfer and update of information within a firm, interpersonal communication is as much useful in enhancing proprietary and reliable information sharing. Accordingly, the interplay of IT integration and interpersonal communication will provide higher effect on the level of information visibility across the supply chain.

The complementarity between internal IT integration and communication encompasses two mechanisms: information validation and shared information interpretation.

Participants identified that they utilized internal communication as an integral part to ensure that the information available in the ES is reliable and of high quality to be used in making supply chain decisions. Although IT integration can facilitate the sharing of information within an organization in a timely manner, the respondents identified the fact that the currency and accuracy of information made visible through integrative ES cannot be guaranteed. Participant 2 said:

*IT system is only as good as the good information you put into it, so if you do not update, if it is not live, so then you could be looking at the incorrect information (Interview 2).*

As a result, the accuracy and currency of shared information need to be validated to avoid obsolete incorrect information. Participants stressed the importance of interpersonal communication with other members within their organization to validate and share the trustworthy information.

*In procurement, we cannot just seek and guess the system that is why we come to ask people...You cannot rely on systems... Because it could be that we are in the forecast update week, and our demand planner might update in the system... We can look at it and say, oh it doesn’t look like any demand there for the next x amount of time; and then a few days later, it changes. That is why we just do a check with people in the supply chain as well (Interview 2).*

The second aspect that illustrates the complementarity between internal communication and IT integration is increasing information richness and thus facilitating common understanding between different members within organization boundary. Information richness is defined as the ability of information to change understanding within a time interval and the sources of richness differences include the communication medium’s capacity for immediate feedback, the number of cues, personalization and language variety (Daft and Lengel 1986). Thus, although different departments within an organization can have access to the data in the ES, it is personal communication that facilitates achieving rich, reliable information and shared
interpretation of available information among the members in the organization, thus reducing internal conflicts resulting in better coordination.

The information obtained from informal communication with people complements the information in the ES to provide a rich, reliable and seamless information flow within an organization.

Information is generally automated ...the SAP [ERP system] is always the starting point. But I can also get the information from the brand manager ...The forecast has information of what is going to sell; but when things happen in the market place quickly, you often can’t wait for the forecast to be adjusted (Interview 4).

In this paper, we have found that internal information visibility is integral part of information visibility in a supply chain; and what its building blocks are.

**Implications**

The preliminary findings of this qualitative paper based on the viewpoint of supply chain professionals identify perceptions of information visibility and its antecedents. We now discuss the theoretical implications and then proceed to the managerial implications of this paper.

Previous studies have investigated external information visibility and its impact on reducing risk and enhancing responsiveness in supply chains (Brandon-Jones et al. 2014; Williams et al. 2013). The importance of internal integrated information flow has also been identified to support cross-function operations in firms (Frohlich and Westbrook 2001). However, prior studies tend to neglect the importance of internal information visibility and thus fail to take into account both internal and external dimensions in elaborating the concept. This study is novel in expanding the previous narrow concept of external information visibility to encompass both the internal and external dimensions of information visibility for supply chain coordination. Particularly, the findings extend (Williams et al. 2013) definition of external information visibility as the outcome of inter-organizational information integration through the identification and addition of the internal dimension. Thus, the findings align with the supply chain integration literature that suggests the importance of both internal and external process integration (Wong et al. 2011). Accordingly, internal information visibility is conceptualized as the outcome of integrated information sharing processes across different functions within a firm and refers to the extent to which high quality information is made available within a firm. Whereas external information visibility is conceptualised as the outcome of integrated information sharing processes across a firm’s boundaries and pertains to the extent to which high quality information is made available to external partners across the supply chain.

This study provides empirical evidence that IT integration capability and interpersonal communication capability complement each other to attain internal information visibility. The empirical finding strongly support the arguments from previous researchers (Rai et al. 2006) who proposed that firms develop IT capabilities and leverage it to create a higher-order capability to achieve sustainable performance gains. The findings further support the notion in the literature of IT payoff, suggesting that the complementary effect of IT capabilities on competitive performance should not be neglected (Bharadwaj et al. 2007).

This research lends strong support for the assertion that interpersonal communication, as relational capabilities, is an important antecedent of supply chain information visibility. Although previous research has discussed the role of IT connectivity and information sharing (Barratt and Oke 2007; Brandon-Jones et al. 2014) as the antecedents of SCV, this paper identifies and provides empirical evidence for the antecedent role of interpersonal communication. In addition, this finding is also consistent with Barratt and Barratt’s (2011) recommendation that organizations need to recognize the role of internal information-based linkages to extend visibility across the entire supply chain. Therefore, our study fills an important research gap by offering empirical evidence that interpersonal communication plays a significant role in enhancing information visibility in the supply chain. Further, the study identifies the antecedent role of internal ES, thus adding to the current literature of SCV in which much prior research merely emphasized the antecedent role of IOIS (Brandon-Jones et al. 2014; Kim et al. 2011).

Besides the theoretical implications, managerial practice can also be informed by this research. This research suggests that it is important for managers to understand the critical role of both internal and external information visibility. Since the various internal functions comprising a firm are as much a part of
the supply chain as are the firm’s external suppliers and customers (Vickery et al. 2003). Furthermore, our findings indicate that the complementarity of IT integration and interpersonal communication capability affects internal information visibility. The managers should thus focus their effort on both improving internal ES and enhancing internal collaboration within a firm’s boundary to achieve information visibility. Also managers should pay more attention to building close relationship with external partners through proactive communication, and further setting up IOIS together to foster seamless information flow across the supply chain.

Conclusion

This paper contributes empirical evidence to the SCV literature, which to date remains fragmented. Our preliminary findings provide a theoretical model for conceptualizing information visibility and understanding how interpersonal communication and internal integrative ES may be viewed as complementary capabilities and as antecedents of information visibility. We see this research as the first step toward understanding the supply chain information visibility concept, as well as its antecedents and impacts on firm performance.

REFERENCES


