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# Framing Supply Chain Visibility Through a Multi-Field Approach

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**Purpose:** Supply chain management (SCM) literature places great importance on supply chain visibility (SCV) and companies are looking to improve it. While better SCV offers benefits to supply chain (SC) actors, SCV is not clearly defined and little is said about how to achieve it. Our aim is to identify its existing meanings, facilitating/hindering factors and to elaborate on the concept.

**Methodology:** To grasp this complex notion, situated at the interface of several fields, we conducted a literature review on the visibility concept using a multi-field approach. This conceptual work was complemented by an exploratory empirical study in an industrial company. Using a “life stories” methodology, we gathered respondents’ experiences of visibility issues in the field to enrich the proposed framework.

**Findings:** Visibility is recognized as a strategic challenge for supply chains, but is also used in other fields. Its complexity and the richness of capabilities it creates is discussed in several disciplines. Field experiences highlight visibility issues in the context of a supply chain: it concerns different needs, objects and organizational levels. These inputs helped to build the SCV conceptual framework.

**Originality:** The originality of this research is that it provides a multidisciplinary perspective to complement the knowledge of SCV in SCM literature. Using the “life story” research strategy, concept characteristics enrich and give meaning to the proposed SCV framework. The resulting integrative SCV framework is helpful to better understand the academic concept and its managerial relevance.

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## 1 Introduction

Supply chain visibility (SCV) is a widely used concept in supply chain management (SCM) (Francis, 2008) and although many people have tried to define it, there is still no consensus on its definition. Perhaps more important than looking for the SCV definition, it is necessary to understand what SCV means, why it is so important to improve SCV and how to improve it (Busse et al., 2017). In this paper, we propose to develop an SCV framework by combining an SCV literature review, a multidisciplinary overview of the visibility concept and an empirical study gathering field experiences about visibility needs in SCM. The first section of this paper presents the literature review on the SCV concept. The methodology section then explains how the multidisciplinary overview and the empirical study were conducted. We also provide a figure to explain how the SCV framework is built. The third section presents the findings from the multidisciplinary overview and the empirical study. In the last section, we discuss their contributions in relation to the SCV literature and propose an SCV framework combining the three approaches.

## 2 About SCV literature

Companies are looking to develop their SCV and, from an academic point of view, the SCV concept is gaining importance in the SCM literature. The technological context of the 2000s, with the development of the Internet and information and communication technologies, has led many actors to seek greater visibility (Roussat et al., 2018). Furthermore, the increasing complexity of supply chains tends to impede the visibility of flows, activities, processes, resources and makes it more difficult to manage them (Christopher, 2005). The outsourcing of activities in supply chains requires more coordination between companies (Handfield and Nichols, 2002). However, the lack of visibility negatively impacts collaboration and coordination between actors (Simatupang and Sridharan, 2002) because “the supply chain is bounded by a fuzzy horizon” (Carter et al., 2015). In this context, SCV has become a highly studied concept in the SCM literature and a major concern for companies (Enslow, 2006).

Companies are suffering from a lack of visibility both inside and outside the supply chain (Fabbe-Costes and Lemaire, 2004) and are looking to improve it. In an annual report on the supply chain industry, Deloitte (2018) characterized the SCV concept as being highly strategic. Based on a systematic literature review, Roussat et al. (2018, p.8) propose the following definition of SCV: "Supply chain visibility (SCV) may be defined as the capacity to see the state of resources and the functioning of activities in the supply chain. SCV allows actors to access or share information relating to a given area or section of the supply chain, using systems and technology, in order to improve the management and/or strategic positioning of the supply chain." Thus,

SCV is also closely related to traceability because tracking/tracing technologies help to enhance visibility (Goel, 2010). In addition to the importance of having access to data through technologies and information systems, SCV emphasizes the benefits of real-time visibility. Real-time visibility can improve companies' responsiveness and potentially impact their agility and strategic alignment (Dubey et al., 2018) and hence help SCs to become more resilient (Azevedo et al., 2013). SCV is therefore a capacity that can play a role in the dynamics of SCs and be an antecedent of many benefits. SCV is considered strategic for many reasons (Caridi et al., 2010). By improving SCV, companies make their supply chains more competitive (Caridi et al., 2014). SCV can improve operational efficiency, operational performance and process planning. Through its impact on collaboration and relations with partners in the chain, SCV contributes to developing competitive advantages. It brings many benefits to the various actors in the network, and therefore has a positive impact along the entire supply chain as well. A global view of the SC (Roussat et al., 2018) makes it possible to ensure the quality of processes, products and services and thus improve SC performance. All these benefits are made possible through information sharing and improved transparency between the actors in the chain. SCV is gained through the information extracted from the traceability system. Finally, in order to benefit from this visibility, it is necessary to develop a "distinctive visibility" (Baratt and Oke, 2007) to create value for all SC actors. However, there is so far no consensus on how to define SCV. It is a subject of interest, but remains an extremely complex concept at the interface of different research areas, including logistics, information systems and operational research (Roussat et al., 2018). It is even more difficult to define SCV

given that it is often associated with the notions of traceability, information sharing and transparency (Evrard-Samuel and Ruel, 2016). Even though there are many articles that seek to define the concept, it is characterized as under-defined and ambiguous (Roussat et al., 2018) and researchers tell us little about how to improve it (Busse et al., 2017).

The aim of this paper is not to propose a new definition of SCV, but to build a framework to better understand its importance in SCM. The SCM literature leads us to the following three research questions:

- RQ1: Why is it important to have visibility?
- RQ2: What do we want to have visibility of?
- RQ3: What factors, conditions and / or tools could facilitate or hinder visibility?

To extend the study of SCV and to understand it by taking a broader and deeper approach, beyond the boundaries of the SCM literature, we have focused our study on the notion of visibility itself. Therefore, in addition to the above SCM approach to SCV, we conducted a multidisciplinary overview of the visibility concept to produce a robust conceptual framework. We also carried out an exploratory study in an industrial company in order to enrich these theoretical perspectives with an empirical study. To develop an SCV framework, we combined these three approaches: the SCM literature, the multidisciplinary overview and the analysis of the field study. Figure 1 below summarizes the overall logic used to build the framework.

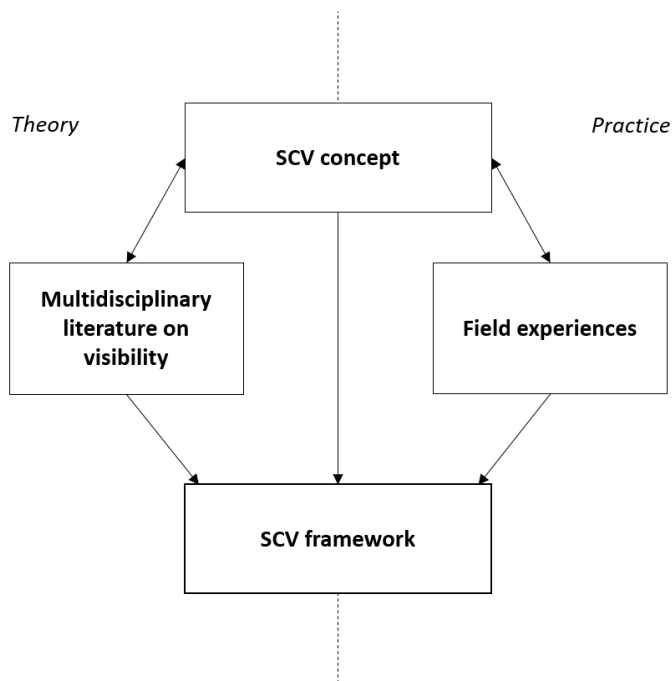


Figure 1: Building the SCV framework

Table 1 is the starting point for building the SCV framework. Drawing on the SCM literature, it provides a definition of SCV and summarizes existing answers to our research questions.

Table 1: SCV concept

Definition and RQs	SCM approach	References
Definition of SCV	<p>"Supply chain visibility (SCV) may be defined as the capacity to see the state of resources and the functioning of activities in the supply chain. SCV allows actors to access or share information relating to a given area or section of the supply chain, using systems and technology, in order to improve the management and/or strategic positioning of the supply chain. Actors' level of visibility thus depends on the magnitude and quality of information sharing."</p>	<p>Roussat et al., 2018 (p.8)</p>
<p>RQ1 Why do we need SC visibility?</p>	<p>Improve SC performance by ensuring the quality of processes, products and services</p> <p>Improve process planning, operational performance / efficiency</p> <p>Develop competitive advantages</p> <p>Improve the responsiveness, agility and resilience of companies and SCs</p>	<p>Caridi et al., 2014</p> <p>Christopher, 2005</p> <p>Dubey et al., 2018</p> <p>Azevedo et al., 2013</p>

Definition and RQs	SCM approach	References
RQ2 See what?	Flows, activities, processes, resources	Christopher, 2005
RQ3 Facilitating factors	Information sharing (including strategic information), transparency, traceability system	Evrard-Samuel and Ruel, 2016 Goel, 2010
RQ3 Hindering factors	Supply chain complexity, reluctance to share information, opportunism, protection of business models based on information asymmetry	Simatupang and Sridharan, 2002 Christopher, 2005

The following section explains how the multidisciplinary overview and the empirical study were carried out. It also clarifies how we combined these perspectives to build the SCV framework that we then present in the discussion section.

### 3 Methodology

In order to build the SCV framework, in addition to the existing SCM literature, we used two complementary methods: a multidisciplinary overview of the concept of visibility and an exploratory empirical study in an industrial company.

#### 3.1 Multidisciplinary overview of visibility

Regarded as under-defined and ambiguous (Roussat et al., 2018), the SCV concept is complex and is situated at the interface of different research areas. We have therefore chosen to improve our understanding by studying the notion of visibility through disciplines other than SCM. This methodology is inspired by Yao and Fabbe-Costes (2018), who studied Supply Network Resilience. Their literature review was based on SCM and other sciences in order to better understand the studied concept.

In this paper, the multidisciplinary overview combines several perspectives from disciplines that deal with the notion of visibility. We selected three broad areas from among the sections proposed by the French Centre National des Universités (CNU):

- Humanities and social sciences: philosophy, sociology and history
- Physical sciences: optical physics, astronomy and meteorology
- Multi-field: communication and information science

After identifying the relevant disciplines, we selected papers by leading and recognized authors that deal with the concept of visibility. In conducting this overview, we selected and focused on the ideas we considered most important on the subject matter in the different fields. Our reading of these

papers was guided by the search for answers to our three research questions. The results are summarized in Table 2 (see section 4 - findings).

### **3.2 “Field experiences” research**

Using a qualitative life stories methodology, we can explore three topics: social worlds, categories of situation or social trajectories (Bertaux, 2016). Our research looks for categories of situation and focuses on any “lack of visibility situations” as a unit of analysis. The objective is to collect data from key informants facing such situations who have one thing in common (Sanséau, 2005): a lack of visibility.

The field research was done at Renault Group, an automotive company with a worldwide and complex SC that outsources a lot of activities. The company is currently looking to improve its SCV. We were able gather data from key informants at Renault Group, involved in the management of its supply chain and with experience(s) of a lack of visibility.

Data collection was done from March until May 2020. Therefore, most interviews were conducted by telephone owing to the lockdown caused by the Covid-19 health crisis. To build our sample, we conducted purposive sampling, which is a non-probability method frequently used in management research (Thiétart, 2014). Some respondents were selected on the advice of a manager working in the outbound SC department and others were proposed by the first interviewees, i.e. a snowballing method. Not all participants could be interviewed due to planning constraints. Of the eleven respondents, one works for the inbound SC division (in transport/ logistics operations) and ten for the outbound SC division (five in transport/ logistics

operations, two in sales operations, two in outbound SC, and one in distribution network engineering). Of the 11 interviews done, 10 were recorded and transcribed. Forty-five field experiences were gathered concerning situations where the informant felt a lack of visibility. Four experiences were collected on average per interview. A short interview guide was used, consisting of an introduction to the study and three questions:

1. Have you had one or more experiences linked to a lack of visibility?
2. In which areas did you want to have visibility?
3. Why and for what purpose?

The analysis and understanding of situations are subject to interpretation since respondents have their own particular history and affiliations. Two types of analysis were conducted to answer the three research questions: a thematic analysis in order to highlight the variety of situations and a comparative analysis to study commonalities that characterize the lack of visibility situations. The results are summarized in Table 3 (see section 4 - findings).

## 4 Findings

### 4.1 Multidisciplinary overview of visibility concept

#### 4.1.1 Humanities and Social sciences

In this sub-section, we combine philosophy, sociology and history to contribute to the conceptualization of visibility.

A study of the notion of visibility cannot be done without considering the work of Maurice Merleau-Ponty. In his work *The Visible and the Invisible* (English edition, 1968), the notions of the visible and the invisible are concomitant. He explains that the experience of the visible is not just the thing we see. There is something beyond the visible that gives shape to it: the invisible. Visibility is therefore what gives access to the invisible, to the basis of the visible. In *Discipline and Punish* (English edition, 1977), Michel Foucault also uses the notion of visibility. He talks about the relations between power and visibility. Using the concept of the panopticon developed by Jeremy Bentham, he develops the idea that visibility can be harnessed to exercise control in modern societies. However, Foucault's model has been criticized as it completely overlooks the role of the communication media (Thompson, 2005). This role must be taken into account since media modify interactions and thus offer new forms of visibility to individuals. It is no longer about the means of surveillance, but new tools to communicate using media to exercise a form of power. These new forms of communication allow a few people to be visible to many, whereas the panopticon model makes many individuals visible to a few. Axel Honneth (2001) also uses the notion of visibility and develops recognition theory. He considers that there

is no possible recognition of an individual without visibility. This notion therefore refers to a practical relationship in which recognition implies that attention is paid to that individual. Those who do not have the means to be recognized and need recognition are called the invisible ones (Rosanvallon, 2014).

Although they are distinct, these approaches allow us to argue that we seek visibility of that which is not visible. Essential to the understanding of the notion of visibility, the contributions of these authors have defined visibility as an entire social dimension (Brighenti, 2007). In *Visibility in Social Theory and Social Research* (2010), Brighenti explains that the concept of visibility helps to differentiate the visible from the invisible and characterizes it with three attributes:

1. Relational, since visibility determines relationships between individuals, because they can only be recognized if they are visible (Honneth, 2001), and to the use of visibility as a means to create a form of power (Foucault, English edition 1968; Thompson, 2005).
2. Strategic, since visibility is manipulated by subjects in order to obtain social effects. We can refer to the "constructed dimension of reality" by using the traces left by history (Tardy, 2007) and also to the way visibility is used by individuals (Thompson, 2005).
3. Evental, since the social effects of visibility are ambivalent: "it can confer power, but it can also take it away" (Brighenti, 2010).

#### **4.1.2 Physical sciences**

Optical physics, astronomy and meteorology also mobilize the notion of visibility. In the hard sciences it is characterized as an ability to observe phenomena or objects.

Visibility is very important for human beings because they are endowed, naturally, with the ability to see: vision is certainly the dominant sensory modality in humans according to Jean Bullier (*Encyclopaedia Universalis* consulted on 20 February 2020). When an individual's eye receives light reflected by an object, he/she sees this object. Light, the eye, but also optical instruments such as glasses give humans the ability to see and identify an object in their field of vision (Hubel, 1988). However, this ability can also be hindered by darkness, an opaque body, distance or even by our eyes, when they do not have or only partially have this ability "to see" (Galifret, 1990). Beyond our sense capacity based on vision, human beings have sought to see even further. The science of observation and astronomy aims to understand the origin, evolution and physical and chemical properties of the stars. Many are studied: the sun, the stars, the inner and outer solar system, the Milky Way, the planets, the Big Bang, the Universe and the galaxies. With the help of specific optical instruments such as telescopes and satellites, this discipline finally seeks to obtain a projection, an image of these extremely distant objects (Maurel, 2002). Although it can be slowed down by the agitation of the atmospheric air, visibility in astronomy affects our ability to observe the stars in the universe (Parisot et al., 2003). It is precisely these atmospheric air disturbances that interest meteorologists. When they are observed, they lead to the construction of hypotheses with the aim of anticipating and predicting phenomena that occur in the atmosphere. These predictions remain uncertain, but can nevertheless help many sectors of activity, such as maritime or air transport (Babari, 2012). In this discipline, visibility has been defined as "the distance up to which an observer located near the ground or the sea can see and identify an object in a given

direction in the atmosphere" (Météo France). Visibility allows viewers to observe and study one or more phenomena occurring in the atmosphere up to a certain distance and in a given direction. This ability is sometimes impeded by obstacles such as weather conditions or the size of oceans and deserts, i.e. the distance at which the phenomenon occurs.

#### **4.1.3 Multi-field**

Other disciplines, such as communication and information science, also use the concept of visibility. Generally, it is approached through issues related to information systems within organizations.

Visibility is provided by the information system (IS): making information visible entails transforming raw and heterogeneous data into visible and comprehensible information, which means "it is a matter of organizing, putting things in order, making them accessible" according to Flichy (2013). In order to provide visibility by sharing data via systems at the intra- and inter-organizational levels, actors need to know the role of the IS they are using and the services it offers in order to use it in a relevant way. This is one of the roles of the organization's IS management: ensure that the organization's actors know the value of the system they are operating (Bohnik, 2010).

Beyond users' knowledge of systems, an optimal transmission of data between the different IS would allow companies to be more flexible (Evgeniou, 2002). Indeed, the transmission of data at the intra- and inter-organizational levels should lead to better collaboration, cooperation and coordination between the different actors of one or more organizations (Said, 2006; Boulay and Isaac, 2007). Nevertheless, this sharing of information re-

quires that the systems be aligned and integrated, according to their functions, but also to the structure of the organizations (Said, 2006). It is precisely thanks to this alignment that visibility is made possible (Flichy, 2013). On the other hand, poor IS construction and architecture or the applications used could lead to poor transmission of information, and therefore to a drop in visibility (Bohnik, 2010). This integration of systems is only possible if the different actors involved communicate about the objectives and issues that drive them. Furthermore, IT systems make the tasks of individuals in the organization visible (Andonova and Vacher, 2013).

Table 2: Synthesis of the multidisciplinary overview of visibility

Definition and RQs	Humanities and Social sciences	Physical sciences	Multi-field
Definition of SCV	Social dimension giving capability to differentiate between the visible and the invisible. Visibility is relational, strategic and eventual	Ability to observe objects or phenomena	Transform raw and heterogeneous data into visible information
RQ1	Access to invisibility	To see what is around us	Gain organizational flexibility

Definition and RQs	Humanities and Social sciences	Physical sciences	Multi-field
The need for visibility	Use it to obtain social effects Be visible to gain recognition	Obtain an image of distant objects Anticipate and predict phenomena	Improve collaboration and coordination between actors
RQ2 See what?	Individuals, institutions, social world	Objects and phenomena	Data, information and tasks performed by actors
RQ3 Facilitating factors	Social recognition, communication media	Visual ability (eyes), light, simple and specific optical instruments	Information systems, systems alignment and integration, collaboration
RQ3 Hindering factors	Social position, access to institutions or media	Darkness, opaque body, distance or visual ability	Poor IS architecture and communication on IS value, poor collaboration

Although these elements are not from the SCM literature, they will contribute to building the SCV framework in the discussion section.

## 4.2 Empirical study

We gathered field experiences from respondents to answer our research questions. The findings are therefore structured in three distinct parts according to the RQs and are summarized in Table 3. If a direct quotation is used, we indicate the experience number it refers to in brackets (e.g. [12]).

Among the 45 field experiences gathered, we found 8 areas in which respondents expressed the need for visibility. Twenty-six experiences mentioned the importance of visibility in order to meet delivery times and/or satisfy end-customers: “Customers are not necessarily satisfied when you can't give them dates” [20]. The idea is to gain visibility in order to satisfy the customer by delivering the product on time. The anticipation of needs and risks is also often addressed: “be able to anticipate our transport capacities” [16], “receive weather bulletins or notification of a worker strike... to be able to anticipate a little bit” [3]. The need to give visibility to all SC actors also arises in interviews: “We are able to explain to the client the reasons for the delays and give them dates” [24]. Costs monitoring and achieving performance targets were also brought up: “The lack of visibility also impacts costs, especially when it comes to speeding up your transport” [44], “I like to anticipate and make sure I'm going to achieve my inventory targets” [16]. Invisibility of some information or actions takes up a lot of working time (“it takes months of email exchanges to find a solution” [41]) and might have an impact on work motivation as well (“The team is losing its motivation although they were actually quite confident” [32]). Lastly, in the case of exceptional situations: “the cars, for example, they come out of

the facility to be repaired and that's not tracked" [8], there is a need for visibility in order to keep track of the products.

The need for visibility does not tell us what respondents are seeking to see though. Seven elements were identified in the field experiences:

- 14 discussed the need for visibility of resources: means of transport, storage and transport capabilities, vehicle information in systems or customs documents (e.g. "to know how many cars there are at each of the centers" [29])
- 14 discussed lead times: the delay of a vehicle launch in manufacturing, of the resumption of activities or vehicle release (e.g. "Today it is difficult to give visibility to the sales department on repair times" [28])
- 9 discussed activities: variations in factory output, vehicle modification possibilities or information about projects: ("it is an informational concern because you see a vehicle that's modifiable and it is not" [37])
- 7 discussed planning or planning variances: e.g. overestimation / underestimation of manufacturing forecasts, the delay or cancellation of means of transport, changing performance targets
- Institutions are discussed during the Covid-19 crisis since the company needs to know government decisions, laws and decrees to reorganize its activities
- Phenomena i.e. visibility concerning weather forecasts and events such as storms
- Actors' responsibility

During the interviews, respondents sometimes explained the causes of the lack of visibility. Most often, there is a lack of communication between actors, mainly at the intra-organizational level (e.g. "No one communicates with each other and it's always very complicated to get information" [25]).

Differences in objectives between company departments help to explain this lack. Exceptional situations mean that the actors do not have the desired visibility e.g. in the event of a health crisis or weather hazard, as such events are difficult to predict. When there is no traceability, it is hard to gain visibility: “We asked them to provide traceability of the customs documents. They haven't done it, so we don't have that visibility” [15]. Another hindering factor is short-term decisions taken by the company that lead to trade-offs between performance objectives. Other obstacles to visibility that were touched on include: non- assumption of responsibility, unreliable information in systems and misaligned systems at the intra-organizational level.

Table 3: Answers to the research question from the field experiences

RQs	Items from field experiences	Number of stories citing the item
RQ1	Meeting delivery times and/or satisfying end-customers	26
The need for visibility	Anticipating needs and risks	21
	Giving visibility: carriers, centers, subsidiaries, dealers, end-customers	9

RQs	Items from field experiences	Number of stories citing the item
	Costs monitoring: avoid additional storage, transport costs, etc.	8
	Saving work time in handling problems	7
	Achieving performance targets (e.g. vehicle invoicing)	6
	Keeping track of resources in exceptional situations	4
	Maintaining work motivation	2
	Resources	14
	Lead times	14
RQ2	Activities	9
See what?	Planning	7
	Actors' responsibility	1
	Institutions	1

RQs	Items from field experiences	Number of stories citing the item
	Phenomena (e.g. weather forecasts)	1
	Lack of communication	Intra-organizational level 12
		Inter-organizational level 3
	Exceptional situations (e.g. health crisis)	10
RQ3	Lack of traceability	8
Hindering factors	Short-term decisions leading to trade-offs	6
	Non-assumption of responsibility	2
	Unreliable information in systems	2
	Misaligned systems at the intra-organizational level	1

## 5 Discussion

In the discussion section, we combine the three perspectives (SCM literature, multidisciplinary overview and field study) and highlight how they complement each other in answering each research question. This discussion ends with an integrative SCV framework.

### 5.1 Benefits of visibility

Throughout this paper, we have been looking at why we want to have visibility (RQ1). We found commonalities between the three perspectives, but also some differences. Three subjects came up in each approach: we seek visibility in order to be efficient and respond quickly in the face of uncertainty and to predict/monitor situations, processes, activities or objects. We seek performance by developing competitive advantages (Table 1), gaining organizational flexibility (Table 2), improving customer satisfaction, costs monitoring, saving work time, maintaining work motivation and achieving performance targets (Table 3). Being responsive also refers to agility and resilience in the event of out of control situations (Table 1), but also controlling and anticipating phenomena thanks to a projection of distant objects that are not visible (Table 2). It could be to keep track of objects in exceptional situations (Table 3). Visibility is also useful for predicting and monitoring: planning process (Table 1), phenomena (Tables 2 and 3) and needs/ risks (Table 3). Our findings from the multidisciplinary literature (Table 2) introduce a new element: social aspects. We seek visibility in order to act on the relational dimension. This involves improving collaboration and coordination between actors and could confer a form of power as a social

effect (Table 2). Sharing information improves visibility for all SC actors (Table 3). Therefore, relational aspects can have an impact on information sharing and transparency, collaboration, alignment between IS, and social recognition. The emergence of a relational dimension is all the more interesting as it also appears in the results of the empirical study in an SC context, but not in the SCM literature.

## **5.2 What we want to see**

Concerning RQ2, two topics appear in the three approaches: the need for visibility of different kinds of resources and activities. We want to see flows, resources (Tables 1 and 3), individuals, data, and information (Table 2). The need for visibility of activities such as processes (Table 1) or tasks performed by actors (Table 2) is also common to all the approaches. The field experiences reveal concerns about events and times such as lead times or planning (Table 3). The field study thus adds the notion of time, which is not addressed in the SCM literature. Deadline visibility would make it possible to transmit information to the different SC actors, and, if it is reliable, to take action on meeting delivery times and on customer satisfaction. Our findings from the multidisciplinary literature also emphasize a social aspect since it includes the need for visibility of institutions and social worlds (Table 2). It highlights the importance of focusing not only on resources or activities, but on entities and groups as well. To this we may add the need to know what their responsibilities are (Table 3). There is one final contribution: we seek visibility of phenomena (Tables 2 and 3). This was not found in the SCM literature, but it appears in the field experiences, in particular

concerning external/environmental phenomena that impact SCs. The challenge here is to be able to anticipate needs and risks (Table 3).

### **5.3 Conditions that facilitate / hinder visibility**

We deal with the hindering/ facilitating factors together since they are in fact related and both feed the discussion concerning the third research question (RQ3). Two subjects emerge in each approach. The first is information sharing and transparency (Table 1). The facilitating condition is collaboration (Table 2), since information cannot be shared without it. Nevertheless, there are situations where the lack of collaboration and communication hinders visibility (Tables 2 and 3). The second subject is information systems. Traceability systems help to collect and share information (Table 1). The multidisciplinary literature complements the SCM literature since it discusses information systems, visual and communication tools. It also emphasizes the alignment between systems and tools (Table 2). If the architecture of the different systems/tools is not well constructed, it will become a visibility impediment (Tables 2 and 3). The reliability of the information shared via the tools is also essential to avoid producing false visibility, i.e. false information (Table 3). Furthermore, the complexity of SCs and the outsourcing of activities (Table 1) probably contribute to the difficulty of achieving systems alignment. The field experiences reveal that company decisions and the non-assumption of responsibility may also obstruct visibility (Table 3). These elements are new and not mentioned in the SCM literature. Finally, there is a social contribution from the multidisciplinary overview, as shown in Table 2: the social recognition of individuals as a facilitating condition for visibility. This is also related to the social position of

individuals, which could be a hindrance to accessing visibility. Another social contribution is institutions/media access, which may constitute an obstacle to visibility for individuals (Table 2).

Combining the three perspectives, we construct the following SCV framework (Figure 2). After comparing them, no inconsistencies were identified between the three. The model is made up of three parts, formed according to the RQs. The first part is composed of facilitating and hindering factors (in two boxes to preserve what has been found in the literature and in the empirical study). A second part shows what we want visibility of and a third one for the benefits gained from improving SCV. All factors constitute items that affect visibility. By improving visibility, there are potential benefits for SC actors. These benefits will, in turn, act on the facilitating and hindering factors. Although it could influence them, these elements interact with each other. Every positive factor has an opposite that constitutes a hindering factor. Finally, the integrated framework brings together all the responses to the RQs and constitutes an academic synthesis of the SCV concept for future research. The field experiences gathered were useful because they illustrated the multidisciplinary literature more than the SCM literature. This confirms the fragmented nature of the SCM literature and the importance of not focusing solely on the SCV concept in this field of research. Finally, the framework could be a useful tool in a business context

in conducting an audit or a diagnosis to identify items that affect SCV positively or negatively, especially since the empirical study has brought up a need to see objects, flows, activities, resources and so on.

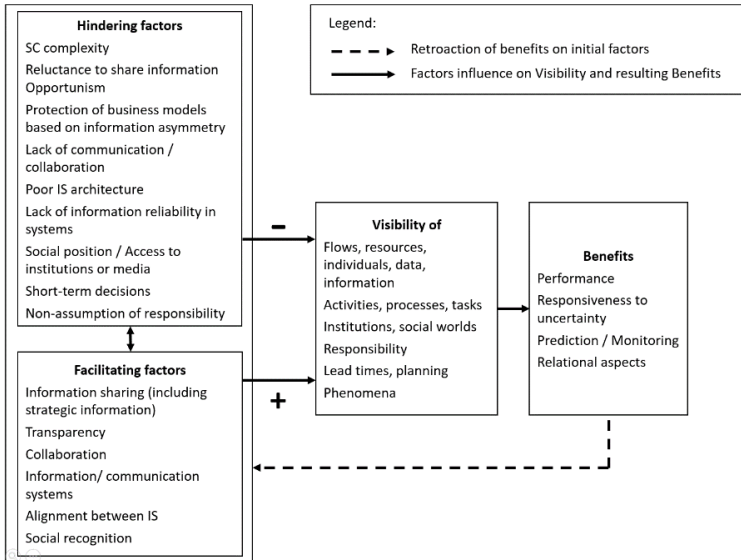


Figure 2: Integrative framework of SCV.

## 6 Conclusion

In conducting a literature review of SCV, we found that there is not as yet any consensus about how to define SCV. This concept is a subject of interest, but remains extremely complex. Situated at the interface of different research areas (Roussat et al., 2018), it is even more difficult to understand because it is often associated with the notions of traceability, information sharing and transparency (Evrard-Samuel and Ruel, 2016). It is characterized as under-defined and ambiguous (Roussat et al., 2018) and researchers tell us little about how to improve it (Busse et al., 2017).

In this paper, we seek to build a framework of the SCV concept. To extend the study beyond the boundaries of the SCM approach, we studied the notion of visibility in general. A multidisciplinary overview of the concept of visibility was performed and complemented by an exploratory study in an industrial company in order to gather field experiences concerning instances of a lack of visibility. At each step of the research, we sought to answer the following questions: why is it important to have visibility? (RQ1); what do we want to have visibility of? (RQ2); what factors, conditions and/or tools could facilitate or hinder visibility? (RQ3).

Our results brought out new elements that complement the SCM approach. By comparing and combining the SCM literature, the multidisciplinary literature and field experiences, we built a framework of SCV.

Because of the Covid-19 crisis, we could only interview 11 key informants, which is a limitation of our empirical study. We need to continue this research by expanding the base of the empirical study. We would like to broaden and diversify our sample, at the intra and inter-organizational levels. The Covid-19 health crisis will probably raise new needs for SCV and

boost company projects to develop SCV. This could be an opportunity for action research with Renault Group.

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