

“The map is not the territory”: a boundary objects perspective on supply chain mapping

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Abstract

Purpose

To empirically examine the usefulness and value of supply chain mapping (SC mapping), a neglected area despite its importance in research and practice.

Design/methodology/approach

Based on three combined theoretical perspectives, we conducted a case study on a car manufacturer’s managers mapping their downstream supply chain (SC). We conducted semi-structured interviews and a mapping exercise with them, followed by a focus group.

Findings

We find differences between individual and corporate SC maps and between how managers define the outbound SC, the SC map they draw and what they say when mapping. The three theoretical perspectives allow us to enrich SC mapping thinking. We focus on boundary objects to formulate propositions. SC mapping and maps are discussed with respect to contemporary SCs and SCM.

Research limitations/implications

Based on a single case study on one firm’s outbound SC. Research could be expanded to the company's external partners and follow the development and use of maps in real time.

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Practical implications

Highlights the usefulness and difficulties of SC mapping, for individuals and organisations. For the company, it opens avenues for further development and use of SC mapping to improve inter-functional and inter-organisational collaboration.

Social implications

Confirms the need for SC mapping competences in SCM and consequently the usefulness of teaching SC mapping courses in logistics and SCM programs.

Originality/value

Highlights the usefulness of SC mapping and rekindles interest in SC mapping and maps in SCM. Introduces boundary objects into SCM research.

Keywords

Supply chain mapping, Map, Case study, Mixed qualitative methods, Focus group, Boundary objects.

Article classification

Research paper

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Introduction

Since the 1990s, supply chain mapping (SC mapping) has been a common practice and an important research topic (e.g. Lambert *et al.*, 1998; Gardner and Cooper, 2003; Farris, 2010; MacCarthy and Jayarathne, 2013). Companies, professors and consulting firms make various supply chain maps, but few studies question the role of these maps, their use or value for supply chain practitioners, or how they might relate to central concepts in SCM theory and practice. Most past conceptions of SC mapping have involved identifying one map of a supply chain as a common reference point for all actors concerned. As such, a supply chain map, like a geographical map, is supposed to represent the SC "territory".

However, no map can represent everything: the people who map supply chains must make choices and, particularly when there is no mapping convention (Gardner and Cooper, 2003), often adopt personal representation codes, thus introducing their biases. SC maps may reflect people's underlying assumptions or ontologies about SCM (New, 2004), be influenced by people's history, discipline, culture, and experience, and may influence people's SC vision (Fabbe-Costes, 2017). Moreover, since a map is a model, it is also projective (Le Moigne, 1990): it is "necessarily constituted in reference to the knowing actor's intentions, purposes, goals, objectives, aims, finalities, etc., regardless of whether the actor is actually conscious of them" (Eriksson, 2003, p.205).

In this paper, we discuss the creation and conceptualisation of SC maps from three perspectives. We argue that, while SC mapping will become still more important as supply chains become more unstable, transient and dynamic, it will also be more important to reflect critically on why and how mapping is done, and how it is used. In contrast to the most prevalent accounts of SC mapping, which take a top-down, objective view, a boundary objects perspective (e.g. Star and Griesemer, 1989) shows how mapping can be treated as an iterative process that creates multiple but coherent local maps that allow for local coordination, across

inter-functional and inter-organisational boundaries, in a fluid and uncertain world. This is consistent with a view of supply chains as complex adaptive systems (Choi *et al.*, 2001).

The purpose of this paper, therefore, is to study SC mapping as a managerial practice at the individual and organisational levels, acknowledging its subjective and purposive nature. The paper seeks to answer the following overarching question: What is the possible usefulness and value of SC mapping and SC maps? The literature review combines perspectives from SCM, from the "network pictures" literature in industrial marketing (e.g. Henneberg *et al.*, 2006) and from the boundary objects literature (e.g. Star and Griesemer, 1989). In the subsequent sections, we detail our mixed methods case study on the outbound supply chain of an industrial company (Renault Group), present the empirical results, then discuss these in terms of the three theoretical perspectives, developing propositions focusing in particular on the boundary objects perspective, and relating our theorisation to the characteristics of contemporary supply chains.

Literature review

Our review of the literature on SC mapping and maps covers the period from the early 1980s to the present. Two complementary reviews in the network picture literature and the boundary objects literature enrich the SCM approach theoretically, to elaborate a framework to further study the usefulness and value of SC maps.

SC mapping in the supply chain management literature

Since the early 1980s, the study of SCM has involved drawing pictures of SCs. Some diagrams presented in early publications are commonly cited, and their influence endures. They show different aspects of SCs. Stevens (1989), for instance, focuses on internal *functions* and gives a linear representation of their integration. Harland's diagram (1996, p.S72) highlights the

structure of the chain (from linear chain to network) and the number of *echelons*, and she argues for analyses that integrate multiple levels from dyad to chain to network. Mentzer *et al.* (2001) add the types of *actor* participating in the chain. Some diagrams (e.g. Lambert *et al.*, 1998) are clearly "centred" on a focal firm with an upstream SC (up to initial suppliers) and a downstream SC (to end customers), a representation echoed in the widely used OM textbooks by Slack *et al.* (2016). In their framework, Cooper *et al.* (1997, p.10) identify *actors*, *flows* (information and product), *business processes* and *SCM components*.

In the industrial networks approach (Håkansson and Snehota, 1995), the basic building blocks are *activity* links, *actor* bonds, and *resource* ties (e.g. in Skott-Larsen *et al.*, 2007): this has influenced some supply chain researchers. Consultants (e.g. Cohen and Roussel, 2005) who focus on SC architecture frame SCs around *entities* (actors), *processes* (activities), *data*, *applications*, and *infrastructure* (IT and physical assets). Maps used in sustainability research represent *reverse* or *closed loop* SCs (e.g. Cruz-Rivera and Ertel, 2009), including flows of returns or end-of-life products and new activities (e.g. sorting, dismantling, recycling). More recent papers that test IT-based mapping tools such as geovisualisation techniques (e.g. Farris, 2010) or natural language processing (NLP) (e.g. Wichmann *et al.*, 2018) also include *geography* and *magnitude* of flows. Mapping has been used to define and compare complex global supply networks (MacCarthy and Jayarathne, 2013) and supply networks in emerging sectors (Srai, 2017).

SCM scholars have noted the consequent "profusion of map styles", including various categories of elements, leading some to call for a SC mapping convention (Gardner and Cooper, 2003, p.37). Hines and Rich (1997) point out that their seven mapping tools are contingent and address different objectives and suggest paying attention to the context and expected *use* when choosing one. Probably the best-known source on mapping for SCM teaching is Lambert *et al.* (2008), which groups maps into two categories. *Relationship-based* maps often take the

perspective of a focal firm, thus they "will look different depending on a company's position in the supply chain" (Lambert *et al.* (2008), p.200). *Activity-based* maps include time-based process mapping (TBPM), pipeline inventory process mapping, focusing on physical flows and steps in the logistics-production-distribution process and extended value stream maps. For these maps, "the determination of the unit of analysis is critical " (Lambert *et al.* (2008), p.212). The chapter concludes as follows:

Many managers believe that supply chain maps, whether they are relationship-based or activity-based are not worth the effort to prepare. However, once management has these maps in hand, they often report that they cannot think of a better way to understand the nature of their supply chain (Lambert *et al.* (2008), p.216).

No map can include everything – “the map is not the territory”². Thus, mapping means making choices, and a map's content depends on what is being studied, and who is mapping it. Maps can reveal the influence of personal attributes and mental representations as well as, for example, personal culture, technical expertise, role in SCM, training, and prior experience. Mapping is also purposive and projective (Eriksson, 2003): it reflects the interests and intentions of those who map. More fundamentally, SCs themselves are socially constructed (New, 2004): construing a collection of firms, people and activities as a SC is a social and linguistic act performed by practitioners, consultants, academics and other commentators. And such an act is not merely descriptive: once actors frame such collectivities as SCs, notions of structure are invoked in modelling SCs, often accompanied by normative assumptions about greater integration between entities in the SC and legitimisation of the use of power by the firms who “do SCM” to other firms (Bates and Slack, 1998; New, 2004, pp. 77; 83-93). In other words, speaking of SCs does not simply describe the world, it constructs the world: it is

² “A map is not the territory it represents, but, if correct, it has a similar structure to the territory, which accounts for its usefulness” (Korzybski, 1933, p.58).

performative, and mapping is potentially an extension of that. New (2004) also comments that, despite the ideas of structure that the notion of SC evokes, graphical representations of such structures are rather rare. He suggests that this is due to a combination of the complexity of real supply networks and commercial confidentiality. Studying the SC maps made by individuals and those that organisations provide to support SCM activities, as well as deconstructing SC mapping to reveal its implicit assumptions, can thus be a powerful research strategy.

Network pictures

The subjectivity of visual representations of networks has been the focus of a stream of literature on "network pictures" in the IMP (industrial marketing and purchasing) tradition (Henneberg *et al.*, 2006 and 2010; Geiger and Finch, 2010), which we outline now. Acknowledging the great complexity of real SCs, many SCM researchers have also adopted the concept of network rather than chain (Choi *et al.*, 2001; Carter *et al.*, 2015), with some drawing on the IMP tradition, in which the network is a central concept (Håkansson and Snehota, 1995). According to the network pictures literature, network pictures made by individual managers constitute "theories-in-use about what the relevant business network looks like, and how it 'works'" (Henneberg *et al.*, 2010, p.356). This research has often involved exercises where managers draw visual representations of their networks and are interviewed about them. Network pictures have mostly been seen as tools that researchers use to collect data about managers' perceptions of their business networks. This is in keeping with the "dialogic" approach to visual research, whereby visuals are used "to engage in a conversation with actors in the field" (Meyer *et al.*, 2013, p.516). This literature pays less attention to the processes of mapping and graphical representations that managers and organisations use outside of the research engagement, that is as part of their organisational practice, but can nevertheless help to inform our approach.

Integration and coordination as central themes in supply chain management

As we consider SC mapping, it is important to reflect on the wider purpose of SCM. Arguably, the central concept of supply chain management is integration. Houlihan's (1983) early statement of the principles of SCM stressed the problems that arise from a lack of integration between the functions within a firm. The supply chain management solution to these problems was:

The total supply chain – from purchased material to delivery to the customer – is treated as a single entity...The approach to direct and indirect logistics functions is to integrate them horizontally – along the supply chain... (Houlihan, 1983: p. 4)

Houlihan argued for integration within the firm, but SCM was quickly extended to encompass integration between firms, and integration in this sense has become a widely-researched issue (e.g. Frohlich and Westbrook, 2001).

Integration within the firm and between firms is a particular framing of a more general phenomenon: the division of labour. Different firms specialise in different parts of the productive task and, within firms, different functions and departments specialise further still. Wherever such differentiation occurs, integration mechanisms (Lawrence and Lorsch 1967) are required so as to “maintain [...] unity of purpose and direction” (Tell *et al.*, 2017, p.1). Integration across boundaries is a fundamental challenge of organisation design and management. In supply chains, it takes a particular form, being concerned with the boundaries arising from the differentiation between various organisations, departments and individuals concerned with the sequence of activities required to source, produce and deliver products to end customers and, if needed, manage their return.

For Lawrence and Lorsch (1967), integration mechanisms included formalised communication systems, temporary and permanent cross-functional teams, as well as individuals with an explicit integrative role. Integration was required to counteract diverging interests among functions, but also to allow communication and coordination between groups with different technical knowledge, language, and ways of thinking and working. More recently, organisation scholars have argued that boundary objects can play an important part in allowing coordination across boundaries between disparate groups. Since such coordination – within firms and between firms – is at the heart of SCM, we propose to consider supply chain maps through the lens of boundary objects, which we now outline.

Boundary objects

Boundary objects are physical or other forms of entity that “*allow different groups to work together without consensus*” (Star, 2010, p.602), or “*tools, objects or concepts that allow cooperation across boundaries*” (Zeiss and Groenewegen, 2009, p.82). In their foundational paper, Star and Griesemer (1989) study how actors from different social worlds, who nevertheless have shared goals, build and use boundary objects to create common understanding of what they have to do without losing the diversity of their social worlds, and despite great differences in knowledge, language, and objectives. To function effectively, boundary objects, created by actors as the need arises and evolves, must be simultaneously plastic and robust (Star and Griesemer, 1989, p.393), that is they must be sufficiently flexible to allow different groups to use them in their own social worlds, and yet stable enough to be consistently identified and used by the different groups.

The concept of boundary objects was developed in science and technology studies, but subsequently adopted by organisation scholars, notably Carlile (2002, 2004) in studies of new product development processes, where members of different functions – engineering,

marketing, production – need to coordinate activities among themselves, across boundaries between different technical specialisms. Objects such as models and drawings allow communication and coordination of activities across boundaries between these functions: the same models might be used by an industrial designer to consider and discuss use and aesthetics, by a design engineer to discuss the functioning, and by a production engineer to discuss the manufacturing process. By using the boundary objects, they can communicate more effectively with one another, without needing to know one another's specialist technical language or methods. Carlile (2002) and Henderson (1991) see maps and drawings as especially important boundary objects for the coordination of work across functions.

Carlile (2004) has argued that in heterogeneous coordination contexts there are three types of knowledge boundaries: syntactic, semantic and pragmatic. At syntactic boundaries, the differences between groups are understood, and a common lexicon is developed, to allow knowledge to be transferred effectively. At semantic boundaries, there is more novelty, and different interpretations from one group to another, so more interaction is required and, rather than being transferred, knowledge is translated. Finally, at pragmatic boundaries, divergent interests as well as novelty create greater challenges to knowledge sharing: under these circumstances, boundary objects are especially important to help identify common interests and permit the transformation of knowledge.

Comparing perspectives on supply chain maps and mapping

Based on our review of the literature, we suggest three possible perspectives on SC maps and mapping: the prevalent one adopted in SCM, one inspired by network pictures, and one based on the concept of boundary objects. These three perspectives are compared, as they relate to SC mapping, in Table 1.

[Insert Table 1 here]

We use these combined theoretical perspectives to empirically investigate the making, use, usefulness, and value of SC maps in companies and SCs and to explore how mapping might be useful and valuable for contemporary SCM.

Research design and methodology

We used a mixed methods approach within a single case study (Voss *et al.*, 2002; MacCarthy *et al.*, 2013; Ketokivi and Choi, 2014) of SC mapping in the outbound SC of Renault Group (RG). RG has strategic challenges in its downstream SC and seeks a clear vision of its functioning and potential changes. One of the authors, involved in the diagnostic analysis of RG's downstream SC, was looking for ready-made SC maps and was surprised not to find many. Being a large firm, RG gives us the opportunity to explore different functional perspectives, even though the overall structure is relatively stable. Moreover, even though the automotive sector is mature and an archetypal research setting in SCM, its downstream SCs are little researched. RG was questioning its mapping practices and wanted to better understand the usefulness and value of SC mapping for its outbound SCM.

The case study took place in two successive stages, using different qualitative methods: stage 1 was semi-structured interviews (including a mapping exercise); stage 2 was a focus group. Data collection was from December 2018 until July 2019.

Case study stage 1

We gathered existing, corporate maps of the distribution chain (also called outbound SC) – from the manufacturing plants to the end dealers – and analysed their purpose and use. With 18 key informants involved in the management of RG's outbound SC, we conducted semi-structured

interviews including facilitated mapping exercises. To gather as many different "visions" as possible, we selected key informants from different functions from Logistics and Supply Chain Alliance (outbound supply chain: [2], [4], **[16]**; distribution network engineering: **[1]**, [5], **[10]**; transport/logistics operations: **[6]**, [13], **[15]**), and other functions (quality: [8], **[12]**, [17]; IT: [7], **[11]**, [18]; sales operations: [3], [9], **[14]**) and different hierarchical levels (of the 18 informants, 8 are managers, numbers in bold). We also gathered many relevant internal documents from RG.

We structured the interview guide around four topics:

1. Interviewee's profile (background, current position in RG, role in outbound SC).
2. Interviewee's definition of the outbound SC (how he[*she*] pictures the "territory" of the outbound SC).
3. Does the interviewee have ready-made maps of the outbound SC? If yes, does he[*she*] use them in his[*her*] work? If no, would a map be a useful device in his[*her*] job?
4. Can the interviewee draw a map of the outbound SC? The facilitated mapping exercise was done on an A4 sheet of paper that was scanned at the end of the interview (see Appendix for map examples).

After recording and transcription, two of the authors coded the data separately and discussed and resolved any differences in their coding. This was done in four steps following an interpretive approach and using cumulative open coding: that is adding new items at each step. In Step 1, we coded the content of maps drawn by the respondents. Every part of the drawings was named (items) and characterised, referring to the categories found in the literature review (e.g. actor, resources, flow). In Step 2, the comments made by the respondents while drawing the maps were coded in the same way, including new items if any were found. In Step 3, we

coded in the same way the content of the outbound SC definitions. In Step 4, the answers concerning the usefulness of maps were analysed in an inductive thematic way.

In order to facilitate discussion about the results of the coding, we produced presence–absence matrices (Miles and Huberman, 1994; cf. Fawcett *et al.*, 2008, p.97), which help to synthesise qualitative data and are quick to read and easy to understand. We also collected significant oral comments made by respondents and RG internal documents to help illustrate, triangulate and interpret the results.

Case study stage 2

We used the focus group (FG) method to gather both individual and collective reflections about stage 1, particularly to explore apparent differences and contradictions between results. Although using multiple methods is common in case study research (Barratt *et al.*, 2011), in particular to triangulate data, the FG method is rarely used in OM, logistics and SCM (Larson and Halldórsson, 2004; Frankel *et al.*, 2005). In logistics research (Sanchez-Rodriguez *et al.*, 2010), FGs are used as a standalone method or in combination with others. We adopted best practice guidelines (Fabbe-Costes and Roussat, 2013) to ensure FG efficacy, concerning the number of groups, optimum group size (6–10 participants), diversity of group composition, and various aspects of session conduct.

The persons interviewed during stage 1 were sent the results of stage 1 and invited to participate in the FG. Seven out of 18 were able to attend the two-hour session held in July 2019. Two of the authors facilitated the session. The seven participants (managers n° in bold) were from: outbound supply chain: [4], **[16]**; distribution network engineering: [5]; transport/logistics operations: [13], **[15]**, and IT: **[11]**, [18]. On the wall of the meeting room we posted the 18 maps produced during stage 1, grouped in four categories of interviewees

(logistics/SCM or not; manager or not). We also posted on the wall three discussion points that arose from the results of stage 1:

1. Why is it that, although the interviewees had agreed that SC mapping was useful, RG had few SC corporate maps and mapping practices?
2. Why are there significant differences between the organisation's and the respondents' maps, between individual maps, and between the maps from the four groups of interviewees?
3. There is a consensus about the need to represent the outbound SC visually, but what sort of map should be made and why is SC mapping of value for SCM?

After a short initial briefing, participants worked individually at first, writing on post-it notes to react freely to the questions and results, then sticking the notes to the wall for comparison. Next, the whole group discussed the three questions. The researchers took real-time notes, stimulated discussion between participants only when necessary, introduced new questions suggested by the discussion, and acted as timekeepers. With the agreement of the participants, the FG session was recorded and subsequently transcribed. As for stage 1, two of the authors coded separately the discussion content and discussed their coding. This was done in two steps with an interpretive approach and cumulative open coding. First, we coded what was directly related to the results of stage 1 (reinforced results, new elements, explanations, collective opinion of first findings). Second, specific results from the FG were coded, adding new results and enriching our understanding of SC maps and SC mapping usefulness and value.

Findings

The findings are structured in four sub-sections. For each, findings from stage 1 (mapping exercise and interviews) are presented and complemented by results from stage 2 (focus group).

Content of SC maps and differences in content between SC maps

The findings support the subjective, purposive and projective nature of SC mapping. They give evidence of the variety of SC map styles and of what can be represented in a SC map. They reveal differences between SC maps done at the organisational and individual levels, and they confirm the importance of viewpoints, influenced by many factors.

- *Existing company maps*

Few maps of the outbound SC are available at RG. Two maps are used in every presentation to depict the outbound SC, but they are quite simplistic – linear and including few actors. They are so old that nobody can remember who drew them. They give a standardised representation of the SC from the moment cars leave the manufacturing plants and include the following elements: the *plant*, the customer (*dealer*) at an international level (*geography*), intermediary warehouses and *logistics points, operations* done on cars in warehouses, means of *transport* and the *physical flow of cars*. It is worth noting that, during the interviews, five participants ([I-1], [I-5], [I-6], [I-15] and [I-16]; henceforth the letter I indicates stage 1 interviews) mentioned other maps. In the two extra maps provided, one is a *geographical* map of RG's distribution network; the other links the outbound SC with RG's entire SC.

In the discussion, participants confirmed that there are few maps available in the company and that the one on the wall is the oldest and most popular: it is common knowledge in RG, a "standard" ([16/13/4]). Participants confirmed the influence of this map on the mapping done during stage 1 ("we all have this map in our head" [13]), although they consider it a (too) basic and simplistic view of the outbound SC ([5/16/18]). "I would like to make more complex maps than that one" [16].

- *The 18 outbound SC maps from the mapping exercise*

For most interviewees, SC mapping is not a common practice at RG: many were reluctant to draw and found it difficult: "I am not good at drawing" (e.g. [I-4/I-9/I-12/I-13]); "My picture is not clear" (e.g. [I-11]), "Have others made better pictures than mine?" ([I-8]). However, everyone produced a map. Table 2 gives the results of the analysis of the 18 maps. Thanks to the respondents' different viewpoints, we ended up with **20 items** in total, referring to **8 categories** found in the literature.

[Insert Table 2 here]

Our matrix analysis shows that three items are quite systematically represented (plant, warehouses, dealers) and four others are frequently present (means of transport, physical flow, points of tracking and the cars). Note that these items are also the ones present in the most popular official company map. The total per column in Table 2 shows the richness of the maps. The individual maps confirm that every interviewee has their own vision of the SC. While the maps are not centered on the respondents' activity, they seem to be influenced by their experience. Most of the 18 maps are much more complex than the company maps. The richer maps were done by respondents [I-15/I-1/I-3] and [I-12], who have more experience in the company, a cross-functional role (interacting with many people and functions) and operational field contacts.

During the FG, the question of what should be represented on the maps was spontaneously raised several times. The FG session confirmed the items extracted from interviews (stage 1) raised the need to represent the physical context of circulation (including transport

infrastructure), volumes (of cars) and responsibility transfers at inter-functional, inter-organisational, and geographical boundaries. For some of the items, participants confirmed the difficulty of representing them (e.g. "responsibility boundaries" [13/15]; "control points" [15]). When discussing the differences between the 18 maps, participants spontaneously formulated the hypothesis of a link between the individual's profession, position, experience in RG and the map drawn, the map revealing the person's "viewpoint" and reflecting their drawing aptitude [11].

- *Differences between respondents' map content, discourse during the mapping exercise, and definition of the outbound SC*

To confirm the underlying hypothesis that individual mental representations of SC influence SC mapping, we compared the content of the individual SC maps with the respondent's discourse during the mapping exercise and with their outbound SC definition³.

First, the analysis of what the respondents said while drawing the maps confirms the importance of the 20 items found in step 1 (Table 2). Second, it reveals some differences between discourses and pictures: seven items were mentioned by respondents but not drawn on the maps. These additional items did not lead us to add any new category of items. Third, comparing the matrices done in steps 1 and 2 shows that all items are cited more often (step 2) than drawn (step 1). The discourse during mapping is richer than the map for every respondent and almost every item (except two items) and it confirms that respondents' experience of SCM influences their way of mapping SC (e.g. "since I am in the export flow..." [I-2]; "you can have a port or not, but since I like ports..." [I-4]; "being in charge of quality, we are concerned by any deviations that may occur" [I-17]). Finally, as for the maps, respondents' discourses vary in richness (ranging from 17 to four items). The exercise led some respondents to reflexively

³ A supplementary file is provided with two tables.

question the scope of the SC (e.g. "Does the outbound SC begin here or there? [...] for me it is a bit unclear" [I-9]; "The boundary must go there [the dealer], but it should go further [the end customer]" [I-12]).

Second, our analysis of the respondents' definitions of outbound SC also confirms the importance of the 27 items found in steps 1 and 2. Seven additional items emerged that were not in the maps or the discourse during mapping; again, we did not need any new item category. Comparing map content and SC definitions we find that all items are more present in definitions (step 3) than pictures (step 1). While most definitions clearly mention that the outbound SC begins "when the car comes out of the plant" ([I-1]), it is less clear where it ends. In line with the company maps, some participants mention the *dealer* as the end-point of the outbound SC, while most (10 out of 18) clearly go as far as the *end-user*. Most definitions (13 out of 18) mention *performance objectives* related to managing the outbound SC that were not so present in the maps (only five out of 18). Some respondents go into detail about some aspects of the outbound SC, in line with their experience or their responsibility (e.g. [I-3] emphasises the SC information system giving visibility to the commercial and sales department). Some definitions clearly state that the outbound SC is "complex" and some reveal fuzzy conceptions of the SC that shift between "physical *operations*", "company *function*" and "company *department*" (e.g. [I-14]).

Although the researchers did not raise the discourse and definition of downstream SC, and the FG discussion never returned to these topics, people spontaneously came back to the difference between the "real SC" (the territory) and the map. The complexity of the outbound SC and how to represent it was mentioned often [4/15/16]. The SC territory was viewed as physical but also as rather virtual due to its geography (all over the world) and the fact that nobody can really view everything (the information systems only provide virtual visibility) [15].

• *Differences between the four groups*

We deliberately selected interviewees from the logistics and SC function as well as from other functions, managers and persons with another role. However, the analysis of data from stage 1 did not lead to a clear conclusion on the influence of these two dimensions on SC mapping and maps.

During the FG, the 18 maps were taped on the wall, arranged in the four groups. We invited participants to think about the differences between the groups of maps. Although interpretation was not easy, participants agreed on the importance of individual viewpoints: "We all work with the view from our window" [13]. And that is not only true inside RG, but also with outside partners: "They see the SC from their window and don't see the whole structure behind it" [15]. Participants referred to the person's position or function (e.g. "He is probably a sales person" [4/15]). "Everyone's viewpoint depends on their profession" [4]. "Everyone wants to include what they imagine, the objectives they attach importance to, what they would like to have there..." [13]. The difference between managers and non-managers was discussed. About one manager's map ([15]), another manager said "Well, he's a manager and we see that managers..." [16]. And a non-manager insisted "We see the difference!" [4].

Usefulness for the company of SC mapping and SC maps

During the individual interviews, the use and usefulness of outbound SC maps was explicitly discussed with respondents (question 3 in the interview guide), who also spontaneously mentioned some of the difficulties of SC mapping. We analysed these responses by coding them, then using a presence-absence matrix, in the same form as Table 2. They can be summarised as follows. A large majority of respondents (12 out of 18) mentioned the need for

maps, even though most of them said that they do not use or make maps. A third also expressed the need for mapping tools. A large majority also said that, since SCs are complex, maps are useful to visualise (12 out of 18) and represent (11 out of 18) the SC to better understand it (6 out of 18). The respondents spontaneously mentioned 11 benefits of maps and seven causes of mapping difficulty. There was a controversy over whether a map should be as complete as possible or not. But some respondents emphasised the need for maps to be as faithful as possible. One respondent stated "I think for a long time carmakers didn't pay much attention to the downstream SC because they didn't really see what was at stake" [I-13].

In the FG, participants confirmed the need for RG to develop SC maps and considered SC mapping an underdeveloped activity. However, some participants asked: "What do we need a map for?" [5]; "Is it useful?" [15]; "In fact, I question whether it is useful...[...] since there is no map available... is it really useful? Do we need maps?" [11]. At the end of the FG, the group confirmed the usefulness of SC mapping for RG, raising the role of tools for mapping [4/5/13/16], and the need to have "updated" [4/5/15] and "attractive" maps [4/5]. It also confirmed the relationship between the purpose of mapping and the objectives of the person who maps or uses the maps, that is the purposive and projective nature of mapping.

- *What makes a corporate map useful?*

The FG participants discussed the diversity of maps they had made and questioned the need to have a single map for RG. They admitted that the answer is not so clear: "It could be useful, but it is difficult to do" [4]. Initially, they discussed having a "one-size-fits-all" map and spent a lot of time discussing the kind of picture that would be useful and what it should include. They concluded that making a single corporate map is difficult [4/15], but that mapping is a skill RG needs to develop. They also repeatedly emphasised the difficulty arising from the need to update

the maps [5/4], because SCs evolve and are dynamic [5/15]. Making a single map is all the more difficult because "thinking about it is one thing, but then you have to get everybody to agree in order to actually make it because everybody wants to constantly optimize their own objectives" [15]. Considering the complexity of the outbound SC and political issues raised by SC collaboration, the participants acknowledge the endless process of trying to make a single map [15].

They mentioned the need for tools, but this does not appear to be a key issue for SC mapping at RG. They agreed on one point: in the logistics/SCM division they should develop maps and use new mapping tools (some are under development). The question of having a standard mapping approach was also discussed, but does not appear to be a key issue, either. The group confirmed that different visions are possible and complementary: flow vision [16], process vision [5], organisation vision, interaction vision, and network vision [16]. We suggested combining them in a hypertext representation and said that tools could easily show the preferred view depending on the intended use of the SC map. They agreed and said that the preferred vision sometimes depends on the person's function in the company (e.g. IT people are more familiar with process-based maps [18]). They also linked "what to represent" to the objective of the mapping and to the purpose of the map (its value). This "ad hoc" perspective of mapping at the corporate level reinforces the criticality of the usefulness of SC maps.

- *Main uses of corporate maps*

The FG confirmed that there are many possible uses for corporate maps, particularly:

- (1) for training purposes, both for newcomers [4] and also for more experienced people "a map to improve your skills could be helpful" [11].
- (2) to improve communication between functions, since they provide a "common basis" from which to work. Coming back to the corporate map taped to the wall, participants

said "it is simple and easy to understand, everyone in the company knows it and we can refer to it" [16].

(3) to promote the SC function and SCM in the company. "[Non-SC people] have a vision of our work that is not clear and even less so about what we manage to accomplish" [13]. This is also evoked for external partners: "In the end they made a map for us... their view of the thing..." [15].

Comments about these uses implicitly suggested that maps could influence people's representation of SCM. They emphasised the importance of the "look" of the maps [4/5], a point also raised when talking about the teaching use of SC maps.

The value of SC mapping and SC maps

The FG discussion went beyond the usefulness of SC maps for companies. The value of SC maps is that they help people better understand SCs and the role of SC operations. This is clearly an important issue both inside RG (e.g. sales or manufacturing) and with external partners (e.g. dealers). "Maps can be valuable in discussions with others in the SC" [15]. Participants gave examples of the value of specific maps dedicated to specific SCM points (e.g. with dealers to explain where cars come from, the different processes, and what problems might occur [15]). These examples suggest that the value of an SC map may be linked to targeted SC stakeholders' role in the SC, their understanding of SCM, their own objectives in the SC and their decision-making process. Since it is not possible to represent everything, it is necessary to know the purpose of the map. "We don't really need to take in everything in a single glance... Before looking you need to make a selection..." [16]. "That's it. You have to begin with what you need. What do you want to represent?" [16].

For the logistics/SCM function, mapping is important to help people communicate with each other in the SC.

In practice, the SC should serve everybody. There is a line where it should serve the factories, there is a line where it should serve customers, or even customers from different sales organisations, etc. And the scope of each representation includes different responsibilities and we have to adapt because we bring them all together. I think that's why it's so hard to represent, because you have to represent multiple points of view. [E15].

Participants raised many times the need for visualisations to better understand what the territory of the outbound SC is [4/5/13/15/16]. The value of mapping, according to the group, is to "make it easier to perceive the SC despite its complexity" [16] to "visualise what we do in the SC" [13], but also to connect the materiality of the SC and the intangible nature of its management. As reported by [15], working in the outbound SC means working on something virtual and mostly intangible: "There is a physical part, of course... and there is a part that is highly dematerialized... By mapping it out, you can connect the physical with the intangible" [15]. "Our work is quite intangible, you know, and this helps you give shape to it. We need something concrete, to be able to feel it" [15]. The first thing is the visibility of the SC. "If we want to be able to do something, we need to be able to perceive it, to take in all the complexity... Begin by seeing, by representing, before doing!" [16].

For the FG, SC mapping means drawing an "ideal SC", but "the ideal organisation doesn't work!" [15]. Acknowledging the subjective, purposive and projective nature of mapping, they considered that having all the different viewpoints ("the view from one's window") was even more useful than trying to make them converge. The discussion turned to the value of SC maps that could help to understand people's views of the SC, in particular when they are related to different areas of responsibility, and to align their objectives *vis-à-vis* SCM. The FG confirmed

that inconsistencies between individual views (and maps) could reveal important SCM issues. "It might be helpful in aligning objectives. I mean, the big problem that we are constantly facing in organisations is that we spend our time managing contradictory objectives... It could be useful to bring these points of view together, especially during alignment phases or transition phases, etc." [15].

Standing in front of the 18 maps, trying to explain their differences, the participants momentarily diverged from maps and mapping and began to discuss SCM. The maps prompted a discussion of SCM problems in the company and interface issues between different functions or with partners, in particular in relation to transfers of responsibility. This discussion suggests that SC maps are valuable "boundary objects" to debate and better understand different viewpoints: we develop this view in the discussion section. The FG session showed the value of SC mapping to discuss what the outbound SC is (the nature of an SC, in terms of ontology), what SCM means, why it is so difficult to manage an SC that is both physical and virtual, and why it is so difficult to integrate internal functions and to collaborate with outside partners.

Paradoxes in mapping

The overall discussion during the FG session raised the dialogic nature (Morin, 1990) of SC mapping, revealing the influence of the objectives behind mapping. The discussion about which maps would be more "valuable" led participants to identify a number of paradoxical issues, which point to some of the tensions and challenges – practical and theoretical – many of which are already evident in the diverging theoretical perspectives we discuss in the literature review. Furthermore, all of them could be understood as the tension between “the map”, and the “territory”.

Many of these tensions relate to the extent to which the map should or could capture and present a more exhaustive representation of the supply chain (i.e. the map should include more (or less) of the territory). This can be expressed in a number of similar ways:

- (1) Exhaustive (rich) / non-exhaustive (poor) [5/15]: "We didn't make the drawing to be encyclopedic though" [5].
- (2) Complex / simple [E4]. Looking at the four groups of maps on the wall: "You sense that it's a bit more linear on this side than the other. There are representations that are a little more complex, a little more elaborate on the left" [13].
- (3) Big picture (holistic) / detailed (zooming): "I think it's an overall view that offers an approach to someone who is just discovering logistics" [13]; "It wouldn't be a bad idea to represent the overall process so that people might understand it." [11].

As we have already argued, a supply chain is a social construction: we construe a collection of (in this case) factories, cars, warehouses, workers, dealerships as a more or less integrated entity. Furthermore, the supply chain, understood as a system, then gives rise to many forms of information, data and managerial discourses regarding strategy, processes and so forth. As such, another tension arising from the interviews and FG discussion is the extent to which a map represents the physical as opposed to the non-physical.

- (4) Abstract (virtual) / physical (realistic, practical) [18/15]: "The difficulty in fact is that the interface where people come together to do their work is not physical. ...we connect all around the world on things that you cannot see." [15].

A further important theme evident from the SC maps and in the discussions between participants is the extent to which maps do and should be common across the groups and within

RG. The paradox is that, as a more standard and universal map is created and considered, in many ways it is criticised:

- (5) Standardised / customised: "To make things easier, we reproduced more or less the same diagram because it's what we all have in mind. ...The paradox is that as things tend to converge towards the middle and it's a standard that doesn't correspond to anyone, everybody wants to include what they have in mind, objectives that are important for them, what they would like to have..." [13].

Finally, even while we discuss supply chains as evolving processes, and the flow of materials and information, maps – certainly those drawn on paper or its digital equivalent – are static. Thus, another tension is around the limited extent to which maps can capture dynamic issues, which are in many ways what SC managers are concerned about in the day-to-day operations.

- (6) Static (reference) / dynamic (evolution of SC and maps): "Is it a static representation or is it a dynamic representation, possibly with cars that move?" [16]. "Yes, on top of that, it's constantly evolving. Logistics diagrams evolve" [5]. "Yes, it's dynamic" [15].

These paradoxical issues offer valuable insights about what SCs and SCM are. We will return to them toward the end of the discussion, to which we now turn.

Discussion

The literature review presented three approaches to understanding SC mapping in SCM: the prevalent SC mapping view, network pictures, and boundary objects. We propose that these latter two perspectives help us to refresh and enrich our conceptualisation of SC mapping. We will first show how our data and analysis relate to and reflect the various perspectives confirming the relevance of our theoretical framework (Table 1). We then reflect on how our

insights can be understood in the context of recent developments in the conceptualisation of supply chain management. In particular, we elaborate upon the boundary object concept, to explore how SC mapping can be used to achieve the central supply chain aims of improved integration and coordination, in contemporary supply chain settings characterised by greater uncertainty, temporariness, and disruption, and which are understood theoretically as complex adaptive systems (Choi *et al.*, 2001).

Three perspectives on supply chain maps and mapping

If we consider the maps produced in terms of the ‘classic’, objective SC mapping view, it is useful to reflect on the apparent purpose of the maps, and the elements they contained. Most of the maps were “activity-based” (Lambert *et al.*, 2008) and the comparison between the 18 maps (Table 2) reveals a “standardised common ground” that is “core” in RG outbound logistics and SCM: actor/place (plants, logistics sites, dealers), means of transport, flows (cars), performance. They are included partly because they matter to the participants. But the inclusion of common elements also arises from the participants’ awareness of the existing RG organisational map: everyone attested that their map was influenced by it (“it’s what we all have in mind” [13]). Other items (<22% in Table 2) seem to reflect more personal representations or interests, related to their particular job function. On the classic SC mapping view, one might try to build, from the various maps created and the elements they include, and from the corporate map, a single, definitive, inclusive map. However, although many of the participants considered and discussed this possibility (“it could be useful, but it is difficult to do” [4]), most also concluded that it would be impossible to create such a map that would satisfy all their needs.

The ‘classic’ SCM approach would support the view that there are *strategic* needs for official “fixed” corporate SC maps to communicate a “common ground to refer to”, an overall

RG company vision of its outbound SC. Being performative and potential power instruments (New, 2004), official SC maps can also promote some strategic aspects of SCM. The purpose of these SC maps, used as top-down “management tools”, is to *align* SC visions and highlight priority objectives and provide standards to apply when working day-to-day in more detail.

From the perspective of the network pictures literature, diversity among individuals’ maps is to be expected and, indeed, embraced (see Table 2). There is no intention within this tradition to use the pictures to manage the network or supply chain between individuals or across functions. The “SC pictures” made by individuals (Table 2) are very different in content (type of items), richness (number of items) and style (drawing). The differences seem to be linked to participants’ personal experience, skills, interests (e.g. "I like ports") and their drawing style. Sharing these personal views is helpful to identify mismatches in representations (e.g. about the SC structure). However, and more importantly according to FG discussion, the differences are also linked to their belonging to different functional areas (IT, commerce, logistics; being manager vs non manager) and their main performance priority (e.g. "being in charge of quality").

A network picture perspective would suggest that, even if there are official, fixed maps, *individual* mental representations (viewpoints) will always exist. Individual SC pictures are useful to engage the actors in a conversation (Meyer *et al.*, 2013) to understand and share their representations as well as to discuss SCM issues. Such conversations can also reveal the inconsistencies, misalignments and problematic interfaces in the SC. Trying to combine individual SC maps to make a bottom-up unique map is therefore, according to participants, a valuable exercise "in particular to find compromises in transitional or alignment phases" [15].

The boundary objects perspective emphasises the need for objects to be both plastic and robust (Star and Griesemer, 1989). The differences between the maps drawn by the diverse participants are evidence of the plasticity: they reflect different social worlds, and differences

in what is “at stake” (Carlile, 2002) for them in their work. The elements that are common across the maps reflect the robustness of the maps as boundary objects: although they are all different, all could be recognised as SC maps. At the same time, although certain visible elements are common to different maps, this does not mean that the drawers have the same representation in mind of what they draw, as partially supported by the variety of the outbound SC definitions given during interviews.

Knowledge transfer across boundaries can be concerned with overcoming syntactic, semantic, and pragmatic boundaries (Carlile 2002, 2004), and boundary objects can be understood in terms of their functions in this process. In our case, the difference between maps, discussion and definitions suggests that the visible items (drawn in maps) are easier to represent and more explicit, so *syntactic* in nature. The others, which clearly refer to boundaries, interfaces and to decision-making (things difficult to draw), are more tacit or invisible, and so *semantic* and/or *pragmatic* in nature. Noticeably, the shared items are also in the RG map, which has some of the characteristics of a *syntactic* boundary object (Carlile, 2002) or an “ideal type” (Star and Griesemer, 1989): a “flexible” standard, a general model, which eases communication about RG’s outbound SC. However, it is not an “efficient boundary object”, since, for many interviewees and FG participants, it does not represent what is “at stake” for them (Carlile, 2002). As Star (2010) explains, not all objects [here maps] are boundary objects. An object “*only becomes a boundary object if it works like one*” (Zeiss and Groenewegen, 2009, p.93).

A boundary objects perspective suggests that, to support *intra and inter-organisational* coordination/integration of heterogenous groups at work in a SC, it is necessary to build iteratively, including every “voice”, a common ground of temporary SC maps. In line with the shared goal of SC groups at work, standards are needed to assemble the “local” SC maps – that fulfill the working needs to improve SC performance – in a coherent system.

Having discussed some of our results in relation to each of the three perspectives it is instructive to combine the three complementary approaches (Table 1). While our data clearly show that SC maps and mapping are useful, what “usefulness and value” are, is less clear. The interviews and the FG discussion revealed that our participants held diverging views about what would, or not, be useful. Considering our data in relation to the paradoxical tensions and differences between the three perspectives leads to the following statement: from a theoretical and ontological point of view (an objective, subjective or constructive representation) (Table 1) the three visions are alternatives, but from a practical perspective they are complementary: FG participants want RG to give strategic organisational maps, they want to discuss individual maps and they want to build boundary maps (bridging organisational and individual) to help them at work. The three SC mapping visions provide a framework for using (industry) and studying (academia) SC maps and mapping.

The boundary object perspective offers a novel perspective to view SC mapping as a pragmatic and iterative practice to improve boundary spanning coordination. In the next subsection we deepen this perspective to elaborate propositions to enrich/complement the SCM vision of SC maps and of SC mapping.

Propositions derived from the boundary object perspective

Our case study confirms the relevance of a boundary object perspective. RG supply chain combines heterogeneous social worlds that have different viewpoints and representation of what the “territory” is and have to coordinate (work together) to improve the performance of the outbound SC (shared goal). Our results also suggest that SC maps could be valuable objects (among others) in SCs and SCM to improve coordination, integration, inter-functional or inter-organisational work and/or to solve complex problems.

If we see SC maps and mapping in SCs with a boundary objective perspective, then we can derive the following propositions. They are “valuable” to study or implement SC mapping as an activity and the SC maps as objects supporting the work of persons, groups, organisations that have to coordinate to improve the performance of SCs.

Our data, as mentioned in the previous sub-section of the discussion, suggest that interfaces in SCs (places where boundary work is performed) belong to the “*pragmatic*” category of boundaries (Carlile, 2004). Therefore:

P 1: SC maps (should) include the 3 levels of needs: syntactic, semantic and pragmatic.

Maps’ *content* then depends on the local *and* global information needs and work requirements (Star, 2010). They should be plastic (to adapt to local needs – customisation) and robust (to maintain common identity – standardisation) (Star and Griesemer, 1989). Since not all SC partner work together to manage the SC, it is impossible to have a unique SC map. Therefore, *many “local” SC maps* will be produced to manage a SC. Since not all SC problems call for boundary work, there is no need to have a SC map that represents in detail the overall SC territory.

P 2: The map has to represent the territory that is relevant to the work to be performed.

Having many maps is not problematic, co-working situations lead to “*systems of boundary objects which are themselves heterogeneous*” (Star and Greisemer, 1989, p.410). The boundary object perspective therefore suggests:

P 3: SC mapping at local and global levels in a SC has to end with a coherent “system of maps” that, as a system, covers the SC territory for the shared goal.

In each “local” SC map, dedicated to a specific task or problem to solve by heterogeneous participants, what is “at stake” (Carlile, 2002) for each of them should be represented to permit

each “voice” to take part in the working. The boundary object perspective does not deny power but suggests that no voice should be louder than the others. In a SCM context, this vision can be seen as utopian, but since boundary object “*materiality derives from action, not from a sense of prefabricated stuff or "thing"-ness*” (Star, 2010, p.603) a more participative approach to SCM is worth promoting.

P 4: Viewing SC maps as boundary objects suggests a more constructive approach to SC mappings.

In a SCM context, to make sure the locals maps “make a system”, we suggest adopting IT tools able to combine maps and to provide different customised SC views from a unique system. A hypertext approach to SC mapping seems relevant. This is all the more so important that maps are a “*category of boundary object that directly supports transforming knowledge. [...] the most complicated and expensive to establish*” (Carlile, 2002, p.452).

P 5: Adopting a tool to support SC mapping should not be or create a constraint or destroy boundary spanning dynamics.

Maps are powerful boundary objects (Carlile, 2002 and 2004) that, like drawings (Henderson, 1991), are complex to elaborate. They are supposed to evolve with the work to perform. Fixing drawing introduce irreversibility (Henderson, 1991).

P 6: Care should be taken in “fixing” maps (e.g. to produce official maps) since it introduces irreversibility which can be a risk for the SC and its SCM in particular in contexts that are turbulent, risky or where SCs are temporary, fluid, agile, ever-changing.

The development of supply chain management, and implications for mapping

SC mapping was most prominent in the SC literature during the relatively early days of SCM. Approaches such as Gardner and Cooper (2003) and Lambert *et al.* (2008) were developed

alongside early conceptualisation of key supply chain ideas such as integration, and sought to identify and draw one version of a firm's supply chain, typically to allow external analysis, diagnosis and improvement. Supply chain practice and research focused on relatively mature, stable industries such as automotive and retailing, where supply bases were relatively constant, technologies changed relatively slowly, and demand was predictable.

Since then, supply chain practice and theorisation has moved on. Supply chains are more global, profoundly affected by the adoption of advanced technology, more transient (Day *et al.*, 2012), and subject to greater uncertainty. The theorisation of supply chains has evolved accordingly. Supply chains are increasingly seen as networks (Carter *et al.*, 2015); there is growing interest in the emergence, development and demise of supply chains – a supply chain life cycle (MacCarthy *et al.*, 2016); supply chains or networks are seen as complex adaptive systems (Choi *et al.*, 2001; Carter *et al.*, 2015), which calls into question the original supply chain ambition to manage the supply chain as “a single entity” (Houlihan, 1983), in favour of allowing local emergence combined with relevant control. Carter *et al.*'s (2015) conception of the supply chain also argues that a supply chain (or network) is defined relative to a particular product or service, and that, from a focal firm perspective, the “visible horizon” – the ability to be aware of and directly monitor suppliers or downstream counterparts – is limited, and subject to attenuation, the further we look from the focal firm. This latter point, especially, is at odds with the early ambition of supply chain management, and SC mapping, to identify and manage the supply chain from raw material to end customer (Christopher, 1998). Lee's (2004) “Triple A” supply chain – even if operating in relatively mature industries – needed to be adaptable and agile, as well as aligned to a particular performance objective.

The network pictures and, especially, the boundary objects perspectives are more appropriate for these kinds of supply chains and supply chain concepts. A boundary objects perspective abandons the prospect of developing a unique common object (in our case, a map),

understood in the same way by all participants, in favour of allowing multiple, locally-developed, heterogeneous maps to be created and evolve, in order to facilitate communication and coordination at particular boundaries. This is, we argue, especially appropriate in contemporary supply chains, which exhibit the characteristics we describe above. Even in our case, although RG is in one of the sectors we have described as mature, it is no longer a stable and slow-changing sector: the automotive industry has had to adapt rapidly to electric power, autonomous vehicles, and radical global restructuring in the face of mergers and acquisitions in the industry, among other shocks. More than ever, to attempt to draw a definitive map of the whole supply chain is a futile exercise: it is an attempt to hit a (fast-) moving and amorphous target. The boundary objects perspective is consistent with the notion of local agency and emergence in supply chains as complex adaptive systems (Choi *et al.*, 2001). Boundary objects also comprise inherently paradoxical characteristics (Star and Griesemer, 1989; Star, 2010), which make them suitable to accommodate the type of paradoxes in SC mapping identified by the participants.

Conclusion

Few previous studies questioned the usefulness or value of SC maps for supply chain practitioners, or how they might relate to central concepts in SCM theory and practice. The purpose of this research was to question the SC mapping tradition in SCM and refresh its practice and study. In this paper, we discuss the creation and conceptualisation of SC maps and question what SC ‘territory’ a SC map is supposed to represent. Combining three alternative but complementary theoretical perspectives, we developed a framework to envisage the variety of way of creating, developing and using SC maps in supply chains and SCM. The boundary object perspective offers a novel perspective to view SC mapping as a pragmatic and iterative practice

to improve boundary spanning coordination. Our theoretical framework and proposals provide a basis to reflect critically on why and how mapping is done, and how it is used.

Since SC mapping, like drawing, needs a visual culture, should not we develop the visual culture of persons working in SCM? This is an important question for SCM teaching and human resources management in companies. Existing SC maps, whether published in books or articles or disseminated in companies, have great influence on people's representation of SCs. They are all the more influential when they are simple. Great care should therefore be taken when choosing pictures to support managerial or teaching activities related to SCM. From the discussion, since contemporary SC are more and more fluid, temporary, complex and adaptive, another question could be: Should we stop making "fixed" maps that introduce rigidity and irreversibility? In contemporary SCs, SC mapping is a practice that could develop reflexivity (it makes people think about what the SC "territory" is and about SCM), engage the actors in a conversation (Meyer *et al.*, 2013) and encourage knowledge-sharing and transforming (Carlile, 2002, 2004).

Our research has some limitations. Its design was based on a mapping exercise. The semi-structured interviews and open discussion during the FG were deliberately to explore all actual and potential usages of SC maps and mapping. Action-research could be undertaken to better document use, usefulness and value of SC maps, based on maps produced during real working conditions.

Our research shows that SC mapping is not an easy task for managers and is a complex issue in SCM. This encourages further research on this aspect and better communication with industry. Philosophically speaking, our research points to the importance of revealing the underlying ontological and epistemological visions of SC managers and researchers. Maps objectivise, but are not objective pictures! Companies need to be fully conscious of the power of SC maps and to take greater care in their mapping activities. It also justifies developing

teaching in this domain and providing a paradoxical approach to this activity. The role of tools in SC mapping also calls for further research. If we acknowledge that it is useful to have rich maps and to produce maps dedicated to specific questions or viewpoints, then there is a need to develop tools with rich databases and hypertext map layers that are able to produce customised maps. This is a call for more flexible and user-friendly SC mapping tools.

Finally, although we have applied it to mapping, there is enormous scope to use the boundary objects concept much more in supply chain management, to examine diverse phenomena such as SC information systems, performance measurement and improvement tools, and contracts. We have, indeed, only just begun to chart this territory.

References

- Barratt, M., Choi, T.Y. & Li, M. (2011), "Qualitative case studies in operations management: Trends, research outcomes, and future research implications", *Journal of Operations Management*, Vol.29, pp.329-342.
- Bates, H., and Slack, N. (1998), "What happens when the supply chain manages you? A knowledge-based response", *European Journal of Purchasing & Supply Management*, Vol.4, No.1, pp.63-72.
- Carlile, P.R. (2002), "A Pragmatic View of Knowledge and Boundaries: Boundary Objects in New Product Development", *Organization Science*, Vol.13, No.4, pp.442-455.
- Carlile, P.R. (2004), "Transferring, Translating, and Transforming: An Integrative Framework for Managing Knowledge Across Boundaries", *Organization Science*, Vol.15, No.5, pp.555-568.
- Carter, C.R., Rogers, D.S., Choi, T.Y. (2015), "Toward the theory of the supply chain", *Journal of Supply Chain Management*, Vol.51, No.2, pp.89-97.
- Choi, T.Y, Dooley, K.J, and Rungtusanatham, M. (2001). "Supply networks and complex adaptive systems: control versus emergence", *Journal of Operations Management*, Vol.19, No.3, pp.351-66.
- Christopher, M. J. (1998), *Logistics and Supply Chain Management*. London: Financial Times Pitman.

- Cohen, S. and Roussel, J. (2005), *Strategic Supply Chain Management – The 5 disciplines for top performance*, The McGraw-Hill Companies, New York, USA.
- Cooper, M., Lambert, D. and Pagh, J. (1997), “Supply Chain Management: More Than a New Name for Logistics”, *The International Journal of Logistics Management*, Vol.8, No1, pp.1-14.
- Cruz-Rivera, R. and Ertel, J. (2009), “Reverse logistics network design for the collection of end-of-life vehicles in Mexico”, *European Journal of Operational Research*, Vol.196, pp.930-939.
- Day, J.M., Melnyk, S.A., Larson, P.D., Davis, E.W. and Whybark, D.C. (2012), "Humanitarian and Disaster Relief Supply Chains: A Matter of Life and Death", *Journal of Supply Chain Management*, Vol.48, No.2, pp.21-36.
- Eriksson, D.M. (2003), A framework for the constitution of modelling processes: a proposition, *European Journal of Operational Research*, Vol.145, pp.202-215.
- Fabbe-Costes, N. (2017), Le choc des images des chaînes logistiques: ce qu'en révèlent nos modélisations”, in Paché, G. (Ed.), *Images de la logistique – Eclairages managériaux et sociétaux*, Presses Universitaire d’Aix-Marseille, Aix-en-Provence, pp.37-42.
- Fabbe-Costes, N. and Roussat, C. (2013), “Refining a tool to prioritize environmental scanning for Sustainable Supply Chains: a focus group approach”, *20th International Annual EurOMA Conference proceedings*, June 7-12, Dublin, Ireland.
- Farris, M.T. (2010), “Solutions to strategic supply chain mapping issues”, *International Journal of Physical Distribution & Logistics Management*, Vol.40, No.3, pp.164-180.
- Fawcett, S.E., Magnan, G.M. and McCarter, M.W. (2008), “A three-stage implementation model for supply chain collaboration”, *Journal of Business Logistics*, Vol.29, No.1, pp.93-112.
- Frankel, R., Naslund, D. and Bolumole, Y. (2005), “The “white space” of logistics research: a look at the role of method usage”, *Journal of Business Logistics*, Vol.26, No2, pp185-208.
- Frohlich, M.T. and Westbrook, R. (2001), “Arcs of integration: an international study of supply chain strategies”, *Journal of Operations Management*, Vol.19, No.2, pp.185-200.
- Gardner, J.T. and Cooper, M.C. (2003), “Strategic supply chain mapping approaches”, *Journal of Business Logistics*, Vol.24, No.2, pp.37-64.
- Geiger, S. and Finch, J. (2010), “Networks of mind and networks of organizations: The map metaphor in business network research”, *Industrial Marketing Management*, Vol.39, No3, pp.381-389.

- Håkansson, H. and Snehota, I. (eds.) (1995), *Developing Relationships in Business Networks*, Routledge, London, U.K.
- Harland, C.M. (1996), "Supply chain management: relationships, chains and networks", *British Journal of Management*, Vol.7, Special Issue, pp.63-80.
- Henderson, K. (1991), Flexible Sketches and Inflexible Data Bases: Visual Communication, Conscriptio Devices, and Boundary Objects in Design Engineering, *Science, Technology, & Human Values*, Vol.16, No.4, pp.448-473.
- Henneberg, S.C., Mouzas, S. and Naudé, P. (2006), "Network pictures: concepts and representations", *European Journal of Marketing*, Vol.40, No.3/4, pp.408-429.
- Henneberg, S.C., Naudé, P. and Mouzas, S. (2010), "Sense-making and management in business networks – some observations, considerations, and a research agenda", *Industrial Marketing Management*, Vol.39, No.3, pp.355-360.
- Hines, P. and Rich, N. (1997), "The seven value stream mapping tools", *International Journal of Operations and Production Management*, Vol.17, No1, pp.44-62.
- Houlian (1983), "Supply chain management: 'The modern approach to logistics' ", *BPICS Control* (June/July), pp.3-5.
- Ketokivi, M. and Choi, T. (2014), "Renaissance of case research as a scientific method", *Journal of Operations Management*, Vol.32, pp.232-240.
- Korzybski, A. (1933), *Science and Sanity. An Introduction to Non-Aristotelian Systems and General Semantics*, International Non-Aristotelian Library Publishing Co., Lancaster.
- Lambert, D.M., Cooper, M.C. and Pagh, J.D. (1998), "Supply Chain Management: implementation issues and research opportunities", *The International Journal of Logistics Management*, Vol.9, No.2, pp.1-18.
- Lambert, D.M., Garcia-Dastugue, S.J. and Knemeyer, A.M. (2008), "Mapping for Supply Chain Management", in Lambert, D. (ed.), *Supply Chain Management – Processes, Partnerships, Performance*, Supply Chain Management Institute, Sarasota, FL, USA, pp.197-216.
- Larson, P.D. and Halldórsson, A. (2004), "Logistics Versus Supply Chain Management: An International Survey", *International Journal of Logistics: Research and Applications*, Vol.7, No.1, pp.17-31.
- Lawrence, P.R. and Lorsch, J.W. (1967), *Organization and environment: managing differentiation and integration*, Boston: Harvard Business School.
- Lee, H.L. (2004), "The triple-A supply chain", *Harvard Business Review*, Vol.82, No.10, pp.102-113.

- Le Moigne, J.-L. (1990), *La modélisation des systèmes complexes*, Dunod, Paris.
- MacCarthy, B.L. and Jayarathne, P.G.S.A. (2013a), "Supply network structures in the international clothing industry: differences across retailer types", *International Journal of Operations & Production Management*, Vol.33, No.7, pp.858-886.
- MacCarthy, B.L., Lewis, M., Voss, C. & Narasimhan, R. (2013b), "The same old methodologies? Perspectives on OM research in the post-lean age", *International Journal of Operations & Production Management*, Vol.33, pp.934-956.
- MacCarthy B.L., Blome, C., Olhager, J., Srai J.S. and Zhao, X. (2016), "Supply chain evolution – theory, concepts and science," *International Journal of Operations & Production Management*, Vol.36, No.12, pp.1696-718.
- Mentzer, J.T., Dewitt, W., Keebler, J.S., Min, S., Nix, N.W., Smith, C.D. and Zacharia, Z.G. (2001), "Defining Supply Chain Management", *Journal of Business Logistics*, Vol.22, No.2, pp.1-25.
- Meyer, R.E., Höllerer, M.A., Jancsary, D. and van Leeuwen, T. (2013), "The Visual Dimension in Organizing, Organization, and Organization Research: Core Ideas, Current Developments, and Promising Avenues", *The Academy of Management Annals*, Vol.7, No.1, pp.489-555.
- Miles, M.B. and Huberman, A. M. (1994), *Qualitative data analysis: An expanded sourcebook*, Thousand Oaks CA: Sage.
- Morin E. (1990), *Science avec conscience*, Le Seuil, Coll. Points Sciences, Paris.
- New, S. (2004), "Supply Chains: Construction and Legitimation", in New, S and Westbrook, R. *Understanding Supply Chain: Concepts, Critiques and Futures*, Oxford University Press, Oxford, U.K., pp.69-108.
- Sanchez Rodrigues, V., Piecyk, M., Potter, A., McKinnon, A., and Edwards, J. (2010), "Assessing the Application of Focus Groups for Collecting Data in Logistics", *International Journal of Logistics: Research and Application*, Vol. 13, No. 1, pp. 75-94.
- Skott-Larsen, T., Schary, P.B., Mikkola, J.H. and Kotzab, H. (2007), *Managing the global supply chain*, 3rd edition, Copenhagen Business School Press, Liber, Denmark.
- Slack, N., Brandon-Jones, A. and Johnston, R. (2016), *Operations Management*, Pearson, 8th ed., London.
- Srai, J. (2017), Mapping industrial systems - a supply network perspective on enabling technologies, processes and actors, *International Journal of Manufacturing Technology and Management*, Vol.31, pp.82-99. <https://doi.org/10.1504/IJMTM.2017.10002927>

- Star, S.L. et Griesemer, J.R. (1989), "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39", *Social Studies of Science* (Sage Publications, Ltd.), Vol.19, n°3, pp.387-420.
- Star, S.L. (2010), "This is Not a Boundary Object: Reflections on the Origin of a Concept", *Science, Technology, & Human Values*, Vol.35, No.5, pp.601-617.
- Stevens (1989), "Integrating the supply chain", *International Journal of Physical Distribution and Materials Management*, Vol. 9, No 8, pp. 3-8.
- Tell, F., Berggren, C., Brusoni, S., Van de Ven, A. (2017), *Managing Knowledge Integration Across Boundaries*. Oxford University Press, Oxford, UK.
- Voss, C., Tsikriktsis, N. and Frohlich, M. (2002), "Case research in operations management", *International Journal of Operations and Production Management*, Vol.22, No.2, pp.195-219.
- Wichmann, P., Brintrup, A.Baker, S., Woodall, P. and McFarlane, D. (2018), "Towards automatically generating supply chain maps from natural language text", *IFAC PapersOnLine* 51-11, pp.1726–1731.
- Zeiss R., Groenewegen P. (2009), "Engaging Boundary Objects in OMS and STS? Exploring the Subtleties of Layered Engagement", *Organization*, Vol.16, No.1, pp.81-1

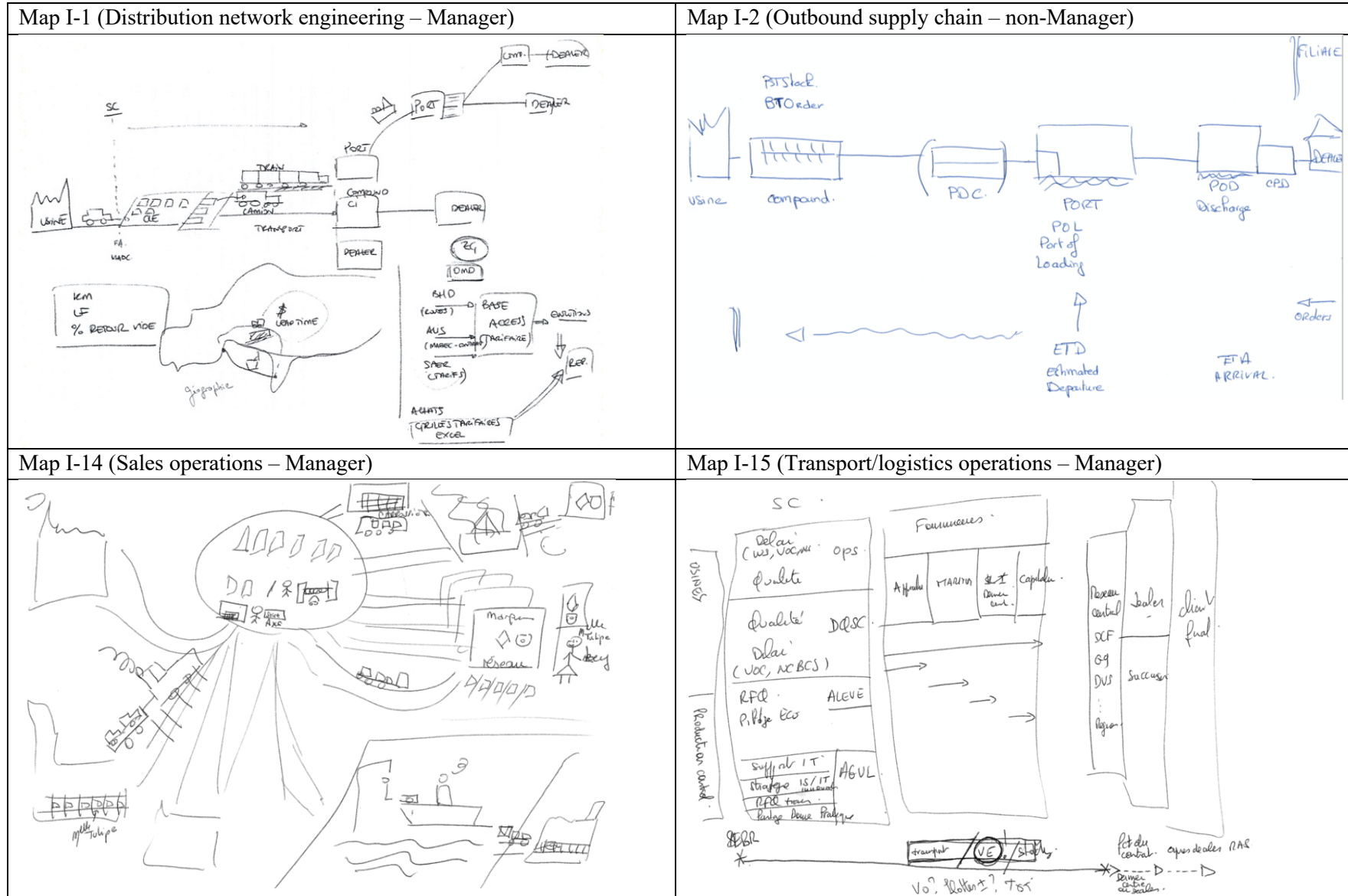
Table 1 – Three approaches to frame SC mapping in SCM

	SCM & SC mapping	Network picture	Boundary Object
What is in the map?	Representation of what the SC <i>is</i> (the territory)	Mental individual <i>representation</i> of the SC	What is <i>needed</i> to work and reach the shared goal, what is “at stake” for each “social world”
Underlying philosophy	Positivistic	Interpretive	Constructivist
Mapping perspective	Outside, from who has the power or wants the SCM power	Individual (the person)	Social (heterogeneous groups at work) => a meso perspective
Main managerial approach	Top-down	Bottom-up	Iterative
How many map(s)?	A one-size-fits-all, standardised map	Many individuals’ mind maps	Not one but various BOs, a system of BOs
What the map represents	What a SC should be, therefore there are implicit assumptions to unveil	Individual idea of what the relevant SC is, looks like, and how it works	An enacted common ground for coordinating the groups’ work in the absence of consensus
About the context	Stable enough SC to fix a standardised map	What is perceived when mapping	Evolving working situation, temporary BOs
Implicit objective behind mapping	Build a “common” (homogeneous) vision of the SC	Understand individual perceptual representation of the network	Have a common ground for work despite different representations of the SC
Main unit(s) of analysis	SC , organizations	Persons (individual), network	Social groups , organisations, SC
Choices when mapping depend on...	The study objectives, the message to be delivered (power)	The vision of the person who maps	What is at stake for the different group in the work performed to reach the shared goal
Main use	To help understand the territory (i.e. the SC), provide a common representation.	To share the representations of “actors in the field”, to have conversations about SC and SCM	To form a common ground for work (an infrastructure) to coordinate heterogeneous social worlds
Standardisation / mapping convention	Need for a mapping convention (global).	No convention is needed. Convention is counterproductive.	Need for standardisation linked to the situation and the needs of the work to perform.
About the different “viewpoints”	There are different possible viewpoints. One needs to be adopted and become “the viewpoint”.	There are different viewpoints. Each viewpoint is important.	There are different viewpoints, it is not a problem. BOs can/should maintain this diversity.
Making a SC map is	An effort to prepare, useful once made.	A creative and reflexive individual tool.	An endless process, an output of the coordination and a work in progress. Some BOs, like maps, need time and effort.
Main references	Hines and Rich (1997), Gardner and Cooper (2003), Lambert <i>et al.</i> (2008), Eriksson (2003),	Henneberg <i>et al.</i> (2006 and 2010), Geiger and Finch (2010), Meyer <i>et al.</i> (2013)	Star and Griesemer (1989), Henderson (1991), Star (2010), Carlile (2002 and 2004), Zeiss and Groenewegen (2009)

Table 2 – Results of Step 1 (coding of the content of the 18 maps)

Category of item	Items represented on respondents' maps	Respondent n° (total = 18 respondents)																		Total	%
		15	1	3	12	4	6	9	14	2	16	11	13	8	5	17	18	10	7		
Place	Manufacturing plant	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	16	89%	
Place	Warehouses (CLE), platforms (PDC), ports	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	15	83%	
Actor	Renault Dealer (customer)	1	1	1	1	1	1	+/-	1	1	1	1	1	1	1	+/-	0	0	14	78%	
Tool/Resource	Means of transport (trucks, ships etc.)	1	1	+/-	1	1	1	1	1	0	0	1	0	0	0	1	0	0	9	50%	
Flow	Physical flow (1 if arrows)	1	1	1	1	+/-	+/-	+/-	+/-	+/-	1	1	+/-	1	+/-	+/-	+/-	1	+/-	8	44%
Place	Points of tracking	0	0	1	1	1	0	1	0	0	1	0	1	1	0	0	0	0	7	39%	
Flow	Car	0	1	0	0	1	1	0	1	0	0	0	1	0	0	1	0	0	6	33%	
Objective	Performance (CO2, cost, quality, satisfaction, etc.)	1	1	0	1	1	0	0	+/-	0	1	0	0	0	0	0	0	0	5	28%	
Flow	Time, leadtime...	1	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	5	28%	
Activity	Operations done on cars (in logistics centres)	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	1	0	4	22%	
Actor	End-user (who buys the car)	1	0	0	1	0	0	+/-	1	0	0	0	1	0	0	0	+/-	0	4	22%	
Actor	Organizational boundary (intra Renault group)	0	0	1	0	0	0	1	0	1	0	1	+/-	0	0	0	0	0	4	22%	
Actor	Logistics suppliers + other suppliers	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	3	17%	
Tool/Resource	Information system (IS)	1	1	1	0	0	0	0	0	0	0	0	0	+/-	0	0	0	0	3	17%	
Flow	Information flow	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	3	17%	
Tool/Resource	Computer (IT)	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	11%	
Decision	Impacts on outbound SC of prior decisions	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	2	11%	
Place	Geography (spatial)	+/-	1	0	0	+/-	0	+/-	+/-	+/-	0	0	0	0	1	0	+/-	0	2	11%	
Decision	Planning (production, SCM) in Renault	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	6%	
Event	Hazards	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	6%	
Number of items represented on respondents' maps (max = 20 items)		11	10	9	9	8	8	8	8	7	7	6	6	5	4	4	3	1	0	114	
		55%	50%	45%	45%	40%	40%	40%	40%	35%	35%	30%	30%	25%	20%	20%	15%	5%	0%		
Legend :												%									
(1) The item is represented on the respondent's map												%		[75%							
(0) The item is not represented on the respondent's map												%		[50, 75[
(+/-) The item is implicitly represented on the respondent's map												%		[25%, 50%[
In calculating the total, +/- = 0												%		25%[

Appendix – Selection of Maps



Supplementary file – Two Tables – Result of coding Step 1 – 2 – 3

Difference between maps (step 1) and discourses during drawing (step 2); and definition of SC (step 3)

Difference between maps (step 1)		and the discourse during mapping (step 2)			and the definitions of what the outbound SC is (step 3)	
		Step 1	Step 2	Difference step 1 vs. 2	Step 3	Difference step 1 vs. 3
Place	Manufacturing plant	16	16	0	17	1
Place	Warehouses (CLE), platforms (PDC), ports	15	17	2	16	1
Actor	Renault dealer (customer)	14	15	1	15	1
Tool/Resource	Means of transport (trucks, ships, etc.)	9	14	5	16	7
Flow	Physical flow	8	8	0	11	3
Place	Points of tracking, traceability	7	6	-1	9	2
Flow	Cars	6	16	10	18	12
Objective	Performance (CO2, cost, quality, satisfaction, etc.)	5	10	5	13	8
Flow/objective	Time, leadtime...	5	12	7	13	8
Activity	Operations done on cars (in logistics centres)	4	6	2	10	6
Actor	End-user (who buys the car)	4	8	4	10	6
Actor	Organizational boundary (intra RG)	4	6	2	16	12
Actor	Logistics suppliers + other suppliers	3	10	7	15	12
Tool/Resource	Information system (IS)	3	6	3	9	6
Flow	Information flow	3	2	-1	6	3
Tool/Resource	Computers (IT)	2	3	1	9	7
Decision	Impacts on outbound of prior decisions	2	3	1	4	2
Place	Geography (spatial)	2	13	11	13	11
Decision	Planning (production, SCM, logistics) in Renault	1	7	6	11	10
Event	Hazards	1	6	5	11	10
Total		114	184	70	242	128
	% of interviewees having explicitly drawn (step 1) or explicitly talked about (step 2) each item, or explicitly integrated the items in their SC definition (step 3)		[75%			
			[50, 75[
			[25%, 50%[
			25%[

Items found at each step of the coding process

Category of item	Step 1: items found in maps	Step 2: additional items from discourses	Step 3: additional items from SC definitions
Place	Manufacturing plant	Boundaries of/within outbound SC	Points of quality control (for cars)
	Warehouses (CLE*), platforms (PDC*), ports		
	Points of tracking (traceability)		
	Geography (spatial, countries...)		
Actor	Logistics suppliers + other suppliers		Role/importance of contracts
	Renault dealer (customer)		Political/relational aspects in the SC
	End-user (who buys the car)		Cross-boundary relations between actors in the SC
	Organizational boundary (intra RG)		
Tool/Resource	Means of transport (trucks, ships, etc.)		Importance of standards
	Computer (IT)		
	Information system (IS)		
Flow	Flow of cars	Link between information and physical flow	Link between physical flow and financial flow
	Physical flow		
	Information flow		
	Time		
Objective	Performance (CO ₂ , cost, quality, satisfaction, etc.)	Time keeping: on time delivery, lead-time	
Activity	Operations done on cars (in logistics centers)	Transfer (of responsibility)	Management of supplier network
		Process (related to outbound SC)	
Decision	Planning (production, SCM, logistics) in RG	Dynamic piloting (thanks to traceability)	
	Impact on outbound SC of prior decisions		
Event	Hazards (in transport or logistics)	Security event (IS hacking)	
Total	20 items represented in maps	7 additional items from discourses (total 27 items mentioned)	7 additional items from SC definitions (total 34 items mentioned)

*: RG acronyms