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Supply chain integration in B2B companies : leveraging downstream actors to address sustainability challenges in the context of the IoT

Justine Marty

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THÈSE

Pour obtenir le grade de

DOCTEUR DE L'UNIVERSITÉ GRENOBLE ALPES

Spécialité : Sciences de Gestion

Arrêté ministériel : 25 mai 2016

Présentée par

Justine MARTY

Thèse dirigée par **Blandine AGERON**, Université Grenoble Alpes
et co-encadrée par **Ludivine CHAZE-MAGNAN**, Université
Grenoble Alpes

préparée au sein du **Laboratoire Centre d'Etudes et de
Recherches appliquées à la gestion**
dans l'**École Doctorale Sciences de gestion**

**Intégration de la chaîne d'approvisionnement
dans les entreprises B2B : Tirer parti des
acteurs aval pour relever les défis de la
durabilité dans le contexte de l'IoT**

**Supply chain integration in B2B companies:
leveraging downstream actors to address
sustainability challenges in the context of the
IoT**

Thèse soutenue publiquement le **10 octobre 2022**,
devant le jury composé de :

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ABSTRACT

Climate change issues are now at the centre of everyday life for people, countries, governments and companies. The Internet of Things (IoT), microelectronics and nanotechnology industries constitute a fairly recent sector that has been widely targeted for its environmental and ethical impacts. The devices associated with this sector are present in many households and exchange information with each other; they can be phones, cars, watches, or headphones amongst many others. Nanotechnology also plays a role in the context of the ecological transition - it can be found in electric cars, solar panels and wind turbines. To manufacture such devices, numerous raw materials are required, including rare metals, critical metals, rare earths and conflict metals. All these metals have significant environmental and ethical impacts during extraction and throughout the manufacturing value chain of the IoT. Moreover, consumers and companies alike are increasingly aware of the significant effort required to address sustainability issues. Customers, consumers and users are increasingly playing a role in the supply chains of companies and are becoming actors of change by proposing more sustainable solutions for both products and processes. However, although it is relatively easy to integrate these consumers into B2C companies, who are close to consumers, this thesis focuses on supply chain integration in B2B companies, and more precisely, on leveraging downstream actors to address sustainability challenges in the context of the IoT. To deal with this problematic, an article-based thesis is proposed. The first article is a bibliometric analysis that attempts to observe the evolution of the literature concerning the integration of downstream actors into the SC, thereby allowing the sustainability dimension to be highlighted. The second article, presented in the form of a systematic literature review and presenting a comprehensive framework, seeks to find out how to integrate these downstream actors in relation to companies' objectives and processes. Finally, the third article is a case study on rare metals that aims to understand how companies in the nano- and micro-electronics sector that are evolving in a B2B system can integrate their downstream actors.

Keywords: Sustainable Supply Chain Management, Supply Chain Integration, Downstream actors, IoT

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PART I: GENERAL INTRODUCTION

The first part of this thesis provides a general introduction regarding the integration of downstream actors into the supply chain to address sustainability challenges in the context of the IoT. Part I introduces the topic. A contextualization is presented in the first chapter relating to the IoT, which is an area that requires further study. The motivation for the research, the problematic and the research questions are presented, as well as the architecture of the research. The second chapter of Part I provides the literature review on the subject of this thesis. This literature review first addresses the issue of sustainability in SCM and related challenges. It then questions the concepts around the integration of downstream actors, first by detailing the integration through the connection and engagement of downstream actors, and then by explaining the differences between downstream actors, namely, customers, consumers and users, as well as the different methods for integrating these actors. A third chapter is devoted to the methodology of this thesis, namely, the quantitative approach for the bibliometric and systematic analysis, and the qualitative approach for the field research. A general outline is presented at the beginning of each part and chapter to underline the main thread of this thesis.

PART I: GENERAL INTRODUCTION		
Chapter 1 Contextualization of the research topic	Chapter 2 Literature review	Chapter 3 Methodology
PART II: ARTICLES		
Chapter 4 Consumer/user/customer integration in Supply Chain Management: a review and bibliometric analysis	Chapter 5 Connecting the customer to the supply chain: proposition of a conceptual framework	Chapter 6 Making supply chains more sustainable through customer and consumer engagement: the case of rare metals
PART III: GENERAL CONCLUSION		
Chapter 7 Discussion of the results	Chapter 8 Contributions	Chapter 9 Limitations and future research

Chapter 1. *Contextualization of the research topic*

Chapter 1 presents the contextualization of the research topic by introducing the main subject and the context in which this thesis evolves. Subsequently, motivations for this research, the problematic and associated research questions are presented, alongside an outline of the research architecture.

This thesis deals with the context of the IoT. To address the issues arising from this context, the ‘Need for IoT’ project emerged to meet both industrial and academic needs. Hence, this thesis is part of the Need project, which has a much broader reach than the questions raised in this research in relation to the integration of downstream actors in SCM within the IoT context. However, it nonetheless seems essential to detail the vision and objectives of the Need project, because they are part of the reasoning and thread of this thesis, whilst the thesis results feed into several approaches initiated by the Need project. The Need project focuses on the theme of a sustainable IoT. Its main objective is to develop methodologies that can be applied to research, taking into account geopolitical issues, economic analysis, sustainability of proposed new technologies, and their acceptance. By tackling components, technical

and technological processes, methodologies and innovation, the Need project also aims to propose a global design for IoT products in order to avoid the risks linked to the supply of certain key materials (such as rare metals), excessive price variations and changes in regulations. The Need project also aims to address design challenges, focusing on the possibility of substituting or replacing certain materials essential to IoT applications. Similarly, for the functions of these applications, alternative physical approaches are intended to be used to achieve the same functions but in a sustainable way. The four priorities of the project are:

- From a supply chain point of view, to identify the precise risks concerning the IoT (including the supply chain risks of rare metals).
- From a design point of view, to substitute critical metals with more sustainable options (more abundant or less critical metals), while keeping the same level of functionality.
- From a design point of view, to reduce the need for rare metals if substitution is not possible, or find ways to reuse some of the critical elements (such as rare earths) during the manufacturing cycle.
- Deployment of alternative physical principles with a sustainable approach to achieve already existing functions.

Thus, this thesis fits into the framework of the Need project in relation to supply chain management (SCM) and the integration of downstream actors in order to respond to the sustainability challenge.

1. Context

This thesis is part of the multidisciplinary project, the Cross Disciplinary Program (CDP) Need for IoT. The Need approach is based on the three pillars of sustainable development, namely economic, environmental and social. Need's philosophy is that issues related to these three pillars interact significantly with technological innovations and research. The Need project has a truly interdisciplinary vision; its objective is to mix the different fields of research such as SCM, organizational science, innovation, and technology to encourage interaction, dialogue and feedback. The idea behind it is to propose new IoT technologies whilst adopting a more sustainable perspective,

by better understanding different research practices. Overall, the objective is to anticipate the impact of the IoT by proposing a new sustainable vision of electronics. This cross-disciplinary project was initiated in response to the current context of new technologies, digital uses and the issues arising from them. This project is innovative in that, to date, there is still little research on this subject in Europe and particularly in France. And yet, this topic is crucial, and will become even more so in the future, mainly with regard to sustainability issues.

In a context where digitalization and IT are increasingly present, implying a rising and exponential demand for IoT as well as for rare metals, consumer uses for the IoT need to be analysed. Indeed, in an environment where the manufacturers of the IoT are extremely distant from the final consumers (due to their B2B market positioning), their primary objective is always to improve the technology of the IoT, by making it ever more efficient. Nevertheless, the question of use is essential. Indeed, sometimes the proposed technology goes far beyond the needs of consumers and the final product is used in a primary way whereby the user does not fully exploit its capabilities. Hence, we must ask whether it is necessary to propose very technologically advanced products, with advanced technologies that rely more and more on the use of rare metals? How can this question be answered? These mismatches between real-life uses, ever-increasing technology, and the distant relationship between B2B companies and consumers have led to reflection through the prism of SCM. An end-user perspective that involves questioning the integration of downstream actors, i.e., customers, and especially consumers and users, has therefore been adopted.

Thus, to address these issues, this thesis focuses on the integration of consumers in the SCM of B2B companies. In fact, the consumer can bring a lot of information, know-how and knowledge to companies. When the question of usage arises, is the consumer not the first to be concerned, and therefore the one who could indicate avenues for future investigation? Particularly if we bear in mind that this consumer is increasingly committed to sustainability, and is more and more aware of environmental, social and ethical issues. The aim of this thesis then is to find

possible ways in which companies using rare metals can propose more sustainable products or processes through the integration of downstream actors. In this regard, several research questions have emerged leading to a global problematic, which will be tackled following the literature analysis and a field study.

The importance of integration is a topic that has been studied for many years but is gaining increasing prominence in both the literature and with companies. As presented by Van der Vaart and van Donk (2008), there is a significant link between integration and performance. There are many factors of performance that lead companies to set up an SCI. For example, the factors may be “long-term orientation”, “joint responsibility”, “relationship commitment”, “information sharing”, “behavioural transparency” but also, “customer service management”, “integration with customers”, “external collaboration” (Van der Vaart and van Donk, 2008, p. 46). The factors connected to performance of particular relevance to this research are related to customers and their integration, and collaboration with the customer. However, performance is not the only objective that drives the implementation of SCI - risk management, innovation and sustainability can also be factors in the development of SCI. As previously mentioned, there are different types of SC performance, such as logistic performance, operational performance, quality performance, service performance, and financial performance (Aktas et al., 2021; Christopher, 2016; Chuang, 2001; Droge et al., 2004; Esper et al., 2003; Fabbe-Costes and Jahre, 2008; Flynn et al., 2010; Frohlich and Westbrook, 2002, 2001; Hertz and Alfredsson, 2003; Huang and Ardiansyah, 2019; Kim, 2017; Narasimhan and Kim, 2002; Thomé et al., 2014; Vickery et al., 2003; Xue et al., 2013; Yao, 2017; Yildiz et al., 2016; M. Zhang et al., 2019; Zhao et al., 2015). But it is also possible to set up an SCI for risk reduction purposes (Jajja et al., 2018; Norrman and Jansson, 2004; Peck, 2006; Tang, 2006; Wagner and Bode, 2008), or for innovation (for the development of new products, or for technical innovations, or innovation in terms of quality) (Adebanjo et al., 2018; Koufteros et al., 2005; Zainol et al., 2019, 2016; Zhu et al., 2017; Zogaj and Bretschneider, 2012), or for sustainability innovation (Barbosa-Póvoa et al., 2018; Berg et al., 2018; González-Ramos et al., 2018; Luthra et al., 2015; Plaisier et al., 2019; Russo et al., 2014; Seuring et al., 2008, 2008; Sul

and Lee, 2020; Vachon and Klassen, 2006; Xing et al., 2017; Zhang and Awasthi, 2014, 2014; Zimmerling et al., 2017). In the framework of this thesis, the primary motivation for the integration of downstream actors relates to risk reduction, but particularly innovation and sustainability. These themes will be addressed in depth in part 2 of this manuscript, mainly articles 2 and 3, corresponding to chapters 5 and 6.

All internal or external members (customers, consumers or suppliers) of SCs have a role to play in companies (Ataseven and Nair, 2017; Flynn et al., 2010; Khan and Wisner, 2019). In this regard, the motivation for this research is to look at the integration of customers and consumers. It is important to stress that numerous analyses are available in the literature regarding integration with external actors such as suppliers, highlighting the advantages of integration, such as better performance and improvement in the development of new products or in terms of sustainable development (C. W. Lee et al., 2007; Lo et al., 2018; Petersen et al., 2005; Rich and Hines, 1997; Walton et al., 1998; Zhang et al., 2016). Downstream integration has also been widely studied, including the integration of logistics processes (Stank et al., 2001a) and the integration of customers (Alshurideh et al., 2019; Griffin and Hauser, 1993; Morash and Clinton, 1998; Van Donk and Van Doorne, 2016), but also of consumers and users in the development of new products (Alicke et al., 2017; Bosch-Sijtsema and Bosch, 2015; Halassi et al., 2019; Leminen et al., 2012; Panda and Satapathy, 2021). The most recent research focuses on the impact of integration in terms of sustainability, thereby connecting with our own research objectives (Lo et al., 2018; Taghikhah et al., 2019; Zhou et al., 2020).

It would seem difficult today to build a robust supply chain without integrating a majority of the actors, whether upstream suppliers or downstream distributors, transporters, customers, consumers and users. The integration of all these actors can help to reduce or share risks, improve collaboration to ensure the fluidity and quality of information, improve the overall quality of products and services offered by a company, and find more sustainable opportunities in a context that today is fraught with environmental challenges (Jajja et al., 2018; Lo et al., 2018; Panda and Satapathy, 2021; Taghikhah et al., 2019; Zhou et al., 2020).

However, B2B companies do not have direct contact with their consumers, and as a result have difficulties integrating these actors. Moreover, sometimes they do not have the necessary keys, so there is a difficulty for companies to integrate the consumer, and above all, to adopt the method that seems to be the best adapted and most relevant to their objectives, which can be varied (risk limitation, quality improvement, innovation, sustainability, etc.). Different integration methods exist to integrate both upstream and downstream actors. For downstream actors (which is the focus of our research), methods such as Voice of Customer, living lab, crowdsourcing, user toolkits, and lead users are methods that can be used depending on the expectations of the company. These different methods have been briefly discussed in the introduction and will be further addressed in part two of this thesis, in article 2, corresponding to chapter 5 (V. E. Castillo et al., 2018; Franke and Piller, 2004; Jeppesen, 2005; Rese et al., 2015; Schuurman et al., 2016; Shin, 2019; Spinuzzi, 2005; Von Hippel, 2001; Voytenko et al., 2016; Wu et al., 2015; Zimmerling et al., 2017). The topic of integration methods is interesting as research increasingly shows that it is important to integrate these downstream actors, even for B2B companies (Lacoste, 2016). And it seems very relevant to propose ways in which B2B companies, especially those closely related to the IoT and rare metals, can use these methods in order to propose a more sustainable SC (Griazev et al., 2016; McLellan et al., 2016; Sauer and Seuring, 2017). This research focuses on downstream actors as it seems that it is more complicated to integrate them when the company studied is upstream. The aim is to observe how these companies manage to integrate them, and to propose methods that could be beneficial according to companies' expectations. The IoT sector, and particularly companies using rare and critical metals which are extremely remote from their consumers in the chain, are especially relevant. Indeed, it is a sector that is developing extremely rapidly and the demand for connected objects is constantly growing. Furthermore, this sector is interesting due to the various issues surrounding the use of these metals (Griazev et al., 2016; McLellan et al., 2016; Moats et al., 2021; Rauer and Kaufmann, 2015; Sauer and Seuring, 2017; Son et al., 2018). Multiple challenges, unknown to consumers, relating to geopolitical, commercial, environmental or ethical issues are at the core

of this field. As explained in the Need project, the issue of sustainability is central to this thesis and is critical to the world today and the challenges of tomorrow. The integration of downstream actors, i.e., customers, consumers and users, in SCM in this sector is worthy of close attention, as it could enable more sustainable opportunities through different integration methods.

2. Topical subject

2.1 Current situation

The Covid-19 crisis has highlighted the supply challenges faced by some countries (Al-Mansour and Al-Ajmi, 2020; El Baz and Ruel, 2021; Geitzholz, 2021). Indeed, the various supplies coming from China or from some other countries have been disrupted. France, in particular, has had difficulties in obtaining supplies of products essential to the health sector such as masks, gloves, hydro-alcoholic gel, and gowns (Geitzholz, 2021). This period has therefore emphasized developed countries' dependence on other countries, for example, France is dependent on China for active substances and on India for finished medicines. Indeed, thirty years ago, only about 30% of the active ingredients in the health sector were produced outside Europe, compared to 80% today, underlining the country's high dependence on China and India (Geitzholz, 2021). Supply disruptions have not only affected the sanitary market, but also the wood, textile, automotive, transport equipment, computer and electrical sectors (Geitzholz, 2021). The automotive sector is experiencing a crisis, especially in relation to semiconductors, with some manufacturers stressing the importance of relocating factories to Europe. Renault now intends to maintain a very close relationship with the French chip supplier STmicroelectronics in order to secure the supply of semiconductors, which is essential in car production (Auto Journal, 2021). These supply shortages are not only an industrial issue, but also a strategic issue for governments. This is why France has chosen to inject a loan of 700 million euros into industry in order to regain sovereignty in multiple fields such as technology (Normand, 2021). France wishes to recover its technology sovereignty, launching the "Nano 2022" project to preserve control of technologies necessary for the industrial and defence sectors. France already has two key players, namely,

STMicroelectronics and Soitec. Nevertheless, France intends to invest massively in this sector, both in its own right and alongside Europe (Lefigaro, 2021), by setting up an investment plan, “France 2030”, investing 30 billion euros to enable France to achieve its energy and digital transition, while remaining competitive on the industrial level (Ti, 2022).

As previously stated, this thesis focuses on the IoT sector. To understand what the IoT is, it is first necessary to explain microelectronics and nanotechnology. Microelectronics is concerned with the research and manufacture of electronic components at the micrometre scale, and includes basic semiconductor physics and semiconductor devices such as resistors, capacitors, and P-N diodes, among others (Yang, 1988). Nanotechnology is defined as “the understanding, control, and restructuring of matter on the order of nanometres (i.e., less than 100 nm) to create materials with fundamentally new properties and functions” (Sanchez and Sobolev, 2010, p. 2061). As explained by Lundstrom (2002, p. 4), “nanoelectronics is not simply a smaller version of microelectronics; things change at the nanoscale. At the device level, silicon transistors may give way to new materials such as organic molecules or inorganic nanowires”; this allows the emergence of new technologies. Nanotechnology is increasingly present in our society. These extremely small materials are nevertheless highly powerful and have particular properties that can be especially beneficial in several sectors such as health or the automotive industry. They are also present in the renewable energy sector, in solar energy, hydrogen energy, wind energy and wind turbines (Hussein, 2015). Nanotechnology is also present in cars, electric cars, and in the batteries of electric cars, as well as in the batteries of everyday objects such as computers, smartphones, and others. Indeed, nanotechnology is essential to the electronic components that can be found in smartphones (for screens, cameras, batteries, memories, etc.), computers, and other connected objects. These connected objects are also called the IoT (the Internet of Things). The phenomenal growth of the Internet of Things (IoT), referring to objects that are able to communicate with each other, has required an increase in the use of basic raw materials, which are metals; due to the metals’ properties, these objects can be connected and become electronic devices. These connected objects are increasingly present in the home -

they can be connected fridges, smart TVs, and connected watches, among others. A study conducted by Avast (Elder, 2019) indicates that in Western Europe, 57% of households have at least one IoT device. Overall, “the number of IoT devices today has officially surpassed the world’s population, and that number is only going to grow”, states Deepali Garg, Senior Data Scientist at Avast (Elder, 2019, p. 1).

Many different raw materials, i.e., raw natural resources, are needed to manufacture these objects. In the case of the IoT, these raw materials include metals from rocks. These metals, all of which are present in the periodic table of elements, have physical characteristics and specificities that differentiate them from a technical point of view. Beyond these physical characteristics, they can be classified according to their scarcity, their supply risks, their high concentration in restricted geographical areas, or their environmental and ethical impacts. And in the case of the IoT, due to its exponential growth, the need for certain types of metal is problematic. Indeed, the metals essential to the functioning of these IoTs are considered rare metals, meaning that they involve supply risks, or environmental or ethical risks (Mossali et al., 2020; Quinteros-Condoretty et al., 2021; Van den Brink et al., 2020). That nanotechnology and the IoT are partly composed of rare metals raises issues in terms of sustainability, as climate change issues are now at the centre of everyday life on Earth. The objective of reducing CO₂ emissions has been at the core of discussions for many years now. It is generally accepted that the promotion of renewable energies is essential. In the field of transport, electric cars seem to be one of the opportunities available to limit “global warming by reducing greenhouse gas (GHG) emissions” (Quinteros-Condoretty et al., 2021, p. 73; Zackrisson et al., 2010).

On September 22, 2020, ‘Battery Day’ was held, whereby entrepreneur Elon Musk made a significant announcement about his electric car company, Tesla. Considered by many to be a visionary as well as a billionaire, Musk put the electric car on the road to fame, and is constantly coming up with more efficient cars. On Battery Day, he presented the new technological innovations that he plans to bring to his electric cars by 2022. The major innovation is obviously the autonomy of the car and its power source. However, an important point was also raised concerning the

environment. Indeed, for the last five years, electric cars and particularly batteries, have been the subject of controversy in relation to the environment and ethics. The IoT's components in these vehicles are nanotechnology devices which contain rare metals, rare earths and critical metals, such as cobalt or lithium.

Lithium, for example, is used in electric car batteries, known as Lithium-Ion Batteries (LIB). These lithium batteries are used in electric cars “due to their high energy density for weight, reduced memory effect and significant number of supported charging/discharging cycles.” (Mossali et al., 2020, p. 1). But this metal creates certain problems, for example, the extraction has a very high environmental impact and a very large quantity of water is necessary during the mining process (Mossali et al., 2020). Another important issue with lithium batteries is their recycling and end-of-life management, in fact, “less than 3% of LIBs are recycled in the world” (Han et al., 2019; Mossali et al., 2020, p. 4; Quinteros-Condoretty et al., 2021; Zackrisson et al., 2010). Moreover, this metal is mined in very restricted geographical areas: “lithium is mainly extracted from two types of sources: 32% from hard rocks (e.g., Australia and China) and 46% from brine (e.g., Argentina, Bolivia, Chile)” (Mayyas et al., 2019; Olivetti et al., 2017; Quinteros-Condoretty et al., 2021, p. 74).

The increasing demand for this metal due to the exponential growth of electric vehicles, but also of all devices requiring batteries, is a real problem, not least because “global battery demand is expected to double between 2024 and 2025 while the growth of lithium production is 3–5% annually” (Quinteros-Condoretty et al., 2021, p. 74) and “lithium-ion battery demand, particularly for electric vehicles, is projected to increase by over 300% throughout the next decade” (Fu et al., 2020, p. 2). Major supply chain problems may occur, such as shortages, or “disturbances in material supply can lead to short-term supply gaps, which have the potential to create significant price volatility and commodity price uncertainty” (Olivetti et al., 2017, p. 233). Moreover, lithium is becoming a “strategic energy resource due to being a critical raw material for its high supply risk and economic importance in Europe” (Quinteros-Condoretty et al., 2021, p. 73). From a supply chain point of view, lithium poses several problems: the increasing demand may have an impact on the scarcity

of raw materials or their supply, the extraction and mining create environmental issues, the geographic distribution is highly concentrated, lithium price fluctuations will have knock-on impacts, and management of the recycling and end of life of the metal is underdeveloped (Egbue and Long, 2012).

The same applies to cobalt, which is used to improve the stability of the positive terminal of lithium-ion batteries. Cobalt is included in the list of conflict metals, which are usually tin, tantalum, tungsten and gold, referred to as the 3TGs (Fraser et al., 2020). These conflict metals are so called because they come from territories under tension. Cobalt is one of the metals on which it is important to focus in terms of sustainability challenges, working conditions, traceability and supply risk (Fraser et al., 2020). Like lithium, cobalt is present in lithium-ion batteries, and demand is growing exponentially: “demand for Co is estimated to range from 235 ktonnes to 430 ktonnes in 2030. This upper bound on Co demand in 2030 corresponds to 280% of world refinery capacity in 2016.” (Fu et al., 2020, p. 2).

The problem of geographical concentration is also very present for cobalt, which is highly concentrated in the Democratic Republic of the Congo (DRC), accounting for around 60% of world production, both for mining and refining (Fu et al., 2020; Jaffe, 2017). In addition to the fact that this high concentration may create geopolitical issues, a problem related to ethics and working conditions emerges with regard to cobalt in DRC (Fraser et al., 2020). According to Van de Brink et al., “Mining in Congo can be problematic from a social point of view [...] related to human rights violations and environmental negligence in the Katanga region of the Democratic” (2020, p. 2). Thousands of children work in a minority of illegal mines in the DRC and several dozen miners die every year in the mines due to accidents (Van den Brink et al., 2020). The lack of stricter regulation has an impact both in terms of the environment and the social aspect. Fu et al. state that “This unregulated, often unrecorded, practice has led to environmental, social, and health concerns particularly around land contamination, water pollution, child labour, and social unrest” (Fu et al., 2020, p. 4).

Lithium and cobalt are two metals whose concentration in the earth's crust is limited and therefore finite. As stated by Mossali et al. "... these sources are not endless, and it was predicted that in 2023–2025 the demand for Li will be greater than the mining supply, unless LIBs are not recycled with a 90% efficiency" (Mossali et al., 2020, p. 3). These two metals have in common that demand for them is growing exponentially, due mainly to the democratization of electric vehicles (Han et al., 2019; Olivetti et al., 2017), and to the use of lithium batteries (Van den Brink et al., 2020), whilst both are characterised by limited availability (Jaffe, 2017), limited regulations (Egbue and Long, 2012), environmental and ethical issues around extraction and mining (Fraser et al., 2020), a high concentration in restricted geographical areas, and major problems in terms of recycling and end-of-life management (Fu et al., 2020; Mayyas et al., 2019; Zackrisson et al., 2010).

To conclude, since he was aware of the problems connected with these metals, on September 22, 2020, at Battery Day, Elon Musk took the time to stress that he would like to progressively replace cobalt by nickel, whose extraction is less controversial and whose recycling is much simpler. He also suggested that lithium will be replaced by silicon, allowing the company to dispense with this rare metal in the first instance, but above all to reduce costs. Elon Musk's decision to reduce Tesla's need for rare metals will not only make the brand's supply chain more secure, but will also meet consumer expectations for a more environmentally friendly and less expensive car. For Tesla as for many other companies, supply chain and sustainability issues have become major challenges.

2.2 The supply chain sustainability challenges

The concept of sustainable SCM is not new. It has been around since the 1950s, previously known as physical distribution or logistics (LaLonde and Dawson, 1969), and has evolved considerably over the years. Today, it is all the more important that companies continue to expand their markets to reach consumers who are increasingly distant geographically, knowing that these same consumers have become more and more demanding and volatile (Christopher, 2016; Roy and Srinivasa Raghavan, 2014). Indeed, as Christopher (2016) explains, companies are becoming increasingly

large and include more and more players, he states that “a global company is more than a multinational company. In the global business materials and components are sourced worldwide and products may be manufactured offshore and sold in many different countries, perhaps with local customisation.” (Christopher, 2016, p. 18). This is the case with Tesla, which sources, manufactures and sells its cars all over the world.

In the definition of SCM, the notion of multiple actors is present. Mentzer et al. define SCM as a “set of three or more entities directly involved in the upstream and downstream flow of products, services, finances, and information from a source to the customer” (Mentzer et al., 2001, p. 4). The Council of SCM Professionals’ (CSCMP) definition, which also includes the different functions of sourcing and procurement, as well as the notions of coordination and collaboration with stakeholders or actors, stresses that SCM “encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers.” (Ballou, 2007, p. 338). Christopher points out that “the ultimate purpose of any logistics system is to satisfy customers.” (Christopher, 2016, p. 27). Hence, SCM is a set of processes that are managed by different actors in the chain, and “these processes are to be coordinated through collaboration and relationship management throughout the various echelons of the supply channel, from initial suppliers to end consumers.” (Ballou, 2007, p. 339). Nevertheless, these questions of SCM and of downstream actors (customer and consumer) were already being questioned in 1998 by Lambert et al. (1998). Ballou (2007) adopted the eight sub-processes of SCM proposed by Lambert et al. (1998), which are: “customer relationship management; customer service management; demand management; order fulfilment; manufacturing flow management; supplier relationship management; product development and commercialization; and returns management.” (Ballou, 2007, p. 333).

Of these eight sub-processes, the first two are of particular interest to this thesis. Indeed, it can be observed that from 1998 onwards, customer relations become more significant. From these different definitions, the question of the different actors in

the SC becomes central, as does the question of how to integrate these actors into SCM. This research assumes that integration goes beyond collaboration. According to the Cambridge dictionary, to collaborate means: “To work with someone else for a special purpose” (Cambridge dictionary). This definition focuses on the notion of working together, thus implying a prior integration of those people. As the notion of integration refers to the fact of adding someone to something (see Chapter 2, Section 2 for more details) in order to collaborate and work with an actor, that person has to be part of the chain first. In this research, it is the integration concept that is emphasised as it involves notions of exchange, relationship and bonding.

Concerning integration, many authors focus on the integration of upstream actors, including suppliers (Cassivi, 2006; Park et al., 2010; Petersen et al., 2005), downstream actors, including customers (Griffin and Hauser, 1993; Morash and Clinton, 1998; Rese et al., 2015), as well as internal and external actors (including suppliers and customers) (Flynn et al., 2010; Frohlich and Westbrook, 2001) into the supply chain. Power (2005) emphasizes that integration is a fundamental objective of SCM. To achieve this, it is necessary to transfer and share consumption data with upstream actors in the chain, allowing each actor to synchronize its production and supply activities, while taking into account the needs of the final consumers (Roy et al., 2006). But global integration seems difficult, as Ballou (2007) points out that few companies (barely 8%) were able to integrate suppliers upstream or the final consumer downstream. This can be explained by the position of the organization within its supply chain. Indeed, it would seem that the more the company operates in Business to Business (B2B) mode, which is very far upstream in the SC, the more difficulty it will have to integrate its final consumer, compared to a Business to Consumer (B2C) company operating downstream in the SC, because the B2B company is very far from the final consumer, with many different actors in between. Moreover, the B2B company often does not have direct contact with its final consumer at all. As Hoejmose et al. explain, “the nature of supply chain relationships varies significantly across business-to-business (B2B) and business-to-consumer (B2C) sectors.” (Hoejmose et al., 2012, p. 609). However, more recent studies underline the importance of a B2B company integrating its consumers (Lacoste, 2016), and

some authors indicate that the use of IT can help to achieve this further integration (Monroe and Barrett, 2019; Yu, 2015). In more general terms, this integration of downstream actors into SCM has become central to research (Gligor et al., 2020; Kim, 2017).

This integration of actors into SCM is often implemented to meet objectives. The objectives of this integration are numerous. In the literature, one of the objectives that often emerges is that of the performance of the supply chain (Droge et al., 2004; Fabbe-Costes and Jahre, 2008; Flynn et al., 2010; Frohlich and Westbrook, 2002, 2001; Narasimhan and Kim, 2002), including logistics performance, with, for example, the issue of the last mile (Aktas et al., 2021; Esper et al., 2003; Hertz and Alfredsson, 2003; Huang and Ardiansyah, 2019; Yildiz et al., 2010), operational performance, which can refer to planning, for example, or forecasting (Thomé et al., 2014; Yildiz et al., 2016), quality performance (Chuang, 2001; M. Zhang et al., 2019), service performance (Christopher, 2016; Vickery et al., 2003; Xue et al., 2013; Yao, 2017), and financial performance (Kim, 2017; Vickery et al., 2003; Zhao et al., 2015).

Integration can also take place to enable risk reduction in SCM, such as limiting the risk of supply disruptions (Jajja et al., 2018; Norrman and Jansson, 2004; Peck, 2006; Tang, 2006; Wagner and Bode, 2008), or to enable innovation (Adebanjo et al., 2018), for new product development (NPD) (Koufteros et al., 2005; Zhu et al., 2017; Zogaj and Bretschneider, 2012), technical innovations (of processes or products) (Zainol et al., 2016), or for innovation in terms of quality (Zainol et al., 2019).

Moreover, integration is increasingly used to address sustainability issues (Barbosa-Póvoa et al., 2018; Luthra et al., 2015; Seuring et al., 2008, 2008; Vachon and Klassen, 2006; Zhang and Awasthi, 2014). This integration can be highlighted for several sustainable objectives - product sustainability (Berg et al., 2018; Sul and Lee, 2020; Xing et al., 2017; Zimmerling et al., 2017), sustainability of processes (González-Ramos et al., 2018), including production and planning (Zhang and Awasthi, 2014), suppliers (Yazdani et al., 2016) distribution (Plaisier et al., 2019), and eco design (Russo et al., 2014).

Thus, integration has objectives in terms of performance, supply chain risk management (which is defined as the probability of disruption multiplied by the impact (Christopher, 2016), and innovation and sustainability (Fabbe-Costes et al., 2009; Flynn et al., 2010; Frohlich and Westbrook, 2001; Lau et al., 2010; Seuring et al., 2008; Vachon and Klassen, 2006; Zimmerling et al., 2017). For example, in the case of Tesla, it could be assumed that the integration of the actors could reduce the supply chain risks linked to rare metals. As the issue of supply of these metals is extremely present, integration could limit the risk of stock-outs or price volatility. From an innovation point of view, Tesla could integrate consumers to enable innovation in terms of materials and processes to offer more ecological cars, as they are planning to do in the coming years. This integration can be implemented through methods that may differ depending on the actor being integrated. Regarding the integration of downstream actors, several methods exist and are presented in this research, such as Voice of Customer, living lab, crowdsourcing, user toolkits, and lead users (V. E. Castillo et al., 2018; Franke and Piller, 2004; Jeppesen, 2005; Rese et al., 2015; Schuurman et al., 2016; Shin, 2019; Spinuzzi, 2005; Von Hippel, 2001; Voytenko et al., 2016; Wu et al., 2015; Zimmerling et al., 2017). This integration is essential to meeting the challenges of sustainability in SCM (Griazev et al., 2016; McLellan et al., 2016; Sauer and Seuring, 2017) as downstream actors can be a source of proposals for more sustainable products or processes in the SC that best meet their needs (Plaisier et al., 2019; Zimmerling et al., 2017).

The issue of the sustainable SC is essential in this context, since sustainability and the environment have become part of popular culture, integrated into the press, books and films. It was not until the 1990s that this approach was emphasised by the management sciences. Sustainability has been defined as “the use of resources to meet the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987, p. 8). Because this definition is broad, many authors have provided their own definitions to characterize the term. In the field of organization and SCM, the definition of sustainability is based on the three pillars - economic, environmental and social (Carter and Rogers, 2008). “While diverse comprehensions of sustainability exist, one central concept helping to operationalize

sustainability is the triple bottom line approach, where a minimum performance is to be achieved in the environmental, economic and social dimensions” (Seuring and Müller, 2008, p. 1,700). The literature on the subject has grown steadily since the 1990s, and the interactions between sustainability and SCM have been recognized as a key issue in the coming years (Ahi and Searcy, 2013; Brandenburg et al., 2014; Carter and Rogers, 2008; Gold et al., 2010; Pagell and Wu, 2009; Seuring, 2013; Seuring and Müller, 2008a). These highly successful authors in the field of sustainable SCM research have produced articles that have been cited hundreds to thousands of times in Google Scholar, and have been cited over 1,000 times and over 6,000 times respectively for the article by Seuring and Müller (2008) entitled “From a literature review to a conceptual framework for sustainable supply chain management”. They have also been cited more than 4,000 times for the article by Carter and Rogers (2008) entitled “A framework of sustainable supply chain management: moving toward new theory”. The topic continues to grow and more recent articles also focus on sustainability, for example, on specific topics such as the sustainable blockchain or the circular economy (Hussain and Malik, 2020; Paliwal et al., 2020; Saberi et al., 2019; Yadav et al., 2020). Nevertheless, authors have not been the only ones to take up the subject. Everyone is impacted on a daily basis by climate change, and sustainable development has therefore become a major and mainstream issue (Seuring and Müller, 2008b). This issue also arises for companies and for B2B companies that are distant from their downstream actors, as Hojmosse et al states, that there is an “increasing pressure for marketing and supply chain practitioners in B2B settings to improve their environmental practices. Not only to respond to external pressure, but also because it is generally accepted that GSCM [Green Supply Chain Management] can improve firm performance” (Hojmosse et al., 2012, p. 609). Similarly, the issue also arises from a consumer perspective. Consumers are conscious of environmental and ethical issues. As a result, companies must respond to their new expectations in terms of sustainability (Seuring et al., 2008). As shown in marketing research, the consideration of consumer needs has largely evolved; whereas before, the objective was to sell and distribute products to consumers in an efficient way, this is no longer the case, as “this conventional mainstream was being challenged on several fronts

including its failure to address marketing's socio-environmental impacts" (Peattie, 2015, p. 2). Consumers are aware of the sustainability of the finished product, but are also concerned with the manufacturing process and the origin of raw materials, so the whole chain must be covered when implementing sustainable changes (Seuring et al., 2008), including in B2B companies, which are more and more implicated in these sustainability issues (Sharma et al., 2010).

2.3 Supply chain challenges in the context of the IoT

The internet is increasingly pervasive in consumers' lives, and individuals are making use of a growing number of connected or electronic objects, such as mobile phones, computers, televisions, and even smart watches (Madakam et al., 2015). As Bekara states, "An object can be any thing/device/entity equipped/embedded with computation, storage and communication capabilities with different capacities (sensor, actuator, mobile phone, desktop, laptop, printer, car, fridge, oven, etc.)." (Bekara, 2014, p. 533). The Internet of Things (IoT) refers to how these different objects communicate with each other through Wi-Fi or Bluetooth (Madakam et al., 2015). Another definition states that, "The Internet of Things (IoT) is the network of physical objects—devices, instruments, vehicles, buildings and other items embedded with electronics, circuits, software, sensors and network connectivity that enables these objects to collect and exchange data." (Gokhale et al., 2018, p. 41). The IoT is also present in cars, which are likewise becoming increasingly connected and intelligent (Rus et al., 2019). The materials and metals that compose the devices have exceptional properties, allowing the devices to be smaller, lighter and more powerful, enabled by nanotechnology (Farooq et al., 2015). There are connected objects in numerous fields, such as "clean energy, defence, healthcare, and electronics" (Gaustad et al., 2018, p. 1). The exponential growth in the use of all these products in the daily lives of the majority of the world's inhabitants has had a significant impact on the supply of these metals and their related issues (Gaustad et al., 2018; Han et al., 2019; Maniglier, 2020; Mossali et al., 2020; Pitron, 2018; Quinteros-Condoretty et al., 2021; Zackrisson et al., 2010).

Before one of these finished products reaches the hands of a consumer, a large number of manufacturing and processing steps have been taken around the world. As is the case with many products today, connected or otherwise, the supply chain for products is very extensive, involving many actors (Christopher, 2016; Gualandris et al., 2015; Mao et al., 2018). The actors include many suppliers who provide part of the raw materials, manufacturers who shape the products, and factories, all of which can be located on different continents (Christopher, 2016). Zhang et al. explain that the Co in lithium-ion batteries (LIB) comes from DRC mines, but the refining phase takes place in China (Zhang et al., 2017). Thus, the extended IoT supply chain includes several phases, including the extraction of raw materials, their transformation, the manufacture of semi-finished products, their distribution, then the manufacture and assembly of finished products, and their distribution throughout the world, including transport to the end consumer at each stage (Christopher, 2016; Walker et al., 2008). This extended supply chain may also include reverse supply chain steps to manage the end of life of the product, via reconditioning or recycling (Busse et al., 2017; Christopher, 2016; Walker et al., 2008).

In the case of the IoT, there are many steps required, from raw material extraction, to refining, to alloying products, to production, to assembling products, and then to distribution all around the world. Actors include suppliers, industrialists, manufacturers, packaging plants, transporters, wholesalers, distributors, customers, and final consumers and users (Wall et al., 2017). The growing demand for the IoT has an impact on all these stages of the SC. As explained for cobalt and lithium (Han et al., 2019; Olivetti et al., 2017), the procurement of these different metals has different impacts depending on the scarcity of the raw materials (Jaffe, 2017), thereby emphasizing the geopolitical conflict potential that arises from these materials being concentrated in certain areas. The ethical and ecological impacts of their manufacturing processes (Fraser et al., 2020) are amplified by limited regulation (Egbue and Long, 2012), and the limited opportunities for recycling and end-of-life management (Fu et al., 2020; Mayyas et al., 2019; Zackrisson et al., 2010).

Some authors have looked into these different challenges and proposed ways to limit SC issues for the IoT and the raw materials (rare metals) (Bakas et al., 2014; Eggert, 2011; Kasulaitis et al., 2021; Ku et al., 2018; Langkau and Tercero Espinoza, 2018; Massari and Ruberti, 2013; Zhang et al., 2017), such as diversification of the supply of resources (Ku et al., 2018). New mining operations are emerging in Australia, India, the United States, Russia and Kazakhstan, and processing plants, such as those in Malaysia, France and Estonia, can reduce rare earth dependency on China (Golev et al., 2014). Moss et al. (2013) recommend finding new opportunities to minimize shortages, by relocating primary production, but also by promoting recycling and limiting waste creation, while looking for substitute metals. To this end, they suggest that some countries or regions such as the United States and the European Union encourage local mining, as well as the recycling or reuse of metals from IoT devices, while promoting the efficient use of critical metals and promoting Research and Development (R&D) for alternative products (Moss et al., 2013). To address these SC issues, Moss et al. (2013) propose options for recycling, waste reduction, extraction and production in relocated mines, as well as metal substitution. For example, to limit uncertainties related to the SC of its batteries, Tesla has built a giant production factory in Nevada to ensure continuity of supply and limit disruptions (Tesla Motors, 2014).

From a sustainability point of view, as seen before, regulation is essential and can have a significant impact on the implementation of ethical and environmental standards and laws (Wall et al., 2017). But regulations vary from country to country, and are sometimes non-existent in some parts of the supply chain, so companies must voluntarily try to respond to these issues to fall into line with consumer expectations (Seuring et al., 2008). Indeed, companies must rethink the way they create products (Izatt et al., 2014) and this may involve questioning how products are used.

The question of usage is important and has unfortunately been very little studied to date. It is all the more relevant as consumers are important vectors for the greening of business practices. The reasons for not questioning usage are multiple: first of all, there is an emphasis on the technological vision of the IoT (and

technological performance to the detriment of sustainable performance). Indeed, as indicated by Kasulaitis et al. (2021), the importance of technological performance strongly influences consumers' decisions. The level of technicality of products is constantly rising, but questioning persists with regard to real usage and utility for the consumer. Questioning the uses that consumers make of finished products is directly linked to the notion of integrating these actors into the SC. Indeed, integrating consumers means taking an interest in these uses. The finished products are destined for them, so it seems pertinent to first observe what their real needs are, and secondly, to consult them to understand what opportunities they can bring. Today it is possible that the products offered to consumers are more technologically advanced than necessary for their intended use, due to a process of constant value creation. Indeed, to illustrate this, the example of the Apollo 11 mission (Naitmazi, 2020) that sent men to the moon, can be considered. At that time, the computer on board the mission had only 4 kilobits (KB) of Random Access Memory (RAM); today a standard computer has easily 8 gigabytes (GB), i.e., 2 million times more. Similarly, it is possible to find a phone worth €200 with 6 GB of RAM. RAM enables fast access to store information, the more RAM, the faster the computer or phone will be. Obviously, ways of working have evolved as much as the technology, and there may be justifiable need for a high number of RAM on a computer when a lot of software is used and a lot of computing power is needed. However, it would seem that generally, the use of smartphones mostly involves the use of call and message functions and social networking applications, or games. Hence, the question of end use is of primary importance.

Secondly, another reason why this question of usage is little addressed is due to the fact that B2B companies are distant from users/consumers and thus, do not think of integrating them. Indeed, the further away consumers are from the company, the more difficult it seems to include them. Taking the example of the IoT, a B2C company that is closer to the consumer can integrate and question the users' usage. For example, Apple, which is a B2C company (i.e., it sells products directly to consumers), announced on 17th November, 2021, that it was launching "Self Service Repair" (Apple, 2021). This is a service where users can now make

some repairs themselves, such as changing the battery, camera, or screen, or even other more technical changes that will be presented in the coming years. Users are provided with a manual and tools to help them carry out these repairs safely. The objective of this approach is to address sustainability issues, “by designing products for durability, longevity, and increased repairability, customers enjoy a long-lasting product that holds its value for years” (Apple, 2021). The sustainability objective here is to produce fewer new objects and repair those that might be still working, thus limiting a complete manufacturing process involving all stages of the SC. This method is known as the user toolkit method, which is defined and explained in this thesis. As defined in Article 2, the user toolkit method allows tasks normally done by the company to be transferred to the user, thus making the process cheaper and faster while maintaining high quality. As Apple explains in an article, “when an Apple product requires repairs, it can be serviced by trained technicians using Apple genuine parts at thousands of locations, including Apple (in-store or by mail), AASPs, Independent Repair Providers, and now product owners who are capable of performing repairs themselves” (Apple, 2021). In so doing, Apple is responding to the issue of usage linked to over-consumption. However, being a B2C company, it is closer to the consumer than the company that, for example, manufactures the chips that go in the phones, which has more difficulty integrating consumers. As will be discussed in Chapter 6 of this thesis, B2C companies in the IoT sector emphasize that not all users of their products are even aware that they are consumers of their products, making potential exchanges even more complex.

It is these sustainability issues and a lack of integration of usage issues and actors by B2B companies that have led to more “human” reflection in the sense used by the Humanities and Social Sciences, and more precisely the SCM. This leads us back to the main subject of this thesis: Supply chain integration in B2B companies to ensure more sustainability in the context of the IoT. It seems essential to place basic reflection on the use of finished products into the process that leads from the design stage of the product to the end of its life. To achieve this, the integration of customers, consumers and usage is key to offering more sustainable consumer goods and supply chains. Figure 1 shows the pathway that led to the development of this thesis.

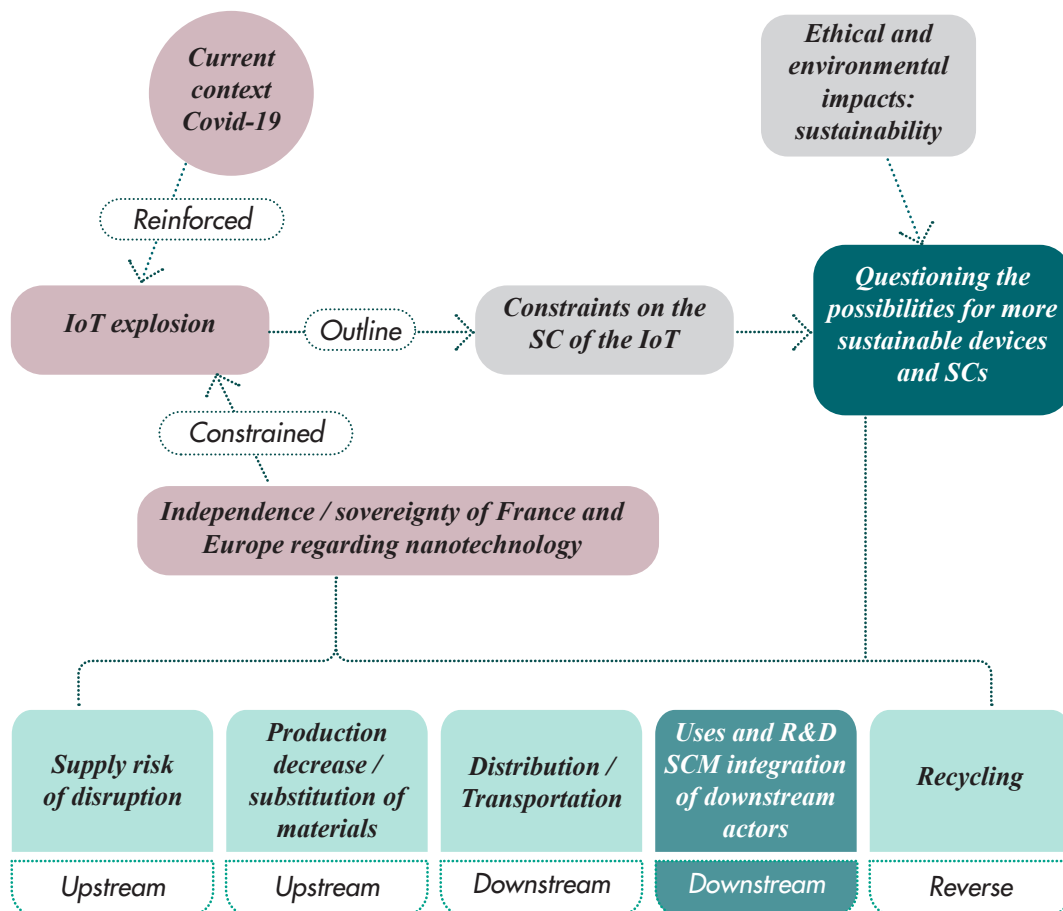


Figure 1: Pathway for the development of this thesis

Within the framework of this thesis, the objective is to find out what is being done to integrate downstream actors to ensure greater sustainability of B2B companies in the IoT sector. Through a literature review, the first objective is to define the issues related to sustainability in SCM. Secondly, the concepts underlying the integration of downstream actors are explained, including the notions of connection and engagement of these actors, and who they are. Thirdly, the different methods that exist to integrate these downstream actors are explored. In the second part of this thesis, three articles are presented in order to study and enrich the existing literature on the concepts of downstream actor integration in SCM, and to analyse the evolution of the literature on the subject over time (from 1996 to 2019). Subsequently, an article proposing a conceptual framework deals with the different integration methods that can be used

to meet companies' objectives, depending on the company processes targeted and the role given to the actor. A third article maps the methods that can enable companies to integrate their downstream actors into their SC according to the desired level of sustainability, and depending on the upstream or downstream process and the type of actor to be engaged. These first two parts aim to answer the main problematic, namely: **Supply chain integration in B2B companies: leveraging downstream actors to address sustainability challenges in the context of the IoT.** This thesis ends with a final part that proposes to discuss the results, to state the different contributions and limitations, and to propose avenues for future research.

3. Research motivation

The current context linked to the COVID-19 pandemic and general supply difficulties, as well as Europe's dependence countries like China, has made it possible to highlight the fact that the IoT and nanotechnology sector is under threat. Moreover, the sector's sustainability issues are becoming more pressing. Indeed, ethical and environmental problems are under the microscope, and the uses that consumers make of these products are finally being called into question. The integration approach of actors in this sector may provide an opportunity to propose more sustainable products or supply chains. Several research gaps have been identified.

- Firstly, downstream actors, including consumers, are not systematically defined in the literature, which sometimes leads to different interpretations and confusion (Marty, 2021; Sampson and Froehle, 2006).
- Secondly, it is noticeable that in the field of SCM, the integration of upstream actors has been widely addressed (suppliers, buyers...) (C. W. Lee et al., 2007; Petersen et al., 2005; Rich and Hines, 1997; Walton et al., 1998). The integration of downstream actors has also been addressed, but mainly through the prism of the customer as opposed to more downstream actors such as consumers and users (Flynn et al., 2010; Frohlich and Westbrook, 2001). Moreover, the literature on the topic of downstream actor integration is well developed in other fields, but less developed for B2B companies. Hence, there is little liter-

ature in the SCM field on how to integrate these downstream actors into SCM. Where methods are proposed to integrate them, they are more discussed in the fields of innovation and marketing (Bosch-Sijtsema and Bosch, 2015; Franke and Piller, 2004; Jeppesen, 2005; Zimmerling et al., 2017).

- Thirdly, even though several integration methods are discussed and detailed in the literature, few articles list them together and detail their use according to the companies' objectives and processes, which constitutes another gap.
- Finally, it seems essential to underline that consumers are amongst the first actors concerned by the finished objects of the IoT, yet their integration by upstream manufacturing companies has rarely been addressed, constituting the last gap.

This is why, in view of the current context, it seems pertinent to question the integration of downstream actors into B2B companies in the IoT sector in order to address sustainability challenges. Figure 2 highlights the above mentioned research gaps:

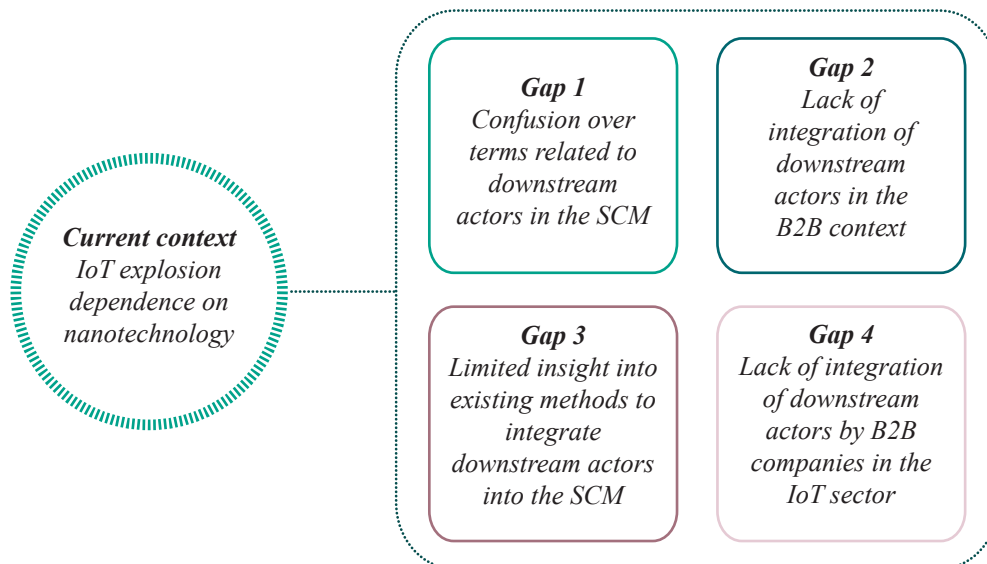


Figure 2: Gap identification

To address these gaps, this chapter first provides the main problematic as well as the research questions that arise from it. In the second chapter, the literature review focuses on the concepts of sustainability, as well as on the different downstream actors, the integration of the latter and the methods that emerge from that. In the third chapter, the research methodology is presented. In the second part, composed of three articles, the evolution of SCM research in the literature with regard to the integration of downstream actors is analysed. Then a comprehensive framework is proposed to highlight the most appropriate methods according to company objectives, processes and roles given to the downstream actors. To conclude the second part, an analysis of what is being done with regard to the integration of downstream actors into B2B companies in the IoT sector is provided. A mapping of methods according to the different downstream actors to be integrated and the desired levels of sustainability is then proposed. This thesis concludes with a third part that highlights the different contributions, limitations and possible future research. The subject matter will be re-specified in order to highlight the problematic addressed in this thesis. The problematic is supported by several research questions that are closely linked to the different articles presented in this thesis. Indeed, this thesis is a dissertation composed of three articles that aim to answer the different research questions, and to address the problematic more generally. The research design is also presented to highlight these different elements.

4. Problematic and research questions

The problematic is built around questions relating to the IoT context as well to the supply chain from a sustainability point of view and the role of downstream actors in responding to these challenges. The research design allows the questions and the problematic to emerge.

4.1 Research design

Research design is essential for a thesis, no matter what type of research or methodology is chosen. It allows the different elements of the research to be articulated in the form of a framework, with the development of the problem, literature, data,

analysis and results (Grunow, 1995; Thiétart, 2014). As with the thesis, research design is paramount in scientific papers, and in general it is a difficult step that many researchers struggle with (Bono and McNamara, 2011). Each element of the research must be chosen according to the others in order to best answer the general problem (Thiétart, 2014). Figure 3 represents the structure of the thesis research by detailing the different stages seen in the previous two parts, outlining the problematic, the research questions and the associated articles. This figure is based on an existing model by Thiétart (2014, p. 186), the parts framed in red are from the author's figure and what is written in green refers to the themes of the thesis. The first box represents the initial empirical question that was asked at the beginning of the thesis. This question has evolved throughout the research, especially after the literature reviews and even after the field study. Indeed, in any research, the problematic can evolve and it is an iterative process, especially when the study is quantitative (Thiétart, 2014). The second box corresponds to the study of the literature, carried out in the form of a bibliometric analysis with a quantitative perspective, then a systematic analysis of the literature which makes it possible to analyse the content of the selected articles. The problematic is then proposed in the third box. The latter nevertheless continued to evolve slightly during the field study and the production of the articles. Concerning the data collection, there was a first stage relating to the two literature articles, with a selection of sources carried out using the Scopus database, which is more relevant to our subject (Fahimnia et al., 2015, 2015; Kazemi et al., 2019), and following an already existing protocol in our field in terms of a bibliometric analysis (Fahimnia et al., 2015, 2015; González-Benito et al., 2013; Kazemi et al., 2019; Xu et al., 2018). The second phase of data collection involved field data, including interviews with employees of B2B companies working in the IoT field, as well as interviews with consumers. Concerning the data analysis, firstly for the bibliometric and systemic literature reviews, the quantitative analysis part was carried out with Bibexcel (Fahimnia et al., 2015, 2015; Xu et al., 2018) in order to perform quantitative queries on the articles of the database (Perera et al., 2019). Then, for the bibliometric analysis, the use of Gephi software (Bastian et al., 2009; Fahimnia et al., 2015) made it possible to highlight clusters in a visual way. For

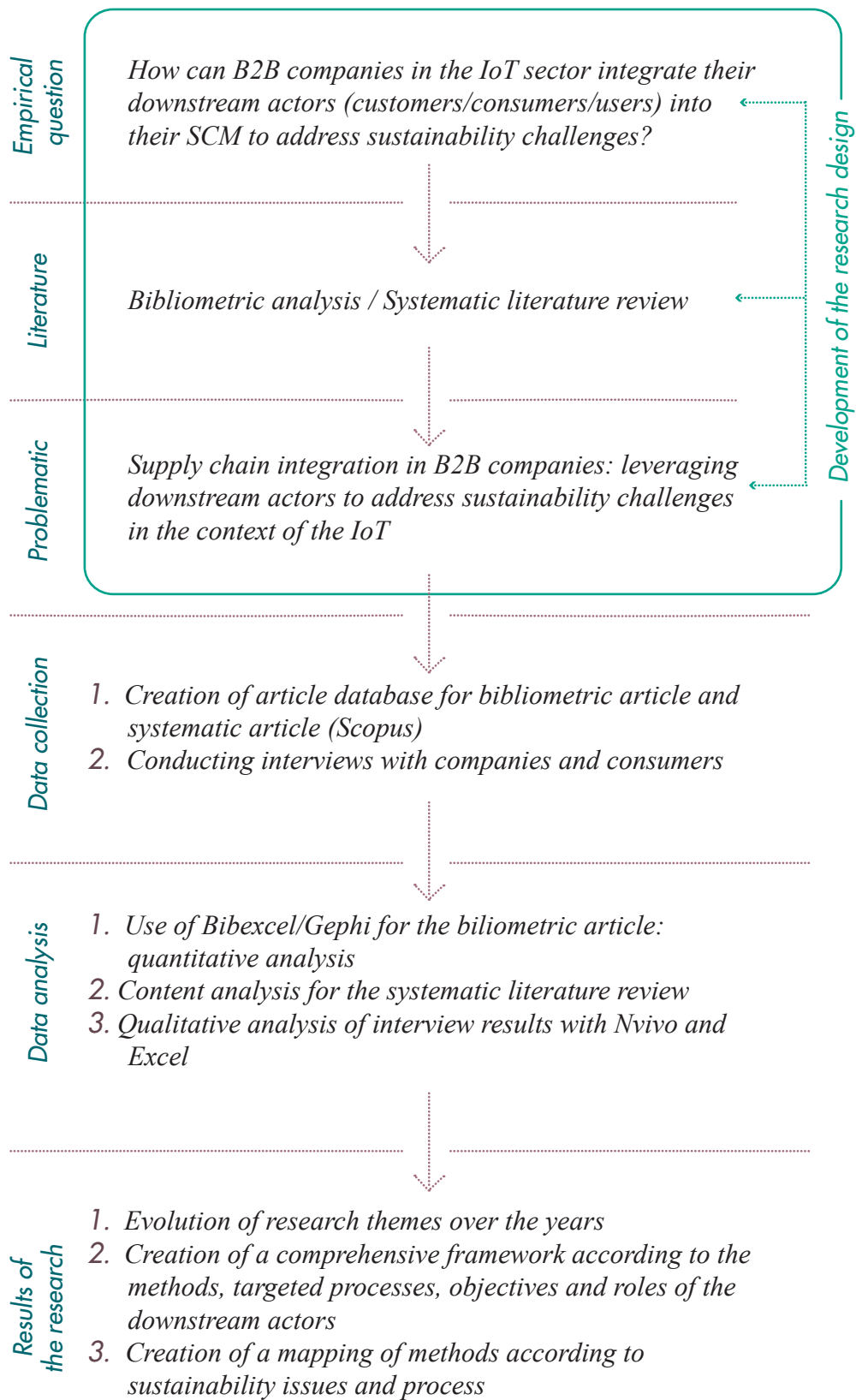


Figure 3: Thesis research design elaboration (based on Thiétart, 2014, p. 186)

the systematic analysis, we followed recommendations already proposed by many authors in the field to analyse content and create categories within a structure (Bastas and Liyanage, 2018; Koberg and Longoni, 2019; Lagorio et al., 2016; Melacini et al., 2018; Saenz et al., 2015; Seuring and Müller, 2008a; Wilding et al., 2012). Regarding the fieldwork, the data analysis was carried out using NVIVO (Kaufmann and Denk, 2011) and Excel (Maher et al., 2018). NVIVO provides structure to the analysis by limiting bias, while Excel offers more flexibility, using different colours and formatting. The use of both software enhances both structure and creativity (Kaufmann and Denk, 2011, p. 201; Maher et al., 2018). The analysis of the data led to results that translate, for the bibliometric article, into the evolution of the clusters over time (Fahimnia et al., 2015), and for the systematic article, into the realization of a comprehensive framework that highlights the best suited integration methods according to the processes and objectives. For the rare metals case study article, it provides a mapping of the methods according to the level of sustainability and risk limitation, according to a downstream or upstream integration.

4.2 Problematic

2 In view of the previous parts, the context and the motivations of this research, several themes are put forward. First of all, the central context concerns the IoT including the notion of nanotechnology, and some of their raw material components, which are rare metals. The main challenge this thesis focusses on its sustainability, and the issue of interest is the integration of downstream actors in the SCM of B2B companies.

The analysis of the context, the topic and the motivation for the research highlights that the literature on the subject of the integration of downstream actors in B2B companies is less developed than for B2C companies. Furthermore, the confusion of terms concerning downstream actors is also an important gap, leading to poorly-identified actors. On the other hand, several integration methods are discussed and detailed in the literature, but few articles list them together and detail their use according to the companies' objectives and processes, which constitutes another gap. Moreover, in the context of IoT, consumers are one of the first actors

concerned by the finished connected objects, and their integration by the upstream manufacturing companies is minimally addressed, constituting the last gap. The problematic is therefore:

Supply chain integration in B2B companies: leveraging downstream actors to address sustainability challenges in the context of the IoT.

These different gaps and the problematic have led to the emergence of a global question statement which is:

How can B2B companies in the IoT sector integrate their downstream actors (customers/consumers/users) into their SCM to address sustainability challenges?

To support this problematic and this global research question, several research questions and sub-questions are presented.

4.3 The research questions

Question 1: What has been published in the SCM literature regarding the integration, connection and engagement of downstream actors?

- Sub-question 1a) What differences are there between downstream actors: customers, consumers and users?
- Sub-question 1b) What differences are there between integration, connection and engagement of downstream actors?
- Sub-question 1c) What are the main themes studied regarding the integration of downstream actors?
- Sub-question 1d) Which topics related to this issue will become more important in the future?

The theme of the integration of downstream actors is studied as it addressed in the literature. It seemed relevant to start with this topic as it would permit us to orientate and deepen the problematic afterwards. The integration of downstream actors has gained a lot of importance in the literature - it is a widely discussed subject,

and the authors underline the importance of integrating these actors into companies' supply chains (Christopher, 2016; Djelassi and Decoopman, 2013; Frohlich and Westbrook, 2001; Jeanpert and Paché, 2016; Maull et al., 2012; Ramaswamy and Gouillart, 2010; Reaidy et al., 2021; Reyes and Bhutta, 2005; Wright et al., 2006; Yee et al., 2010). However, it is noticeable that the different downstream actors are not clearly defined in the literature (Marty, 2021; Yadin, 2002), and can be confusing in terms of their integration and role. To address this issue, further research is proposed in Chapter 2 of this first part to clarify and define the different downstream actors, namely, customers, consumers and users. Furthermore, the literature on the integration of these actors in the field of the SC does not necessarily detail how to achieve this integration, and deals more with SC performance issues (Droge et al., 2004; Flynn et al., 2010; Frohlich and Westbrook, 2001; Narasimhan and Kim, 2002). It was hoped that by analysing the literature in the fields of marketing and innovation, it would be possible to find ways of implementing this integration (Hoyer et al., 2010; Leminen et al., 2015; Lusch and Vargo, 2011; Zimmerling et al., 2017). Nevertheless, the articles studied do not use the term 'integration' much, and more often refer to connection or engagement. Thus, in the second chapter of the first part, these concepts in the literature are reviewed and interpreted according to their uses in the rest of this thesis. Finally, to answer the last two research questions on the main themes studied in SCM on the integration of downstream actors, and on the themes that will predominate in the coming years, a bibliometric article is proposed. Through the analysis of the co-citations and of the clusters, the themes were able to emerge (Fahimnia et al., 2015, 2015; González-Benito et al., 2013; Kazemi et al., 2019; Xu et al., 2018).

Question 2: Which methods can be used in order to integrate downstream actors into the SC?

- Sub-question 2a) What methods can be used for integration?
- Sub-question 2b) Which SC processes can be targeted for this integration?
- Sub-question 2c) What are the objectives of such methods?
- Sub-question 2d) What are the different roles of downstream actors in this integration?

After answering the first questions on the subject of the integration of downstream actors, it seemed appropriate to ask how this could be achieved and by what means. This is why we focused on methods, and chose to list and study them in the context of SCM.

“Traditionally, consumers have been viewed largely as passive recipients of SCM output” (Ta et al., 2015, p. 133), but as mentioned before, many authors promote the integration of downstream actors in company SCs (Christopher, 2016; Djelassi and Decoopman, 2013; Frohlich and Westbrook, 2001; Jeanpert and Paché, 2016; Maull et al., 2012; Ramaswamy and Gouillart, 2010; Reaidy et al., 2021; Reyes and Bhutta, 2005; Wright et al., 2006; Yee et al., 2010). Some authors emphasize the importance of this integration in terms of objectives, e.g., to improve sustainability, reduce risks, and improve performance, among others (Flynn et al., 2010; Frohlich and Westbrook, 2001; Vachon and Klassen, 2006; Zimmerling et al., 2017). Several methods exist to integrate downstream actors, and many have been proposed in the literature, such as the Voice of Customer (VoC) method, methods based on the use of the internet and new technologies such as crowdsourcing, idea competition, living lab methods, participatory design, lead user methods, and so on (Birgitta Bergvall-Kåreborn et al., 2009; Carbone et al., 2017; Franke et al., 2006; Gonzalez et al., 2008; Howe, 2006; Lee and Lin, 2006; Reynolds and Gutman, 1988; Soroor et al., 2012; Von Hippel, 2001, 1986). As previously explained, some downstream actors have long been perceived as passive in the chain, but thanks to integration methods these actors can play a more or less active role in the SC (Ta et al., 2015).

To answer the above mentioned questions, a systematic literature review is conducted and a comprehensive framework is developed to highlight the most relevant methods for integrating customers into companies' SCs according to their objectives, targeted processes and the role to be given to the customer. Before the framework proposition, all methods are presented and defined. This research is presented in Part 2, Chapter 2, corresponding to Article 2 of this thesis.

Question 3: To what extent do downstream actors' perceptions lead to greater sustainability when these actors are integrated into the IoT supply chain?

- Sub-question 3a) What are the sustainability challenges in the SC?
- Sub-question 3b) What are the sustainability challenges in the context of the IoT?
- Sub-question 3c) How is this issue perceived by the companies in this sector, and particularly the link to sustainability and the integration of downstream actors?
- Sub-question 3d) How is this issue perceived by consumers, and particularly the link to sustainability and the integration of downstream actors?

Finally, after having studied the integration of downstream actors, different methods for integrating them into the SC, the focus becomes the IoT and the components involved in related products, namely, rare metals. The purpose is to investigate whether this preliminary research on the integration of downstream actors can be applied to this recent and rapidly evolving context, specifically in relation to sustainability issues.

As previously explained, rare metals are widely used in the IoT and nanotechnology products. IoT devices have a significant impact on the environment, but also on the working conditions of those involved in the exploitation of primary components (rare metals), and in the manufacturing processes of IoT products (Maniglier, 2020; Massari and Ruberti, 2013; Mutumi and Simatele, 2017; Pitron, 2018). To answer the question of sustainability in SCM first, the evolution of sustainable supply chain management (SSCM) is studied, as well as the issues that arise from it. In Chapter 6 of Part 2, the links between the SSCM issues and the constraints that the IoT has on sustainability are explained. In this same chapter, which corresponds to the third article of this thesis, the perceptions of companies in this sector and of consumers are questioned. Discussions with these actors take place in a qualitative study in order to elicit the important points, and to propose a map to engage the consumers in the supply chain, according to the company's desired level of sustainability.

Table 1 summarizes the problematic, as well as the main research questions and sub-research questions.

Table 1: Problematic, research questions and sub-research questions

Problematic

Supply Chain integration in B2B companies: leveraging downstream actors to address sustainability challenges in the context of the IoT

Question 1	Question 2	Question 3
What has been published in the SCM literature regarding the integration, connection, and engagement of downstream actors?	Which methods can be used in order to integrate downstream actors into the SC?	To what extent do downstream actors' perceptions lead to greater sustainability when these actors are integrated into the IoT supply chain?
Sub-question 1a) What differences are there between downstream actors: customers, consumers and users?	Sub-question 2a) What methods can be used for integration?	Sub-question 3a) What are the sustainability challenges in the SC?
Sub-question 1b) What differences are there between integration, connection and engagement of downstream actors?	Sub-question 2b) Which SC processes can be targeted for this integration?	Sub-question 3b) What are the sustainability challenges in the context of IoT?
Sub-question 1c) What are the main themes studied regarding the integration of downstream actors?	Sub-question 2c) What are the objectives of such methods?	Sub-question 3c) How is this issue perceived by the companies in this sector, and particularly the link to sustainability and the integration of downstream actors?
Sub-question 1d) Which topics related to this issue will become more important in the future?	Sub-question 2d) What are the different roles of downstream actor in this integration?	Sub-question 3d) How is this issue perceived by consumers, and particularly the link to sustainability and the integration of downstream actors?

For the production of the articles, and this thesis, a wide reading of the literature was carried out to refine the subject. This analysis of the literature on the different themes has brought to light several gaps (Tranfield et al., 2003), making it possible to highlight a problematic. This problematic is supported by several research questions. The research questions are divided into three themes, - the integration of downstream actors into SCM, integration methods, and B2B companies in the rare metals and IoT sectors. These three main categories of questions led to the realization of the three research articles that make up this thesis (Part 2, Chapters 4, 5 & 6). Following the study of the literature and the emergence of the problematic and related research questions, a bibliometric analysis was proposed for several reasons. Firstly, this type of analysis provides a quantitative assessment of the literature on the topic as it highlights the most productive authors on the topic, the most contributing journals, organizations and articles, and through a co-citation analysis it is possible to identify broad themes related to the topic. The bibliometric analysis also makes it possible to analyse the evolution of the literature over time as well as the evolution of major themes called clusters (Barbosa-Póvoa et al., 2018; Broadus, 1987; Feng et al., 2017; Kazemi et al., 2019). The first article is a bibliometric analysis of the integration of downstream actors into SCM. The research questions then lead to the investigation of the integration methods that connect downstream actors to the SCM. A systematic analysis is therefore proposed in order to enable the content of the articles to be studied following a statistical analysis (Bastas and Liyanage, 2018; Koberg and Longoni, 2019; Lagorio et al., 2016; Melacini et al., 2018; Saenz et al., 2015; Seuring and Müller, 2008a; Wilding et al., 2012). This research led to the realization of a conceptual framework. Finally, the research questions related to rare metals and the IoT field led to a qualitative field study (Eisenhardt and Graebner, 2007; Kaufmann and Denk, 2011; Ozcan and Eisenhardt, 2009), involving interviews with companies and consumers, and this research allowed the emergence of method mapping, thus providing guidance to companies in choosing the most relevant methods according to the desired level of sustainability. Figure 4 represents the master plan of this thesis, including the different steps followed and the evolution of this research.

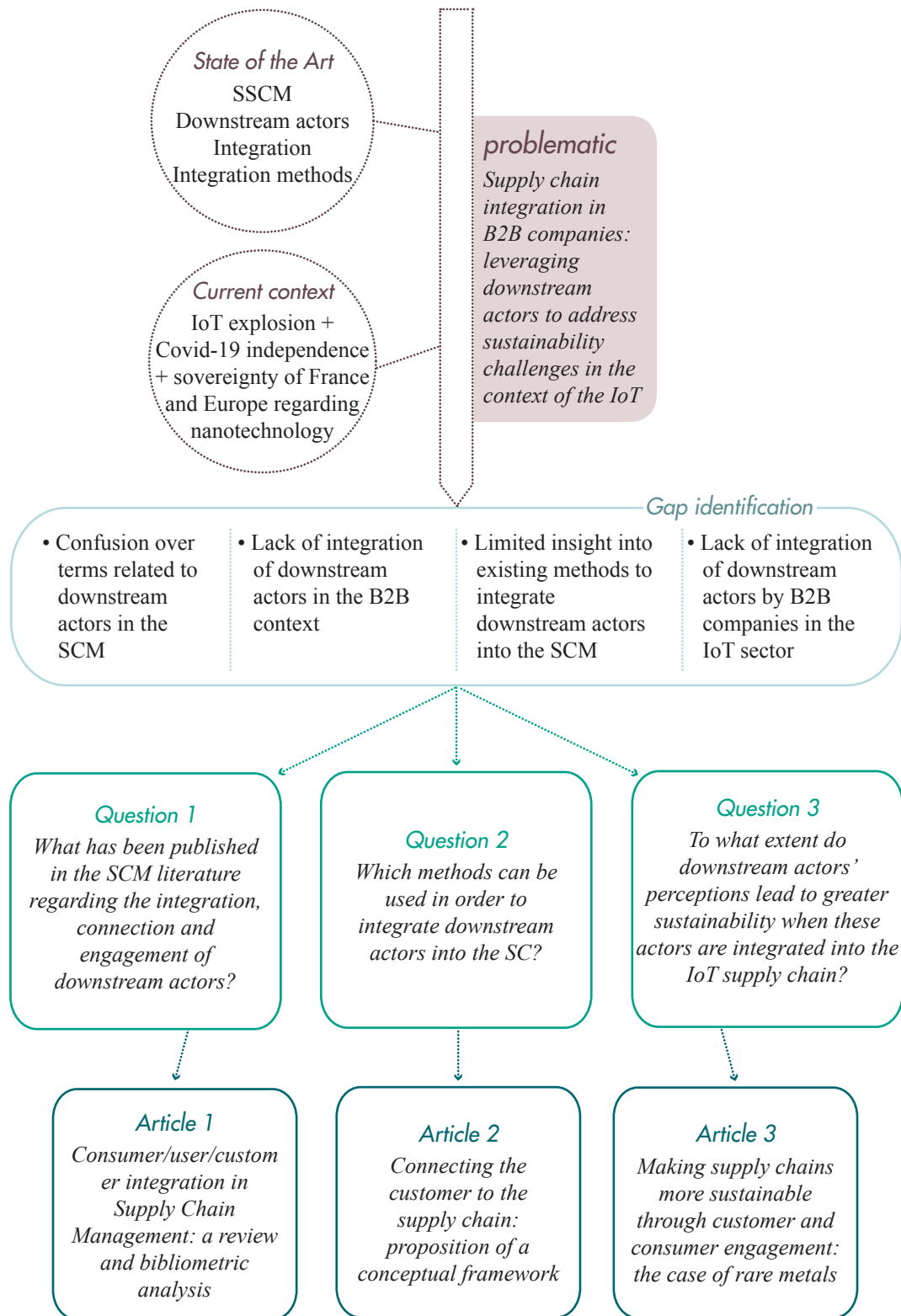


Figure 4: Thesis master plan

5. Research architecture

5.1 Epistemological positioning

When writing a thesis, it is important to place the research project within an epistemological framework. Several paradigms are used in management sciences, the two most common being positivism and constructivism, however, between these two there is a range of subtlety from post-positivism, to critical realism, to interpretivism and others (Gavard-Perret et al., 2012). Figure 5 is inspired and translated by Gavard-Perret et al. (2012) and Mellard (2016, p. 145) and represents the different epistemological paradigms. This thesis focusses mainly on the constructivism and interpretivism approaches.

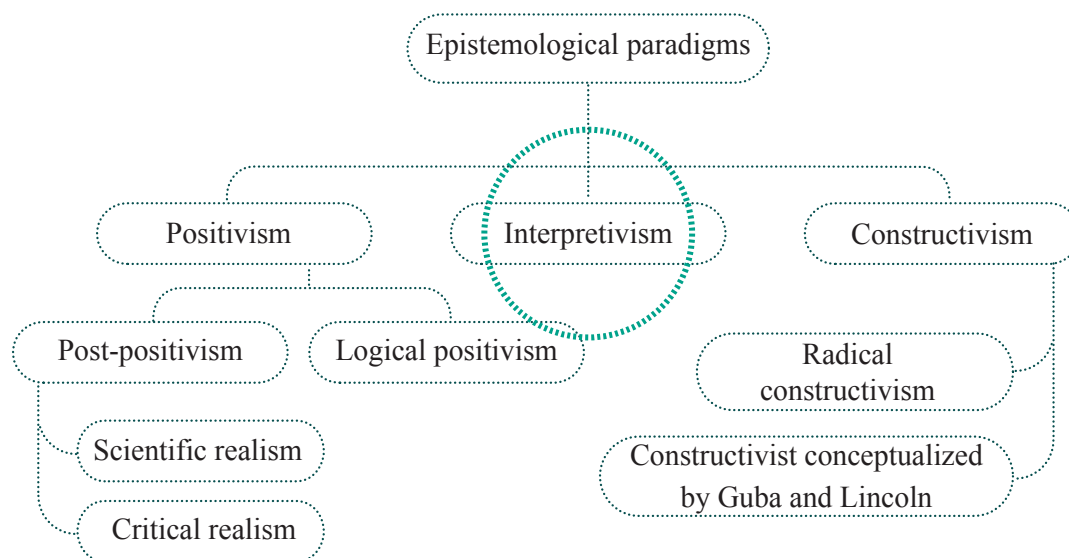


Figure 5: Epistemological paradigms (Gavard-Perret et al., 2012; Mellard, 2016, p. 145)

It is important to note that epistemology involves philosophical concepts such as knowledge, cause, and reality (Velmuradova, 2004). Sometimes, the context has a significant influence on the epistemological position. Positivism seeks to prove knowledge from an established and indisputable reality in an objective manner. Conversely, within the framework of constructivism, the constructivist epistemological paradigm focuses on construction, whereby experience of reality and empirical investigation are essential and can represent a source of knowledge. The representations that researchers construct depends on the specific context and

the aim of the problem to be solved. Within the framework of interpretivism, the researcher may wish to determine the perspective of these understandings by creating and grouping categories or meta-categories in order to make sense of them (Paillé and Mucchielli, 2012). Our research aims to construct, understand and interpret the practices of companies in terms of integration.

For the interpretivists and constructivists, reality cannot be known in its essence (Thiétart, 2014), it can only be discovered through experiences and representations (Avenier and Thomas, 2015; Sandberg, 2005). Thus, in the interpretivist paradigm, reality is not objective because it is unattainable, but is based on representations and interpretations of that reality (Velmuradova, 2004). Within the framework of constructivism and interpretivism, there is not just one possible solution, but a multitude of possible interpretations and opportunities (Applefield et al., 2000).

The main difference between interpretivism and constructivism lies in the impact of the researcher and his or her role as an observer. In this paradigm, reality depends on the researcher's perception, which makes knowledge subjective and contextual (Allard-Poesi and Perret, 2014). The interpretivist researcher aims to understand the social reality of individuals in a context. Thus, from this perspective, ontological, constructivist and interpretivist assumptions agree that knowledge creation is subjective and contextual. However, with regard to knowledge creation, the interpretivist seeks to understand a phenomenon, whereas the constructivist aims to understand the meaning constructions of that phenomenon. Nevertheless, in both approaches the relationship between the object and the subject are shared (Allard-Poesi and Perret, 2014). Understanding phenomena through the meanings that people give to them is the goal of the interpretivist researcher (Orlikowski and Baroudi, 1991). Habits, ways of seeing things, and different constraints are part of this paradigm, which is based on a social construction (Sandberg, 2005). There are many schools of thought that offer different definitions of interpretivism. Nevertheless, for constructivism and interpretivism, "all these diverse schools of thought share a common phenomenological base that stipulates that human and world are inextricably related through lived experience" (Avenier and Thomas, 2015, p. 7)

Regarding epistemological positioning, the nature of the knowledge produced is subjective and contextual, not objective and non-contextual. Concerning the nature of reality in the context of this thesis, it is based on a phenomenological and not an ontological hypothesis. The researcher assumes that reality is unknowable by nature, but that it can be studied through experiences; what is knowable is the lived experience (Gavard-Perret et al., 2012; Velmuradova, 2004) which is part of the constructivist approach. The vision of the social world is intentional and not determined (Le Moigne, 1995). The constructivist and interpretivist paradigms are thus adopted in this research in view of the questions posed - i.e., the how and why - integrating the psychological complexity of the object of research (Maurand-Valet, 2011).

Within this paradigm the interpretivist approach is central, often presented as a constructivist variant (Dumez, 2010; Perret and Séville, 2003). This research seeks to understand a phenomenon in depth as well as the way in which individuals give meaning to the experiences they live, instead of trying to develop a model of human experience or a project of knowledge, which would correspond to a constructivist approach (Avenier and Thomas, 2015; Thiétart, 2014).

To conclude this reflexion on epistemological positioning, part of Avenier and Thomas's (2015) table is adapted to understand the epistemological interpretivist paradigm. This table was originally entitled "Founding assumptions concerning knowledge's origin and nature in alternative epistemological frameworks" (Avenier and Thomas, 2015, p. 9), and is completed here by the approach used in this research (Table 2).

Table 2: Interpretative approach (adapted from Avenier and Thomas, 2015, p. 9)

	Interpretivism	Interpretivism applied in this research
Ontological founding assumptions of Interpretivism	<p>There exist multiple socially constructed realities not governed by any natural laws, causal or otherwise (Guba and Lincoln, 1989).</p> <p>The agreed meanings about a situation constitute the objective, intersubjective reality of this situation (Sandberg, 2005).</p>	<p>The reality in which this thesis is currently placed is based on current realities that occur in a context where the demand for rare metals is exploding and where environmental impacts are having significant consequences for people and the planet. This is the current objective and intersubjective situation, which depends on the current context.</p>
Epistemic founding assumptions of Interpretivism	<p>'Facts' are produced as part and parcel of the social interaction of the researchers with the participants and knowledge is gained only through social constructions. Lived experience is knowable. Intentionality has a constitutive power on the meaning of reality that appears to us in our lived experience.</p>	<p>The results found in the interviews are dependent on the social interactions the researcher has with the respondents. The experiences in these interviews and in their analysis are part of the knowledge that is created.</p>
Goal of the knowledge generation process of Interpretivism	<p>Understand how human beings make individual and/or collective sense of their particular world and engage in situations.</p>	<p>In the context of the research, the researcher tries to understand and interpret the meaning that the interviewees give to the question of sustainability, rare metals and the integration of downstream actors in the SC. Each respondent's opinion differs according to their values, their role in the company, their relationship to their company, to the researcher and to the subjects raised.</p>
Status and shape of knowledge of Interpretivism	<p>Plausible interpretations that fit lived experience. Narratives supported by thick descriptions, and, in certain currents within interpretivism, generic statements.</p>	<p>The results are interpretations based on the experiences of the interviewees. These results are based on narratives supported by a precise interview guide to make the interpretations plausible.</p>

5.2 Methodological choice: quantitative method and inductive approach

The literature was first studied in depth on the subject of the integration of downstream actors and the methods that arise from it. The chosen approach to studying the literature was quantitative for the first subject, which is the integration of downstream actors in supply chain management, and the analysis followed a standardized structure already conducted in the field of SCM (Fahimnia et al., 2015, 2015; González-Benito et al., 2013; Kazemi et al., 2019; Xu et al., 2018). Indeed, this subject is not recent and has been studied for decades, so the literature is consequent, and for this reason, a bibliometric analysis was conducted enabling the analysis of the evolution of this subject over time and to bring out the major themes addressed by the authors, and future avenues for research (Apriliyanti and Alon, 2017; Barbosa-Póvoa et al., 2018; Broadus, 1987; Feng et al., 2017; Kazemi et al., 2019; Merigó and Yang, 2017; Perera et al., 2019; Zupic and Čater, 2015). Concerning the subject of integration methods, a systematic review of the literature was carried out in order to highlight quantitative data on authors, journals and articles, and in a second step, this allowed a deeper analysis by studying the contents and by finding categories to identify the themes (Bastas and Liyanage, 2018; Koberg and Longoni, 2019; Lagorio et al., 2016; Melacini et al., 2018; Saenz et al., 2015; Seuring and Müller, 2008a; Wilding et al., 2012). Subsequently, the content of these articles was analysed in order to go deeper, and to be able to propose a comprehensive framework. Following the literature review, which was initially more quantitative and then more conceptual, the context of rare metals was tackled by linking it to the first two topics of study, the integration of downstream actors in the SCM and the methods. As this context is new and little studied, the practices of companies and the opinions of consumers on the subject of the sustainability of rare metals were observed and interpreted from an interpretivist epistemological position (Goulding, 1998). Their point of view enabled an understanding of the phenomena (Charmaz, 2006). From an exploratory and investigative perspective, a qualitative approach was chosen (Kaufmann and Denk, 2011). As previously mentioned, the epistemological positioning is interpretivist, and in view of the fairly recent context of rare metals and the IoT, the qualitative

approach seemed appropriate. Within the framework of this thesis, the qualitative method was used as the study is exploratory - it has been hardly discussed to date and little literature is available. Hence, it seemed necessary to study the field, and for this purpose, qualitative analyses were carried out to interpret the qualitative results collected during the semi-structured interviews.

Qualitative investigation is conducted prior to qualitative analysis. Qualitative investigation consists of all the operations carried out in the research field in order to obtain relevant data. Once the subject has been problematized, quantitative analysis corresponds to the construction of meaning and the interpretation of the data collected (Paillé, 2019).

Qualitative research can be conducted through interviews (Orlikowski and Baroudi, 1991), which is a technique for collecting data that reflects the conscious and sometimes unconscious minds of individuals. The method of individual interviews was chosen (Gavard-Perret et al., 2012) instead of group interviews. Individual interviews are usually conducted face-to-face (Velmuradova, 2004). However, in this particular case, the Covid19 pandemic had an impact on the data collection process and these interviews were thus conducted either by telephone or by videoconference. These interviews were conducted between an investigator (a researcher) and a subject, the latter either an employee of a B2B company in the rare metals or IoT sector, or an end consumer. Interviews can take three different forms (Velmuradova, 2004), firstly, the directive interview (which is more like a survey), often with close-ended questions designed for yes or no answers. Then there is the free, non-directive interview, in which the interviewer proposes the subject of the study and leaves the interviewee to express himself/herself as he/she wishes, without intervening. The third type of interview is the semi-directive interview (Cucchiella et al., 2012), which is used in this research. These interviews are structured (Robert K Yin, 2003), and although the interviewee is free to express him or herself on the subject, subthemes are proposed and the researcher can guide the interviewee by bringing him or her back to a subject not much discussed (Velmuradova, 2004). Semi-directive interviews allow respondents to express their ideas freely, making it easier

to talk about things. The follow-up elements proposed by the interviewer are based on subjects already expressed by the respondent. Unlike the non-directive interview, the researcher addresses topics that have been previously defined in a structured guide, and the answers to the questions are transcribed in this pre-established response grid (Thiétart, 2014).

Regarding the qualitative analysis of the results, the interviews were all transcribed and analysed using Nvivo software (Kaufmann and Denk, 2011). This software allows the interviews to be coded using nodes and sub-nodes. Nvivo makes it easier to observe the data and to see the resulting concepts. As reported by Maher et al. (2018), using Nvivo is useful for storing information in a digitalized way and segmenting interviews, however, as the authors mention, the lack of a visual aspect to Nvivo makes analysis faster, moving directly to category development instead of spending more time on “participant stories” (Maher et al., 2018, p. 9). In this thesis, more traditional methods in addition to Nvivo were used, using colour coding with Post-it notes for a more “fruitful analysis procedure” (Maher et al., 2018, p. 10). Thus, the interviews were transcribed in Nvivo, allowing the text to be segmented, and creating nodes based on the information collected. The file was then exported in Word format and Excel in order to use colour coding to analyse the content by deepening the categories. “Coding of the documents involved open coding of meaning units, i.e. words, phrases, sentences, paragraphs, which essentially involves labelling concepts. After some time, concepts began to form patterns or clusters and as such, fit into categories” (Flint and Golicic, 2009, p. 847). Hence, the analysis was based on categories that allowed elements related to sustainability, the integration of downstream actors, and the importance of rare metals to emerge.

In this qualitative approach, an inductive reasoning is often used for the exploration of new subjects (Eisenhardt and Graebner, 2007; Ozcan and Eisenhardt, 2009). Deductive reasoning starts from the general and moves to the particular, whereas in the case of inductive reasoning there is a willingness to go from the particular to the general. Usually, the deductive approach aims to test, whereas an inductive approach seeks to explore. Indeed, when researchers want to explore, they will either follow an

(Thiétart, 2014). The objective is to examine and explore a phenomenon (Martinet, 2006); it is commonly used in exploratory research, and involves words rather than numbers (Thiétart, 2014). The inductive approach was chosen as there is limited literature on the subject (Eisenhardt and Graebner, 2007), and it seemed that no existing theory allowed the questions being investigated to be answered (Ozcan and Eisenhardt, 2009). This is why an inductive approach based on a qualitative study seemed to be the most appropriate for this research (Kaufmann and Denk, 2011).

5.3 General approach and structure of the thesis

This thesis is structured in three parts. The first part is devoted to the research context and literature review, including the general introduction. This introduction includes the subject and detail of the current context, allowing the motivations for this thesis to be highlighted. The importance of the Need project, of which this thesis is part, is also underscored. The problematic is also presented in the introduction as it is connected to the motivations, context and the subject. Subsequently, the architecture of the research is presented, including the epistemological positioning of the researcher, methodological choices the general approach and structure of this thesis (current part). Chapter 2 then presents a literature review on the key themes of this thesis, namely, rare metals and sustainable supply chain management. The three pillars of sustainable development are detailed as well as the evolution of sustainable supply chain management (SSCM) over the years, and the integration, connection and engagement of downstream actors. The third chapter presents the overall methodology, detailing the bibliometric analysis, the systematic analysis and the qualitative part.

This paper-based dissertation addresses the integration of downstream actors in the SCM of B2B companies, from a sustainability perspective, in the context of the IoT. The second part of this PhD is dedicated to the three articles.

The first article, entitled “**Consumer/user/customer integration in Supply Chain Management: A review and bibliometric analysis**” has been published in *Supply Chain Forum: An International Journal*. It proposes to study, in the form of a

bibliometric analysis, the integration of downstream actors in SCM. After explaining and analysing this integration, it is important to define how these actors can be integrated. This article aims to take stock of existing literature on the integration of customers, consumers and users in SCM, and to propose future avenues of research. The bibliometric analysis is conducted to study the integration of downstream actors. The analysis provides details on the most cited articles, published authors and influential journals using Bibexcel, and then Gephi is used to create a network. This article first proposes a quantitative analysis of the literature by highlighting the best authors, articles and journals on the integration of downstream actors in SCM. Subsequently, a network analysis reveals five clusters and the challenges to come. Finally, this research suggests how and to what end these actors might be integrated. The bibliometric analysis proposes to explore this subject in depth, by identifying key research topics such as sustainability and information systems, interrelations, and the evolution of publications over time. From this first study of the literature on integration in SCM it can be seen that the theme of sustainability emerges in a significant way and allows the pertinence of this thesis to be highlighted, creating links with the subsequent articles. This first article highlights in a quantitative way the authors, organizations and countries that have contributed most to this field, the most cited articles, and the most frequently used keywords. The analysis of citations and co-citations that is carried out allows clusters to emerge. The study of these clusters has brought out the concept of sustainability and the fact that this challenge can be addressed through certain tools and methods. Following the results of Article 1, the methods that allow the integration of downstream actors in SCM can be observed.

The second article, entitled “**Connecting the customer to the supply chain: proposition of a conceptual framework**” focuses on the different integration methods that can be used to connect the customer to the SC. It is conducted as a systematic literature review. The purpose of this paper is to explore the options that exist for organizations to proactively connect their customers to their supply chains. In the article, the researchers conduct a systematic literature review of the methods used to integrate the customer into SCM according to their objectives. A descriptive analysis is performed - categories and dimensions are identified in the selected articles

in order to propose a comprehensive framework. The first finding of this article is an objective study of the integration methods used in a SCM context, based on descriptive statistics on the selected articles. The second finding is a comprehensive framework to highlight which methods are more appropriate for companies to better integrate their customers into their SC processes, depending on their objectives. To our knowledge, the subject of the customer integration methods has been little studied in the field of SCM. This article brings together the studies carried out on this subject and goes further, by proposing a comprehensive framework to help companies find the right method depending on the process and the objective, as well as the role they wish to give to customers. This second article, which proposes a comprehensive framework, highlights the different objectives that a company can target, such as sustainability, but also performance objectives, technical objectives, risk limitations, quality improvement and innovation creation. It also highlights the processes targeted for integration, such as upstream, internal and downstream processes. Depending on these objectives and the processes targeted, specific or global integration methods are proposed. Following this article, it seemed pertinent to go out into the field to observe whether B2B companies in the IoT and rare metals sectors were using these methods, and to hear consumer opinions on existing methods and their own integration. That is the purpose of Article 3.

The third article, entitled “**Making supply chains more sustainable through customer and consumer engagement: the case of rare metals**” focuses on the topic of rare metals, and the integration of downstream actors in the SC of B2B companies. In this qualitative article, which features a case study of rare metals, the research question is as follows: How can customer and consumer engagement be improved to enable a greater degree of ‘co-creation’ in the search for greener products and the supply chains that support them? To answer this question, the terms related to rare metals and their challenges are defined; then, the different methods of customer and consumer engagement proposed in the literature are reviewed. Secondly, through interviews with companies in the Internet of Things sector and with consumers, downstream actor integration in the context of rare metals is analysed. The results propose a mapping of the different methods that enable co-creation for sustainability

objectives. This study emphasizes the presence of these methods in companies with complex processes that use rare metals in the composition of their products. The research investigates whether integration methods that encourage the engagement of downstream actors are implemented to improve sustainability, and aims to provide a variety of methods depending on the challenges companies face. The mapping highlights methods according to either upstream or downstream engagement of consumers or customers in the SC, as well as according to the challenge faced, either with the objective of limiting risk or prioritizing sustainability.

These first two articles highlight the theme of sustainability and its importance in technical and specific SCs, as well as the place of integration methods in sectors of activity evolving in B2B. The main integration methods corresponding to different issues, including sustainability, in the literature are studied, resulting in the conceptual framework proposition to help identify the most appropriate methods according to the company's objectives and targeted processes. This research then aims to study the presence of these methods within B2B companies whose scope of activity includes rare metals, for sustainability purposes. Thus, the third and final article of this thesis is devoted to a qualitative analysis based on interviews with employees of companies in the sector, as well as with consumers. As stated in Chapter 5, some methods highlight the importance of co-creation and emphasize that consumers can be a source of proposals. Hence, the observations and proposals that consumers can contribute are studied.

To complete this dissertation, the third part focuses on the conclusions that can be drawn from this research. The results of each article are discussed, and an overall discussion is provided. The limitations of this research are discussed, including those related to the field, the methodology, epistemological positioning, and the context of the IoT and rare metals sector itself, which is still a recent subject in the literature. Future avenues for research opportunities are also proposed on the integration of downstream actors, in connection with the theme of sustainability in the supply chain, in the context of rare metals and IoT.

Summary Chapter 1

Chapter 1 highlights the subject and the main research question: How can B2B companies in the IoT sector integrate their downstream actors (customers/consumers/users) into their SCM to address sustainability challenges? This question leads to the problematic of this thesis, namely: Supply chain integration in B2B companies: leveraging downstream actors to address sustainability challenges in the context of the IoT. To address this question and deal with what constitutes a relatively new and little-discussed topic in the literature, a global inductive approach is followed, using a qualitative methodology. An interpretivist epistemological position was chosen, allowing this recent topic to be fully explored and interpreted. This research therefore consists of three articles. The first article is bibliometric, enabling the integration of downstream actors into SCM to be studied in the most objective way possible, via a quantitative study. This also allows the various themes covered in this field of research to be highlighted, giving a clear view of how it might evolve in the future. The second article is a systemic review, leading to the creation of a comprehensive framework dealing with integration methods of downstream actors. The third article is a field study. Using a case study on rare metals and interviews with B2B companies and consumers, it maps possible methods according to the desired level of sustainability and the integration process.

Chapter 2. *Literature review*

Chapter 2 provides a literature review of the issues surrounding sustainability in SCM and the challenges it presents. In this chapter, the notion of downstream actors is extensively discussed, highlighting the ambiguous nature of the use of the terms ‘customers’, ‘consumers’ and ‘users’. The chapter also proposes to focus on the concept of integration, defining the term, as well as the actions of connection and engagement. Finally, this chapter also details the different integration methods that exist depending on the type of integration.

1. Sustainable supply chain management

As sustainable supply chain management (SSCM) is at the core of this thesis, the definition used in the research follows the definition given by Christopher (2016, p. 3): “The management of upstream and downstream relationships with suppliers and customers in order to deliver superior customer value at less cost to the supply chain as a whole”. More specifically, taking into account the notion of connection between actors, including the end user, the supply chain can be defined as “A network of connected and interdependent organisations mutually and co-operatively working together to control, manage and improve the flow of materials and information from suppliers to end users.” (Christopher, 2016, p. 4).

1.1 Evolution of SSCM

Although there are multiple definitions, the authors studied all base themselves on the three dimensions of sustainable development, namely, environmental, economic and social (Elkington, 1997; Seuring and Müller, 2008a). The advantage of this definition is that it takes into account the environmental, social and economic tryptic, without neglecting the main goal of a company to remain competitive (Carter and Rogers, 2008). Like all sectors, that of the IoT and nanotechnology his highly impacted by increasing demand (Fu et al., 2020; Mossali et al., 2020), so company competitiveness is essential. As defined by Seuring and Müller (2008, p.1,700), “in sustainable supply chains, environmental and social criteria need to be fulfilled by the members to remain within the supply chain, while it is expected that competitiveness would be maintained through meeting customer needs and related economic criteria.”.

Nevertheless, the concept of sustainability has existed for many years (Hardin, 1968; Linton et al., 2007; Parsons et al., 1977). Sustainability and the environment have become part of popular culture, represented in the press, books and films. It was not until the 1990s that this approach looked at more closely by the management sciences. The literature on the subject has grown steadily since then, and the interaction between sustainability and SCM is a key topic discussed in the literature (Ageron et al., 2012; Ahi and Searcy, 2013; Bentahar and Benzidia, 2018; Brandenburg et al., 2014; Carter and Rogers, 2008; Corbett and Kleindorfer, 2003; Dubey et al., 2017; Gold et al., 2010; Hong et al., 2018; Khan et al., 2021; Kleindorfer et al., 2005; Koberg and Longoni, 2019; Pagell and Wu, 2009; Panigrahi et al., 2019; Saberi et al., 2019; Seuring and Müller, 2008a; Zimon et al., 2020). The impact of climate change and sustainable development have become a major issue (Seuring and Müller, 2008b). As presented in the introduction, sustainability has been defined as “the use of resources to meet the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987, p. 8). Numerous laws have been adopted by States to limit climate change, such as the elimination of chemicals with ozone-depleting potential, or new EU

legislation aimed at regulating the supply of metals from conflict zones (Cook, 1996; European Commission, 2018; Linton et al., 2007). As a result, the public and private sectors have taken up this concept and are seemingly attempting to limit global warming (Ball, 2004; Bodansky, 2004; Linton et al., 2007). The European Union (EU) is also at the centre of this discussion. The EU considers this topic to be of utmost importance; numerous ordinances have been issued, such as the new EU directives on waste and electronic equipment, whilst studies on critical raw materials and the circular economy have been launched (European Commission, 2020; Gislev et al., 2018; Linton et al., 2007).

The private sector and businesses have also been threatened by the issues of climate change and the need for more ethical and sustainable products (Khan et al., 2021). Nowadays, companies' production processes can be spread across different regions of the world. All members of the supply chain are linked by financial, material and information flows. Depending on the products created, the environmental and social burdens associated with them vary during the manufacturing process, and can be higher or lower (Khan et al., 2021). Companies are often subject to external pressure from non-governmental organizations (NGOs) or consumers, as their environmental performance is sometimes controversial (Carter and Jennings, 2002; Taticchi et al., 2015).

Thus, companies must take into account these challenges, which are sometimes recurrent throughout their supply chain. Numerous scandals have arisen as a result of SCM that excludes any notion of sustainability. This was the case with Nike, Adidas, C&A and Disney, for example, which forced their employees to work in degrading conditions (Seuring and Müller, 2008a), or actively participated in the contamination of the local environment (streams, soil, rivers and other natural elements) (Seuring, 2001). As a result, some companies have taken the lead and implemented SSCM processes focusing on the greener aspect by applying standards such as ISO 14,001, or adapting their tasks within their production facilities (Beske et al., 2008).

Within the framework of SCM, many authors have been working on the concept of SSCM. Some authors have carried out bibliometric or systematic literature reviews to list the various researchers working on these subjects (Ahi and Searcy, 2013; Ansari and Kant, 2017; Dubey et al., 2017; Fahimnia et al., 2015, 2015; Khan et al., 2021; Nimsai et al., 2020; Rajeev et al., 2017; Tseng et al., 2019), summarizing the various definitions, most important topics discussed, and the most frequently cited articles in the literature over the years.

There are a number of different definitions that have been provided. However, in the last ten to five years, there have been no new definitions within a well-established theoretical framework, which is why the references proposed in the graphs below are not recent. Nevertheless, SSCM has been studied in more recent years, i.e., between 2015 and 2021. The definitions and concepts related to SSCM are grouped in Figure 7.

From a definition perspective, an analysis of sustainable supply chain management is conducted by comparing the main themes studied over the years. Sustainable supply chain management is based on the environmental, social and economic components, and takes a greater account of social responsibilities and issues, focusing on a dynamic of collaboration with the various partners throughout the chain. The study of the definitions highlights four major topics (Figure 7). Some definitions are based on the three central pillars of sustainability in business - environmental, social and economic (Ciliberti et al., 2008, p. 1,580; Font et al., 2008, p. 260; Seuring and Müller, 2008, p. 1,700; Wittstruck and Teuteberg, 2012). The second topic deals with decision-making and the implementation of global environmental and social action with the aim of increasing sustainability and minimizing the associated risks inherent in the SC (Closs et al., 2011, p. 102; Haake and Seuring, 2009, p. 285). The definitions of the third topic focus on inter and intra-company environmental, social and economic strategy, highlighting the collaborative aspect (Carter and Rogers, 2008, p. 368; Jorgensen and Knudsen, 2006, p. 450; Wolf, 2011, p. 223). The last topic focuses on a shared vision among chain members to improve the sustainability of products and processes (Badurdeen et al., 2009, p. 57; Pagell and Wu, 2009, p. 38;

Seuring, 2008, p. 132). To carry out this analysis and produce Figure 7, a selection of literature articles on the subject of SSCM was first made, then all the definitions retrieved were extracted from the articles, sorted and analysed in order to cluster these four topics.

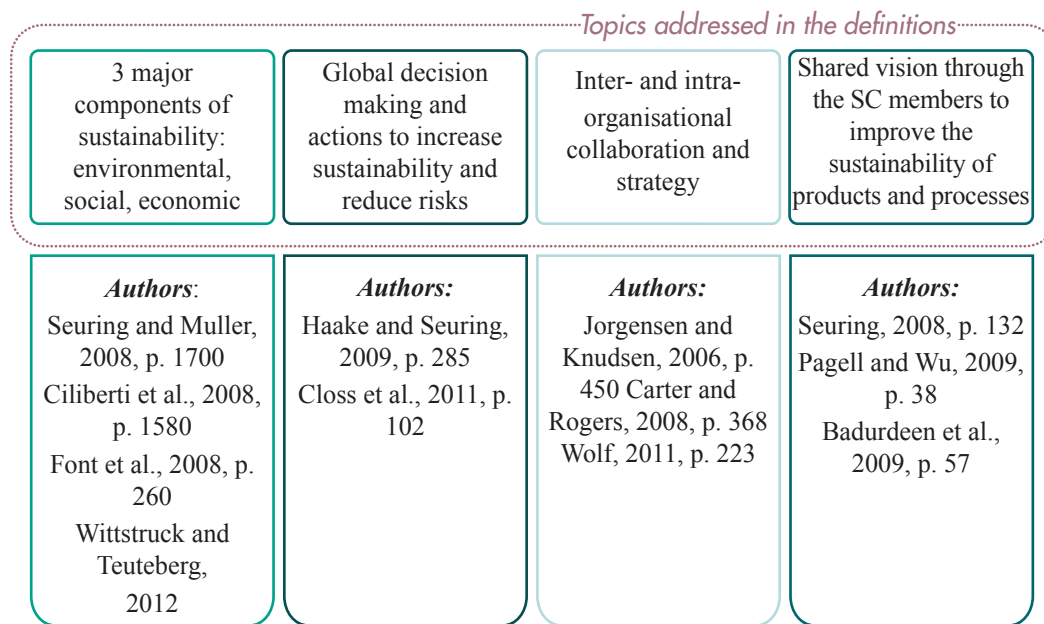


Figure 7: Topics related to sustainable supply chain management in the literature

The definitions proposed by the authors demonstrate, first of all, that two distinct strategies can be implemented within sustainable SCM: (1) supplier management of risk and performance and (2) supply chain management for sustainable products (Seuring and Müller, 2008a). “Bowen et al. (2001) distinguish ‘greening the supply process’ and ‘product based green supply’” (Seuring and Müller, 2008, p. 1,703). The interest here is to understand that there is a difference between the objective of making SC processes sustainable, and the objective of creating a sustainable product through the SC. These two points are of particular interest for the rest of this thesis, as the objective is to propose opportunities for B2B companies to implement a more sustainable SC, as well as to produce more sustainable products. The analysis of SSCM highlights the importance of actors and of collaboration in SSCM to improve global sustainability and environmental aspects.

The different elements highlighted in these figures make it possible to show that it is important to integrate all the actors from one end of the SC to the other, and that customers (like suppliers) play a key role, but also that the impacts must be evaluated throughout the chain, both for products and processes. All of these elements are at the core of this thesis and are arguments that support the proposed research.

The different themes have now been addressed through the prism of definitions proposed by key authors studying SSCM from 1997 to 2013. The literature on these same themes from 2015 to 2021 is also studied (Figure 8).

With regard to SSCM, the major themes currently addressed (Figure 8) in the literature are also sustainability through collaboration (Ding et al., 2016; Hsueh, 2015; Sancha et al., 2016; Silvestre et al., 2018), global decision-making for sustainable supply chains (Allaoui et al., 2019; Kirchoff et al., 2016; Sitek and Wikarek, 2015; Tseng et al., 2018), and the increasingly discussed circular economy, which proposes to evolve in a closed-loop SC in order to improve recycling as well as to reduce resource scarcity and depletion (Aminoff and Kettunen, 2016; Genovese et al., 2017; Hussain and Malik, 2020; E. Manavalan and Jayakrishna, 2019; Yadav et al., 2020). In addition, information systems are also a widely addressed theme in SSCM, particularly new technologies to improve the sustainability of the SC, such as blockchain, the Internet of Things (IoT) and industry 4.0 (Benzidia et al., 2021; de Camargo Fiorini and Jabbour, 2017; Esmailian et al., 2020; Manavalan and Jayakrishna, 2019; Paliwal et al., 2020). Figure 8 was produced following the same methodology as Figure 7, i.e., by retrieving recent SSCM definitions and analysing their content in order to generate four distinct topics.

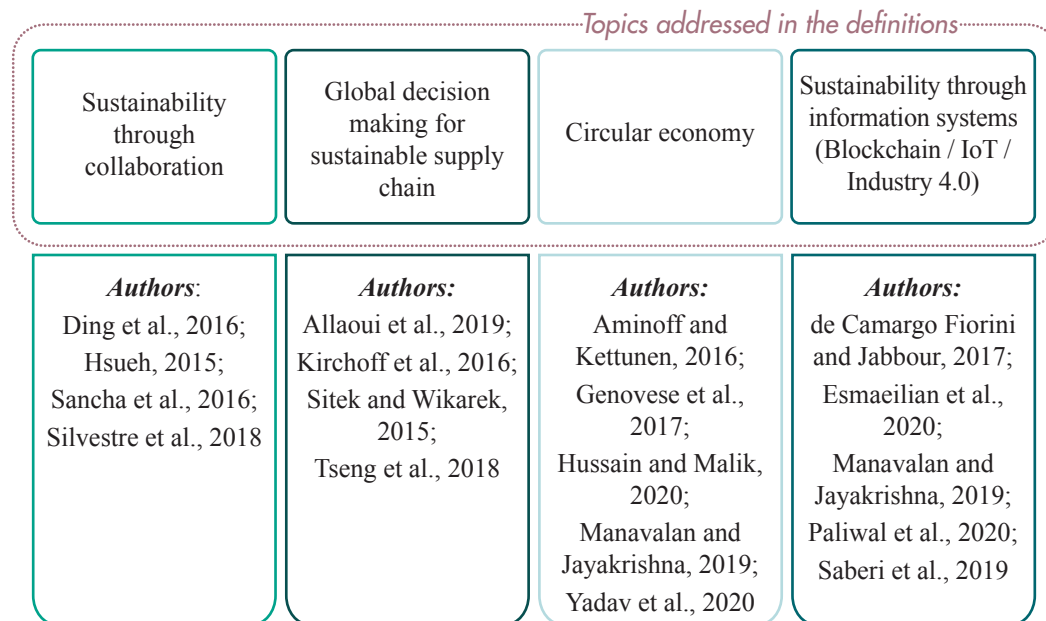


Figure 8: Topics related to sustainable supply chain management in the recent literature

By studying the different themes and authors in the SSCM field, it can be observed that for SSCM, the themes are more focused on strategy, such as decision-making, or the circular economy. It can be noted that some themes are more recent than others, such as the circular economy and sustainability through new information systems such as blockchain or IoT. This can be explained by the fact that sustainability encompasses all three pillars (economic, environmental and societal), including social and ethical aspects which are increasingly important in the supply chain. Indeed, the ethical aspect and the human factor are crucial; the ethical aspects of sustainability, ethical procurement and ethical purchasing are increasingly being addressed (Lu et al., 2018), as well as procedures on ethical trade, complex environmental and societal problems and human rights. In fact, it is no longer just the product that is perceived, but the whole chain, and as Silvestre et al. indicate, we are living “in an era of highly publicized scandals and rising public concern about global environmental degradation and poor labour conditions in supply chains” (Silvestre et al., 2018, p. 3). The integrity of the sustainable supply chain is also being addressed, through the human aspects, as Castillo et al. (2018) explain in their article, using the example of working conditions in relation to conflict metals. They take the example

of the company Intel, which was able to “to achieve certification of certain 3TG smelters as conflict-free, while eliminating supply chain problems such as unethical labour issues (e.g., underage or underpaid workers), and undereducated workforce of their suppliers” (Castillo et al., 2018, p. 4)

This literature review on the evolution of SSCM emphasizes the importance of the subject and the high level of attention it receives. Today, a large number of articles are literature reviews, or bibliometric/systematic analyses that show and explain the evolution of this research field (Ansari and Kant, 2017; Fahimnia et al., 2015, 2015; Khan et al., 2021; Koberg and Longoni, 2019; Nimsai et al., 2020; Rajeev et al., 2017; Tseng et al., 2019). A figure from an article entitled “Mapping the knowledge base of sustainable supply chain management: A bibliometric literature review” by Nimsai et al. (2020, p. 7,348) is presented in Figure 9. This bibliometric article proposes to study the evolution of SSCM from 1995 to 2020. Figure 9 provides an overview of the evolution of the themes covered by SSCM from 2010 to 2018. In it, the authors underscore that the evolution started in the 2010s, with the topics of competitiveness and strategy, and that thereafter the importance of environmental aspects took precedence. The most recent research in this figure is based on decision-making, one of the elements that was also identified in the previous analysis of SSCM. This figure highlights what is being undertaken in the field of SSCM, and even though the theme of collaboration is addressed in Figures 7 and 8, it can be observed in general that the issue of integration (a step further than collaboration) is not very present in the literature, including in Figure 9. However, Nimsai et al. (2020) indicate that one of the most cited articles in SSCM is “Extending green practices across the supply chain: The impact of upstream and downstream integration”, authored by Vachon and Klassen (2006) (Nimsai et al., 2020, p. 12). From the title and the prestige of this article, it seems that the subject of integration is paramount. Furthermore, as indicated by Castillo et al. (2018, p. 11) “Cross-Organizational Integration” could be a future research avenue. However, as can be seen in Figure 9, the integration of downstream actors does not emerge as a theme in the literature. For that reason, this research studies integration, and more specifically, the integration of downstream actors, in order to propose a more sustainable SC.

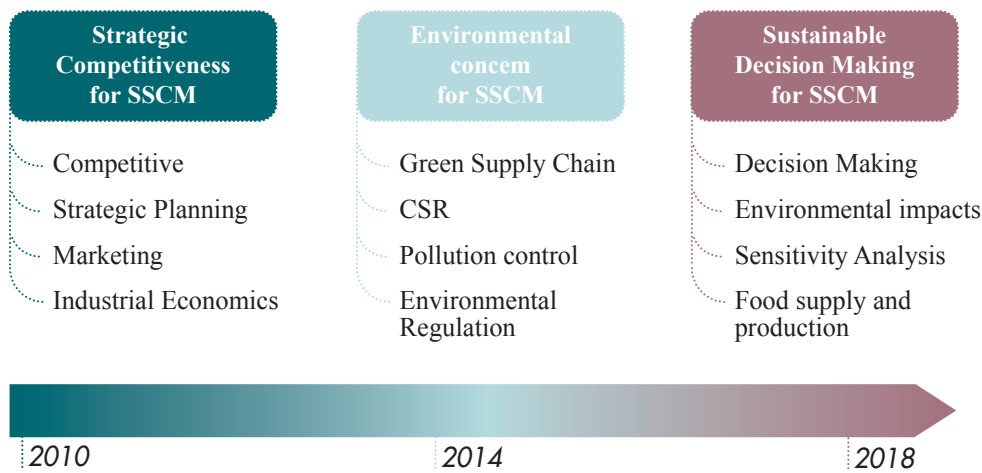


Figure 9: Evolution of the themes research front in SSCM (Nimsai et al., 2020, p. 15)

Furthermore, as shown in Figure 10, taken from the article “Evolution of sustainability in supply chain management: A literature review” by de Rajeev et al. (2017, p. 312), which studies the evolution of SSCM, a lot of research has been carried out on sustainability in terms of strategy, performance, and closed-loop supply chains (CLSC), as well as reverse logistics. However, little research has been completed on sustainable design and sustainable production in the field of SCM. It is from this gap that the challenges of the Need project, and this thesis emerge, with a view to proposing more sustainable SC products and processes. It will be seen later that these themes have been more often addressed in the field of innovation, but here we focus on the issue of sustainability in SCM.

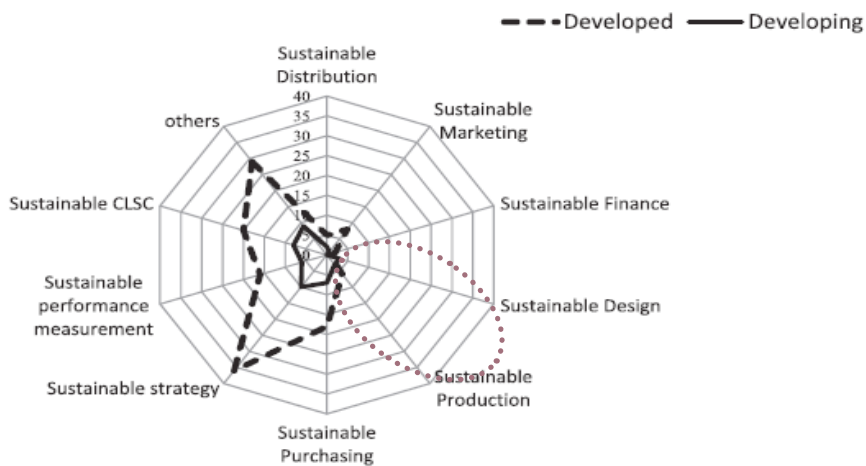


Figure 10: Various issues in SSCM (from Rajeev et al., 2017, p. 312)

In their research, Seuring and Müller (2008) propose 19 issues in SSCM that go beyond the environmental aspect. Some of the elements they identify are directly related to this topic, so 6 of these 19 issues are included in this thesis. The other 13 issues are not directly related to the topic of this thesis. For example, the development of sustainable standards in SC processes, such as ISO 14001, are not the focus of this research. Nevertheless, Figure 11 shows the 19 issues studied by Seuring and Müller (2008), ranging from sourcing and regulation to financial aspects, whilst the dark boxes represent those that are directly relevant to this research, namely:

- “Supply chain-wide cooperation and communication (cross-border information management; long-term contracts; providing confidence; generating common values)
- Awareness of social and environmental responsibility; corporate social responsibility
- View on extended SC; extending sustainability efforts beyond immediate interfaces; SC network; chain-wide process integration; product life-cycle
- Sustainable innovation
- (Public) Pressure of stakeholders; need for transparency (especially related to focal companies)
- Labour conditions” (Seuring and Müller, 2008, p. 459)

Indeed, since here we are concerned with the integration of downstream actors, the notion of collaboration is relevant. When two actors collaborate it means that they work together, so the notion of integration is present, because actors who are sometimes not part of the chain can be added to it, and can subsequently collaborate. Secondly, in this thesis and particularly in the empirical part, the question of how sustainability of SCs is perceived, both by companies and by consumers, is examined. Thirdly, the notion of extended SCs is also important, as, in this research, the sustainability of both products and processes is perceived. Fourthly, a fundamental point is sustainable innovation, which is studied in this thesis through integration methods. Fifthly, the question of external pressures is not necessarily at the heart of our subject, but allows the context to be better understood, including pressure from governments or consumers that forces companies to create more sustainable SCs and products. Sixth and finally, the issue of working conditions is important

in the context of this thesis, as forced labour and child labour are at the core of the issues relating to the exploitation of rare metals, nanotechnology and the IoT. These different elements will be looked at in more or less detail in the remainder of this research. It is interesting to see that authors do not refer directly to the integration of downstream actors. Though they do stress the importance of integrating suppliers and collaborating along the chain, the notions of customers, consumers and users are not mentioned. This gap in the literature confirms the relevance of questioning and observing practices related to integration of downstream actors in order to propose more sustainable products and SCs.

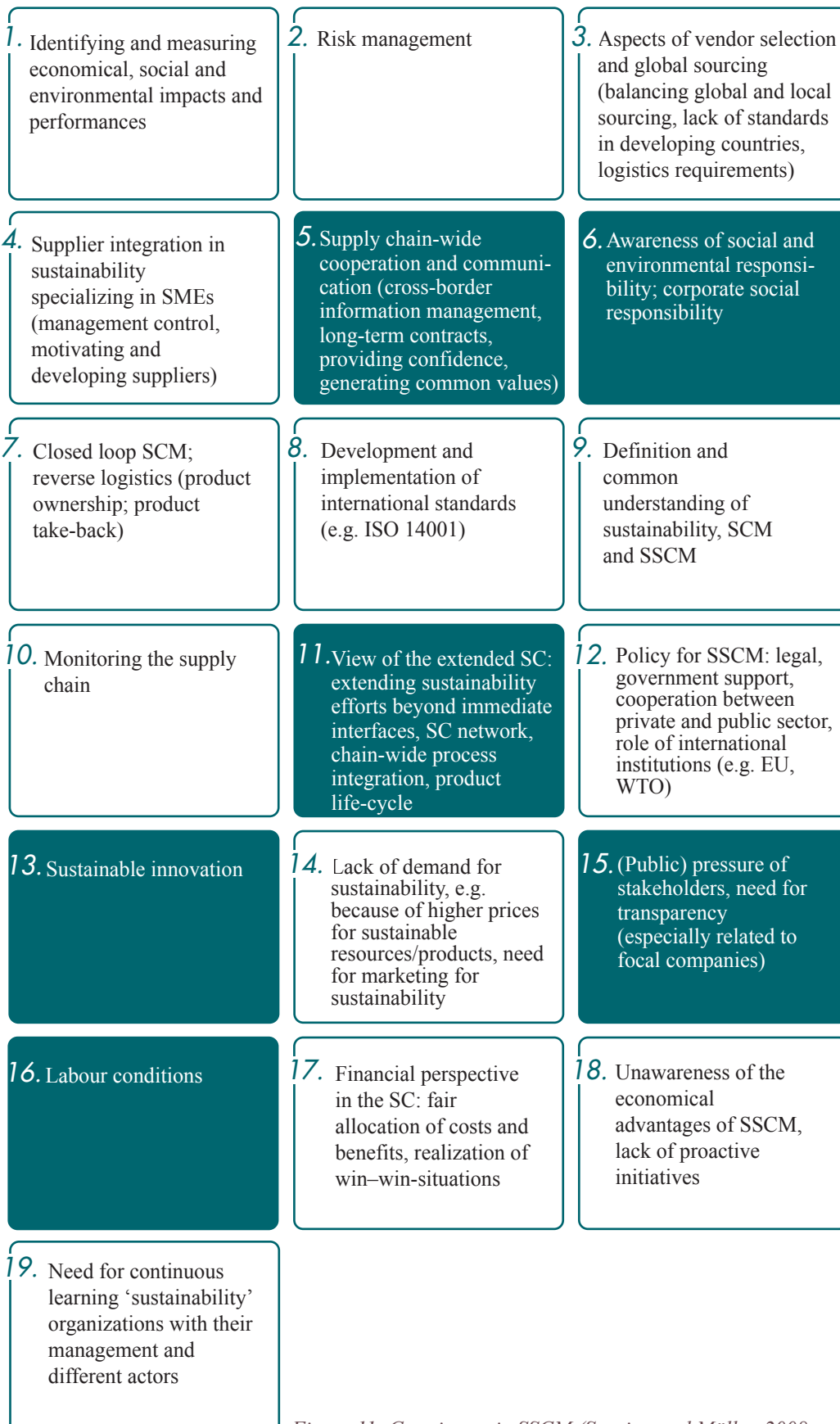


Figure 11: Core issues in SSCM (Seuring and Müller, 2008, p. 459)

1.2 SSCM along the chain

In general, implementing a sustainable approach forces organizations to create more added value throughout the supply chain by sacrificing lower costs (Leenders and Blenkhorn, 1988). The important factor is to apply this concept from the processing of the initial raw material through to delivery of the product to the final consumer (Koberg and Longoni, 2019; Tseng et al., 2019). However, sustainability must also be applied at the level of all flows, taking into account product design, manufacturing components, materials used in manufacturing and machining, improvement of product life, end of product life-cycle, and the product recycling process (Genovese et al., 2017; Linton et al., 2007). Some studies have analysed the life-cycle of a product and have helped us to understand how to design a product while minimizing its environmental impact during and after its life (Genovese et al., 2017; Karna and Heiskanen, 1998; E. Manavalan and Jayakrishna, 2019; Pennington et al., 2004; Rebitzer et al., 2004). This field is at the crossroads of product engineering and design, and deals with the depletion of material resources and environmental impacts. By extending the life of a product, the depletion of resources related to its production is limited (Linton and Jayaraman, 2005). This idea runs counter to the programmed obsolescence of objects and overconsumption (Guide Jr et al., 2003; Linton and Johnston, 2000; Woellert, 2006). The product design stage is crucial with regard to the probability of reuse, recycling or incineration of the product (Ansari and Kant, 2017; Genovese et al., 2017; Micklitz, 1992; Shih, 2001). Regarding the implementation of sustainability, companies can be proactive to avoid being passively affected by regulations imposed by governments (Carter and Rogers, 2008). But regulations, laws, incentives or disincentives are necessary to force companies to manage sustainability and the waste they produce. Related aspects must also be addressed, such as logistics, transport and all other functions related to operations or remanufacturing (Linton et al., 2007). Governments are likely to impose a stricter legal framework for the implementation of sustainable practices in industrialized companies, and the financial impact for these companies will be even greater if they do not anticipate this ecological shift (Carter and Rogers, 2008). Furthermore, it is essential to remember that the total cost of a product must include elements related to resource depletion and waste generation, both in its manufacture and its disposal (Hussain and Malik, 2020; E. Manavalan and Jayakrishna, 2019).

The downstream phase of the supply chain is also important, and product recovery and reverse logistics should be discussed at length (Dubey et al., 2017; Jayaraman et al., 2003; Linton et al., 2007; Meixell and Luoma, 2015; Zimon et al., 2020). However, adding this sustainable evolution to the equation makes SCM more complex. Strategic business issues are impacted, and short-term investment is required both for the implementation of new processes and the uncertainty associated with these changes, and for the implementation of new tasks on a daily basis (Corbett and Klassen, 2006). Companies have every interest in adopting a sustainable SCM approach, but implementing such an approach can sometimes be challenging. It can generate a financial cost that some companies are not prepared to pay (Corbett and Klassen, 2006). Seuring and Müller (2008) point out the bottlenecks in implementing SSCM and the gaps that still need to be tackled:

- “Sustainable supply chain management has to take into account a wider range of issues and, therefore, look at a longer part of the supply chain.”
- “Sustainable supply chain management deals with a wider set of performance objectives, thereby taking into account the environmental and social dimension of sustainability.”
- “There is a much increased need for cooperation among partnering companies in sustainable supply chain management.”
- “Sustainable development is often reduced to environmental improvements.”
- “A theoretical background is often missing.” (Seuring and Müller, 2008a, pp. 1,705–1,706).

In light of these elements provided by Seuring and Müller, cooperation emerges as an important notion. The elements presented in SSCM insist on and highlight the need to have an end-to-end vision, to collaborate, to “do together”, to involve and engage all the actors of the SC in order to achieve a more sustainable SC and products. This is why it seems essential to study the link between SSCM and integration into the SCM.

1.3 Link between SSCM and the integration of actors

As indicated, “the intensification of international competition, media scrutiny, and consumer awareness has forced firms to pay more attention to their sustainability performance” (Silvestre et al., 2018, p. 1). This statement clearly indicates that the end consumer is becoming a source of pressure for companies - even B2B companies have to take into account consumers’ expectations in terms of sustainability (Seuring et al., 2008; Sharma et al., 2010). As previously mentioned, the theme of collaboration is central with regard to the sustainability of SCs. Many authors point out that it is important to collaborate with upstream and downstream actors (Chin et al., 2015; Irani et al., 2017; Vachon and Klassen, 2006). Indeed, as “these supply chains involve diverse stakeholders (i.e., producers, retailers, distributors, and final consumers) in different geographical locations” (Silvestre et al., 2018, p. 5), it is important to go further and to integrate them in order to achieve more sustainability in the SC. Vachon and Klassen (2006) suggest that integration can have an impact on the implementation of sustainable supply chain practices, affecting practices in different ways, for example, “collaborative activities include joint planning sessions with regard to the environment, knowledge sharing activities pertaining to greener product design or process modification, and reducing waste in the logistics process.” (Vachon and Klassen, 2006, p. 799). The most relevant part for this thesis is the reference to “greener product design or process modification” (Vachon and Klassen, 2006, p. 799). These authors propose a figure entitled “Simplified supply chain – with Green Supply Chain [GSC] practices and supply chain integration” (Vachon and Klassen, 2006, p. 800) which highlights environmental practices through integration into SCM (Figure 12). Focusing on this figure, an interesting point to note is that consumers do not feature in it (the original figure is framed in red and the consumer in blue has been added in this thesis), although they are increasingly recognized as important actors in the SC (Christopher, 2016). In the rest of this thesis, the focus remains on the blue part of this figure, i.e., the integration of downstream actors, including the customer, but also the consumer, with the aim of proposing products or supply chain processes that are more environmentally friendly and more sustainable, taking into account the social and economic aspects.

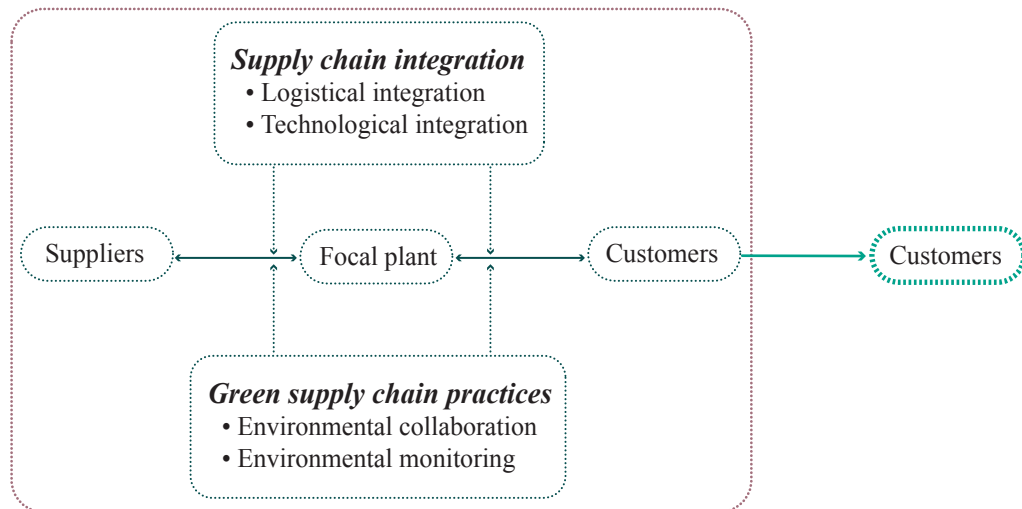


Figure 12: GSC practices and SCI (Vachon and Klassen, 2006, p. 800), including consumers

Indeed, downstream collaboration often stops at the customer, especially in a B2B model, but collaborating with consumers is also important to enable a greening objective for the chain (Gunasekaran et al., 2015; Kasulaitis et al., 2021). Again, as previously mentioned, this is because “there is also high consumer pressure for quality products that respect environmental and social standards and policies” (Silvestre et al., 2018, p. 5; León-Bravo et al., 2017; Bravo et al., 2021). The literature on this subject is not widely discussed in the SCM field. The articles discussing this subject are often at the crossroads between the fields of SCM and innovation, for example, the journals that most address this topic are mainly the *Journal of Cleaner Production* and the *Journal of Product Innovation Management*. An article entitled “Linking sustainability-oriented innovation to supply chain relationship integration” (Neutzling et al., 2018), which deals with integration for sustainability, is published in the *Journal of Cleaner Production*. As another example, an article entitled “Developing sustainable new products in the textile and upholstered furniture industries: Role of external integrative capabilities” (Dangelico et al., 2013) also deals with actor integration with the aim of creating sustainable innovation. Furthermore, a limited number of researchers place the consumer or the user at the centre of their research (Carrillo-Hermosilla et al., 2010). It should be borne in mind however, that some authors disagree on this aspect. For Laperche and Picard (2013), the integration of consumers and users is a prerequisite in terms of sustainable

innovation in manufacturing companies. While De Marchi (2012) points out that the consumer's lack of complex and technical knowledge does not help very much with environmental innovation. For others, the manufacture of sustainable products and services encourages industries to collaborate while eliminating many boundaries (Dangelico et al., 2013). This enables a better vision of consumer behaviour (Vergragt et al., 2014), while demonstrating that these sustainable innovations are of real benefit for consumers, whose acceptance is sometimes a major barrier to the creation of this type of product (Heiskanen et al., 2005). This is why several authors stress the importance of consumer integration in innovation (Hyysalo et al., 2013; Slotegraaf, 2012; Vergragt et al., 2014).

Consumers, who traditionally play a passive role by simply giving their opinion on a product or service consumed (Bosch-Sijtsema and Bosch, 2015), are nowadays important sources of innovation for companies. Indeed, the user innovation described by Von Hippel (2007) depicts end users ready to innovate with their own consumption in mind, for example, by making technological changes to a product. Some companies actively integrate consumers, integrating their needs and exploiting their technical knowledge to provide sustainable opportunities (Priem et al., 2012; Von Hippel, 1986; Zimmerling et al., 2017).

The evolution and the importance of SSCM subjects emerges quite clearly, emphasizing the triptych of the environment (which is predominant in GSCM), alongside the social and economic aspects. The social aspects seem key in the current context of companies using rare metals and manufacturing IoT products, especially human aspects (such as working conditions). Thus, the importance of the link between SSCM and the integration of actors, as well as the importance of downstream actors, has been highlighted. The theme of integration, referred to as supply chain integration (SCI), which is a highly developed theoretical field in SCM, will now be examined in more detail. This research will also look to the concept of engagement and connection, which is also relevant even though it is found more in the fields of innovation and marketing.

2. Integration, engagement, and connection with downstream actors

Downstream actors and how to integrate, connect and engage them in SCM is detailed in the subsequent section, as well as the methods that can be used to achieve this integration.

2.1 Who are the downstream actors?

Clear definitions of the different downstream actors are not put forward in the literature (Marty, 2021). This topic is discussed in the literature review in Chapter 4 of Part 2, which has already been published (Marty, 2021).

In this part, the dictionary definitions of these terms are briefly recalled (Table 3) and then the ambiguity in the literature with regard to these terms is observed. This table shows that the definition of the customer is more widely discussed in the literature than that of the consumer and user.

Table 3: Definitions of the terms customer, consumer and user

	Customer	Consumer	User
Definition in the literature	“The actual or prospective purchaser of products or services” (Bennett, 1995, p. 73)	The consumer is defined as “a buyer or user of a product or service” (Yadin, 2002, p. 85)	The end user is defined as “the actual user of a product, as distinct from its purchaser or specifier” (Yadin, 2002, p. 135)
Definition in the literature	The customer is defined as “one of the parties to a legally binding contract to purchase goods or services” (Yadin, 2002, p. 106)		
Definition in the Cambridge dictionary	“A person who buys goods or a service”	“A person who buys goods or services for their own use”	“Someone who uses a product, machine, or service”
Definition in the Larousse dictionary	“A person who receives commercial supplies or services from a company for payment”	“A person who buys any products for his use”	“A person, a group that makes use of something, that uses a device, a service”

The concepts of final consumer, customer and user are frequently interchanged and used interchangeably, making it difficult to understand and apprehend the subject's scope. A number of articles in the literature were found (20 quotations from a dozen articles), which demonstrate the complexity of the terms consumer, customer, and user. The terms are classified into three categories: interchangeability, imprecision and confusion.

For example, in the same documents Pergelova states "Marketing scholars have suggested that value is nowadays increasingly co-created in an interactive dialogue between firms and consumers [...] scholars in management and marketing have started to underline that value is co-created with customers in an interactive process" (Pergelova, 2010, p. 12). In the same paragraph, this author stresses the importance of co-creating with consumers and then emphasizes the same point with regard to the customer. In this context it is difficult to define whether the author is distinguishing between the two actors, or using these words as synonyms. Table 4 lists all the references analysed in regard to ambiguity of terms.

2.1.1 Ambiguity of terms: Interchangeability

Some authors, such as Kaulio (1998), openly explain that they do not make any differences between these terms. For example, he states, "In this paper, the word 'customer' is employed as a synonym for consumer or user" (Kaulio, 1998, p. 142) and "the customers here refer to the end consumers." (Kurniawan et al., 2004, p. 5). This can nevertheless be disconcerting for the reader. Some authors leave readers in a kind of blur that does not enable them to understand whether there is a real distinction between the consumer and the customer or the user. For example, Sampson and Spring (2012) indicate that "In traditional manufacturing supply chains, the customers—end consumers in particular—are beneficiaries of the various supply chain roles but are only responsible for selecting, paying for, and using the outputs" (Sampson and Spring, 2012, p. 31). This example shows that the authors use the term 'customers' and 'end consumer' more or less as synonyms. However, if the authors had not stipulated the term 'end user', the sentence would have implied that it is the customer who uses the output, which is not entirely correct according to

the dictionary definition. In view of this example, it seems necessary to clarify the terms. Other examples of quotations from literature are presented in Table 5, which highlights these ambiguities in terms of the interchangeability of words.

2.1.2 Ambiguity between terms: Imprecision

Other authors confirm that there is a knowledge gap on this subject and that consumers and customers are sometimes difficult to separate, as is the case for Sampson and Froehle (2006, p. 332), who cite the definitions proposed by Bennett: “The concept of ‘customer’ is so fundamental as to almost elude definition. The American Marketing Association (AMA) defines ‘customer’ as ‘the actual or prospective purchaser of products or services’” (Bennett, 1995, p. 73). This definition does not entirely satisfy the authors and they point out that in some situations it is not accurate. They state that “the AMA’s definition of ‘consumer’ is a bit broader: Traditionally, the ultimate user or consumer of goods, ideas, and services. However, the term is also used to imply the buyer or decision maker as well as the ultimate consumer” (Sampson and Froehle, 2006, p. 332). However, this is not always the case, and the authors take the following example: “a mother buying cereal for consumption by a small child is often called the consumer although she may not be the ultimate user” (Bennett cited in Sampson and Froehle, 2006, p. 332). Similarly, Giese and Cote (2000) confirm that “the literature has been lax in distinguishing between consumer satisfaction, customer satisfaction, and satisfaction” (Giese and Cote, 2000, p. 3). It could be assumed that the same is true for the basic terms of consumer, customer and user. Pergelova (2010, p. 12), states that “Marketing scholars have suggested that value is nowadays increasingly co-created in an interactive dialogue between firms and consumers” and that “Scholars in management and marketing have started to underline that value is co-created with customers in an interactive process”.

Nevertheless, the actor to be integrated in a co-creation approach remains unclear. Indeed, several authors take up the definition of co-creation, sometimes indicating the customer, sometimes the consumer (Table 4).

Table 4: Definition of co-creation proposed by different authors

Definition	Author
“Hoyer et al. (2010) [...] They define co-creation in this context as ‘a collaborative new product development (NPD) activity in which consumers actively contribute and select various elements of a new product offering.’”	(Verhoef et al., 2010, p. 249)
“‘a collaborative new product development (NPD) activity in which consumers actively contribute and select various elements of a new product offering’ (O’Hern and Rindfleisch, 2009, p. 4)”	(Hoyer et al., 2010, p. 283)
“collaborative NPD activity in which customers actively contribute and/or select the content of a new product offering.”	(O’Hern and Rindfleisch, 2017, p. 4) (The latest version of their book)

It can be seen in Table 4 that the definition of O’Hern and Rindfleisch (2017) uses the term customer, while Hoyer et al. (2010) have replaced the term customers by consumers, and that Verhoef et al. (2010) have also recovered the word consumer. This example highlights the ambiguity and imprecision of these terms. Table 4 also groups together quotes from the literature concerning the use of imprecise terms.

2.1.3 Ambiguity between terms: Confusion

Finally, the last category corresponds to articles where the terms customer, consumer and user are used in a way that is confusing to the reader. Confusion means a situation in which the reader cannot understand which actor is involved. For example, the quote “firms can better leverage their internal resources to meet the expectations of the ultimate customer” (Patel et al., 2013, p. 719), does not enable the reader to understand whether the ‘ultimate customer’ refers to the last customer in an extended SC or whether it refers to the consumers of the product. Similarly, the quote “recognising end-user customer service level requirements” (Jones and Riley, 1985, p. 19), does not make it possible to understand whether the required level of service applies to the user or to the customer, whereas this distinction is necessary to identify the actors in the chain to whom the issue of service level improvement applies. Table 5 also highlights several quotes from the literature that refer to a confusion of the terms consumer, customer and user.

The terms are not always defined by the authors' articles and this can lead to ambiguity, as can be seen in Table 5.

Table 5: Article references: asymmetry between consumer, user, customer

Ambiguity	References
Interchangeability	- "In traditional manufacturing supply chains, the customers–end consumers in particular—are beneficiaries of the various supply chain roles but are only responsible for selecting, paying for, and using the outputs" (Sampson and Spring, 2012, p. 31).
	- "A product is a thing whereas a service is an activity—a process—which involves the treatment of a customer (or user) or something belonging to them" (Johnston and Kong, 2011, p. 3).
	- "This is true whether the customer is an end consumer (for example, consumers of health care, education, personal care, or legal services) or a business (for example, organizations purchasing maintenance, insurance, computer consulting or training services)" (Jo Bitner et al., 1997, p. 193).
	- "Typically, customers (or users) have the most accurate and detailed knowledge" (O'Hern and Rindfleisch, 2017)
	- "The co-creation of value is a desirable goal as it can assist firms in highlighting the customer's or consumer's point of view and in improving the front-end process of identifying customers' needs and wants" (Payne et al., 2008, p. 84)
	- "The customers here refer to the end consumers ." (Kurniawan et al., 2004, p. 5)
Imprecision	- "In this paper, the word ' customer ' is employed as a synonym for consumer or user " (Kaulio, 1998, p. 142)
	- "A mother buying cereal for consumption by a small child is often called the consumer although she may not be the ultimate user " (Bennett cited in Sampson and Froehle, 2006, p. 332)
	- "The literature has been lax in distinguishing between consumer satisfaction, customer satisfaction, and satisfaction" (Giese and Cote, 2000, p. 3)
	- "Hoyer et al. (2010) [...]They define co-creation in this context as 'a collaborative new product development (NPD) activity in which consumers actively contribute and select various elements of a new product offering.'" (Verhoef et al., 2010, p. 249)
	- "A collaborative new product development (NPD) activity in which consumers actively contribute and select various elements of a new product offering'(Hoyer et al., 2010, p. 283)
	- "Collaborative NPD activity in which customers actively contribute and/or select the content of a new product offering." (O'Hern and Rindfleisch, 2017, p. 4)
- "Marketing scholars have suggested that value is nowadays increasingly co-created in an interactive dialogue between firms and consumers [...]Scholars in management and marketing have started to underline that value is co-created with customers in an interactive process" (Pergelova, 2010, p. 12)	

- “Further, it highlights the value-creation process that occurs when a **customer consumes, or uses**, a product or service, rather than when the output is manufactured.” (Payne et al., 2008, p. 83).
- “Firms can better leverage their internal resources to meet the expectations of the **ultimate customer**” (Patel et al., 2013, p. 719).
- “Recognising **end-user customer** service level requirements” (Jones and Riley, 1985, p. 19).
- “On the **users’ or customers’** side, collaboration may provide ideas for entirely new products and/or modifications to existing ones” (Al-Zu’bi and Tsinopoulos, 2012, p. 667).
- “For instance, Gallup research found that on a per-trip basis, ‘fully engaged’ **customers in the consumer** electronics industry spent \$373, compared to \$289 by the ‘actively disengaged’ customers” (Kumar et al., 2019, p. 138).
- “That **customers’** adoption of offerings is influenced by other **customers** who live nearby and other **customers** who are similar and that social contagion influences the adoption of the Internet channel more than the retail store. Additionally, Risselada et al. (2014) find that similar **consumers** are more likely to share their experiences and communicate with each other” (Kumar et al., 2019, p. 153).
- “For example, leisure firms proactively ask recent customers to provide ratings on independent comparison websites. Recently, Lays’ chips asked **customers** to develop a new chips flavor in a contest. The winner will receive 1% of the turnover of the resulting new product.” (Verhoef et al., 2010, p. 248).

As shown in Table 5, the ambiguity between the terms consumer, customer and user is present in the literature. For the remainder of this thesis, these terms are used according to the definitions proposed previously. Customers correspond to an intermediary before consumers, who do not buy a product for their own consumption. Consumers are the last component of the SC (with the user)—they pay for a product to consume it. Users are those who use or consume the product, without necessarily having bought it themselves, unlike consumers.

To conclude, this research proposes a clear and simple definition of the terms customers, consumers and users, applicable in the field of supply chain management.

- The customer is a member of a company’s downstream supply chain, who may be the actor between manufacturing (or distribution) and the final consumer of the product or service. Customers buy goods or services not for their own consumption, but to benefit others (this often involves a resale stage).
- Consumers are the last member of a company’s downstream supply chain, they buy and consume a product or service for their own consumption.
- Users are also the last members of a company’s downstream supply chain, but can also be considered a member of the reverse supply chain—they are the last actors to consume the product or service, without necessarily having purchased it.

Figure 13 shows the three downstream actors and their respective definitions in the context of SCM.

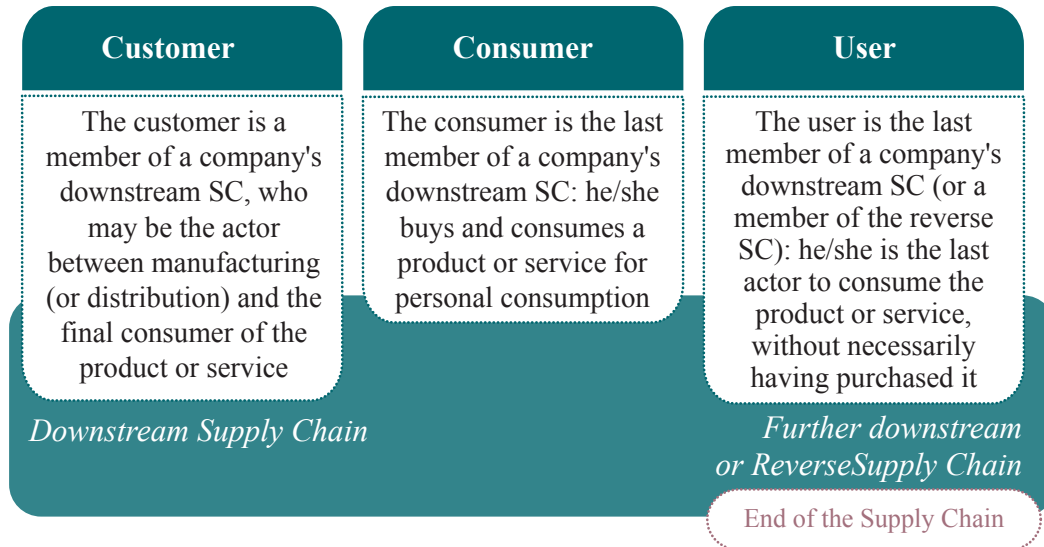


Figure 13: Downstream actors and their definitions in this thesis

2.2 Difference between integration/connection/engagement

The difference between the concepts of connection, integration and engagement can be seen in the literature, particularly in relation to the fields that apply the concept, namely, SCM, innovation and marketing. This analysis of the literature is supported by the definitions proposed by the English Cambridge dictionary and the French Larousse dictionary. These definitions are observed in relation to the verbs they relate to, namely to integrate, to connect and to engage. For example, the Larousse dictionary definition of integration translates into English as ‘the act of integrating’. In our analysis of the literature, the meanings we attached to the terms connection, integration and engagement align with the definitions given in the Cambridge English and Larousse French dictionaries.

2.2.1 Integration

The topic of integration is present in the fields of marketing (Vargo, 2008; Vargo and Lusch, 2004; Wilson et al., 2016), innovation (Da Mota Pedrosa, 2012; Edvardsson et al., 2010; Petersen et al., 2003; Tomas et al., 2014) and supply chain management (Flynn et al., 2010; Frohlich and Westbrook, 2001; Jacob, 2006; Vachon

and Klassen, 2006; Yao, 2017; Y. Zhang et al., 2019). In the field of SCM, the concept of integration has a much more operational orientation as opposed to the behavioural approach seen in marketing. As indicated by Vachon and Klassen, “Integration [...] is undertaken to improve the operations in the buying organization and/or the supply network. [...] [and] can occur upstream with suppliers and downstream with customers” (Vachon and Klassen, 2006, p. 800).

The integration seen in supply chain management corresponds to improving and facilitating exchanges, connecting the different members of the supply chain, allowing more efficient decision-making, and improving the visibility of supply chain activities, thereby anticipating bottlenecks (Power, 2005). This topic of integration in SCM has been studied for many years, and is still studied today through issues such as sustainability (Chen et al., 2017; Neutzling et al., 2018; Shee et al., 2018).

Inter-organizational relationships, a volatile and demanding customer due to increasing global competition, and the importance of information are the main drivers behind supply chain integration (Handfield and Nichols Jr, 1999). According to Handfield and Nichols Jr (1999), the management of physical flows, information and financial flows, and the relationships between the various members of the supply chain are the three fundamentals of SCM integration. Integrated process management results from collaboration, cooperation, information and technology sharing, and mutual trust between partners (Akkermans et al., 1999). Integration must begin from the design of the product to the distribution of the product to the final consumer, including all intermediate steps (Ballou et al., 2000). Through integration, the company is transformed, traditional physical barriers are broken down and major changes are noticeable, both in terms of internal processes which are then implemented by different partners, as well as in terms of performance objectives and customer satisfaction (Cottrill, 1997). The alignment of the objectives of all supply chain actors is necessary, leading to potential cost savings, more accurate information sharing, and improved customer satisfaction (Wood, 1997). Integration is effective when customers and suppliers develop partnerships and common goals (Parnell, 1998). Authors emphasize that integration is a fundamental objective of the SCM (Frohlich and Westbrook, 2001; Power, 2005).

In the current global context, the integration of actors into SCM is key to gaining resilience, flexibility and responsiveness. SC integration aims to improve and facilitate exchanges, allowing more efficient decision-making while improving the visibility of SC activities, thereby anticipating bottlenecks and increasing overall performance and competitiveness (Frohlich and Westbrook, 2001; Lee et al., 1997; Narasimhan and Jayaram, 1998; Narasimhan and Kim, 2002; Power, 2005; Stevens, 1989; Vickery et al., 2003). This integration must be a two-way ‘outward facing’ process, i.e., an opening towards suppliers as well as towards customers (Frohlich and Westbrook, 2001), beginning from the design of the product or service to its distribution to the final consumer, including all intermediate stages (Ballou et al., 2000).

A significant amount of research has been conducted on the integration of suppliers, and it suggests that this upstream integration creates an effective competitive strategy, providing greater flexibility and coordination both internally and externally (C. W. Lee et al., 2007; Petersen et al., 2005; Rich and Hines, 1997; Walton et al., 1998). From an environmental perspective, Walton et al. highlight that regulations are not sufficient to achieve acceptable performance from a sustainability point of view, and that most companies integrate their suppliers and buyers “to meet and even exceed the environmental expectations of their customers and their governments” (Walton et al., 1998, p. 2). Petersen et al. (2005) indicate that supplier integration can be beneficial in the context of new product development, allowing access to supplier expertise and better quality information exchange earlier and further upstream in the new product development process. Thus, the integration of upstream actors, such as suppliers or buyers, can respond to different issues like sustainability or new product development.

This integration does not stop with upstream actors, even if a lot of literature exists on this topic; indeed, it was already a subject of investigation in the past (Abdallah et al., 2017; C. W. Lee et al., 2007; Petersen et al., 2005; Rich and Hines, 1997; Walton et al., 1998), but nowadays, SCI research focuses on all actors as well as the issue of sustainability (Chen et al., 2017; Neutzling et al., 2018; Shee et al.,

2018; Vachon and Klassen, 2006; Wiengarten and Longoni, 2015). This topic is addressed in Part 1 of Chapter 2.

It would therefore seem that integration concerns all the actors in the chain (Frohlich and Westbrook, 2001), and can be implemented for several objectives, whether improving sustainability, reducing risks, or enhancing performance (Flynn et al., 2010; Frohlich and Westbrook, 2001; Neutzling et al., 2018; Vachon and Klassen, 2006). The integration of downstream actors in order to achieve these objectives is addressed in the SCM literature (Yu et al., 2013; Zhang and Awasthi, 2014; Zhu et al., 2018; Zondag and Ferrin, 2014). Indeed, Marty (2021, p.2) argues that

“Customer integration emerges as a new challenge for companies as it enables the collection of a large number of indispensable data, improving the company’s [...] performance, [...] in terms of customer satisfaction, product diversification and product innovation” (Marty, 2021, p. 2). This integration of downstream actors may concern distributors, transporters, customers and consumers, and their integration into company processes is a much discussed subject (Djelassi and Decoopman, 2013; Frohlich and Westbrook, 2001; Maull et al., 2012; Ramaswamy and Gouillart, 2010; Reyes and Bhutta, 2005; Wright et al., 2006; Yee et al., 2010). For SCs, it is essential to collect information on the consumer (Frohlich and Westbrook, 2001) to achieve the different objectives (Djelassi and Decoopman, 2013; Droge et al., 2004; Fabbe-Costes and Jahre, 2008; Shee et al., 2018). In the field of SCM, consumers have long been seen as passive actors (Ta et al., 2015), but today their integration as active participants can help to create new, more sustainable, better quality and more innovative products.

2.2.2 *Connection*

The topic of connection is approached much more in the field of marketing (Behnam et al., 2020; Bonsu and Darmody, 2008; Forza and Salvador, 2006; Kimmel, 2010; Mikkonen et al., 2008; Pergelova, 2010; Schmitt, 2010; Wilson et al., 2016) and innovation (Burton et al., 2020; Haas et al., 2016; Kurniawan et al., 2004; Margulis et al., 2020; Noble and Kumar, 2008; Pynnönen et al., 2019, 2012) than in SCM (Kim

and Hall, 2015; Vachon and Klassen, 2006). It manifests as exchanges of views and interaction with downstream actors (customers and consumers), sometimes through new technologies (Pergelova, 2010; Pires et al., 2006).

From a marketing point of view, Sheth and Sisodia (2005) emphasize the importance of aligning consumer needs with corporate activities. As consumers are increasingly active and connected to the internet, they like to share their experiences on networks, thus breaking down barriers between the company and customers (Lindberg-Repo and Grönroos, 2004a; Pires et al., 2006; Urban, 2004). Consumers can have an influence on companies with regard to companies' responsibility for the products and/or services offered (Wind and Rangaswamy, 2001). They also have an impact on companies as they increasingly provide feedback. Companies themselves often connect with consumers through methods such as crowdsourcing, based on new technologies and the internet, or the Voice of Customer method (Acar, 2019; Alam and Campbell, 2017; Djelassi and Decoopman, 2013; Green et al., 2020; Kurniawan et al., 2004; Zhu et al., 2017), enabling product innovation, quality and sustainability better overall company performance (Berg et al., 2018; Koufteros et al., 2005; Sul and Lee, 2020; Xing et al., 2017; Zainol et al., 2019; Zhu et al., 2017; Zimmerling et al., 2017).

The connection between the consumer and the marketer creates value for the company by offering an interactive dialogue with the consumer, who then becomes a co-creator. In the marketing sector, the issue of co-creation with customers and consumers, and of interactive exchange and connection is receiving more and more attention and has been studied for several years now. It allows the company to create more value for itself, but also for its downstream actors (Grönroos, 2006a, 2006a; Normann and Ramirez, 1993; Ponsonby and Boyle, 2004; Prahalad and Ramaswamy, 2004, 2003, 2000; Ramirez, 1999; Vargo, 2008). From this connection perspective, consumers are no longer seen as passive actors (Ta et al., 2015), their status has evolved, they have been solicited to give feedback. Indeed, today, more and more companies are giving them an active role where they become actors, sometimes in relation to innovation, sustainability, quality or performance (Berg et al., 2018;

Koufteros et al., 2005; Sul and Lee, 2020; Xing et al., 2017; Zainol et al., 2019; Zhu et al., 2017; Zimmerling et al., 2017). Consumers therefore have much more power and can influence overall company strategy (Wind and Rangaswamy, 2001).

It can thus be argued that interaction with consumers has become a true value-creating process (Ballantyne and Varey, 2006; Vargo and Lusch, 2004). The connection is increasingly made through technological communication tools and the internet, allowing consumers to have more power, to share information with more people, to communicate with each other and with companies, and to have more decision-making power (Lindberg-Repo and Grönroos, 2004b; Pires et al., 2006; Urban, 2004). The democratization of these communication and internet tools also allows consumers to communicate increasingly quickly, and to develop their knowledge and understanding of products, processes and links in the chain. They can therefore have an impact on companies and on the demand for products by asking for more innovative, better quality, or more environmentally friendly products (Kim and Hall, 2015; Leek et al., 2003). From a marketing perspective, interaction with consumers and the ability to co-create value can be a source of competence and an important competitive advantage in a dynamic and complex environment (Prahalad and Ramaswamy, 2004; Ramani and Kumar, 2008; Ramirez, 1999). This approach can lead to deep learning for both companies and consumers, and can also lead to improvements in innovation (Kim and Hall, 2015; Lundvall, 1993; Wikström, 1996). This connection and interaction allows for the continual renewal of knowledge among the different actors in the chain and is seen as a fundamental and sustainable competitive advantage (Ballantyne and Varey, 2006; Ramani and Kumar, 2008).

Yet, the co-creation of value and interaction drastically changes the original roles of companies and consumers. The roles are no longer diametrically opposed - an active company and a passive consumer - but on the contrary, a convergence is born from the co-creation process (Pergelova, 2010; Ta et al., 2015). In this perspective, companies have to change their marketing approach, moving from a marketing system where customers are oriented in their purchasing behaviour, to a more holistic vision where consumers interact with the company, through internet

platforms, for example (Sheth et al., 2000). This vision may pose managerial difficulties, and a different approach to consumers' needs must be adopted (Gibbert et al., 2002), but innovative capabilities, gains in productivity, quality, sustainability, profit, and overall performance can be expected from this connection (Kim and Hall, 2015; Prahalad and Ramaswamy, 2004; Urban, 2004; Zimmerling et al., 2017).

This whole connection and co-creation approach can be based on the theory of service dominant logic (S-D logic) in marketing, which was put forward by Vargo and Lusch (2004) and has been taken up many times (Ballantyne and Varey, 2008; Grönroos, 2006b; Grönroos and Gummerus, 2014; Joiner and Lusch, 2016; Koskela-Huotari and Vargo, 2018; Kuzgun and Asugman, 2015; Merz et al., 2009; Osborne, 2018; Skälén et al., 2015; Vargo et al., 2017, 2014; Vargo and Lusch, 2017, 2016, 2014; Wilden et al., 2017). In this perspective, the term 'service' does not correspond to the opposite of 'goods' - this theory can be applied in the case of a company selling goods. The idea of service here corresponds to a process of dealing with someone. In this theory, the concept of interaction is central, the consumer becomes an active resource and co-producer, instead of being seen as a passive resource in the form of a target to somehow be reached (Ballantyne and Varey, 2006; Lusch and Vargo, 2006; Vargo et al., 2020). This consumer-centric perspective, coming from the SD-logic, is essential to this research, as the downstream actor is the one who could provide insights regarding the sustainability of products and the SC.

Moreover, while the connection with the consumer is important in marketing, it is also relevant in innovation (Burton et al., 2020; Haas et al., 2016; Kurniawan et al., 2004; Margulis et al., 2020; Noble and Kumar, 2008; Pynnönen et al., 2019, 2012), where the consumer has a real role as a designer in the product design and creation process (Kurniawan et al., 2004). As Grönroos (2006a) points out, the consumer can be connected and active at every stage of the chain in order to enable value creation throughout the process. Indeed, the different actors in the chain are no longer as separate as they used to be, and interact with each other, making the lines between B2B and B2C and between goods and services companies less clear (Lovelock and Gummesson, 2004; Vargo and Lusch, 2004). Hence, it might be interesting to see

if this connection nurtured in marketing with downstream actors, customers and consumers can also take place further upstream, between the production or design phases and customers and consumers, allowing upstream firms to have a more global interaction, and to create value between different actors, including the consumer (Prahalad and Ramaswamy, 2000).

2.2.3 *Engagement*

Like the concept of connection, the engagement approach is much more present in marketing than in supply chain literature (Bijmolt et al., 2010; Bowden, 2009; Harrigan et al., 2018; Kumar et al., 2019b; Moliner et al., 2018; Verhoef et al., 2010), and it can also be enacted through engagement via the internet, new technologies (Hollebeek et al., 2016; Malthouse et al., 2016), or social networks that facilitate exchange and engagement from customers and consumers (Deighton and Kornfeld, 2009; Goncalves et al., 2016; Malthouse and Hofacker, 2010).

In the field of marketing, this notion of engagement is closely linked to that of consumer behaviour and relationship with the brand. Such engagement aims to facilitate exchanges and also to try to shape consumer behaviour (Brodie et al., 2013; Grönroos, 1997). Indeed, engagement is defined thus: “Customer engagement is considered as a behavioural manifestation toward the brand or firm that goes beyond transactions.” (Verhoef et al., 2010, p. 247). Overall, as stated in this definition, engagement goes beyond the transactional aspect, and the behaviour and motivation of the customer can go beyond the simple act of buying (Van Doorn et al., 2010). This concept of engagement is part of the theoretical field of customer management (CM) (Boulding et al., 2005; Kumar et al., 2019b; Verhoef et al., 2010). This theoretical field is divided into two streams. The first consists of perceiving customers as an asset for the organization; before engaging them it is important to document and measure this asset (Reinartz and Kumar, 2003, 2000; Rust and Verhoef, 2005; Venkatesan and Kumar, 2004), resulting in “a much better understanding about the various metrics of the customer’s value to the organization” (Verhoef et al., 2010, p. 248). The second stream focuses on how to engage and by what means (Becker et al., 2009; Ernst et al., 2011; Jayachandran et al., 2005; Reinartz et al., 2004).

This second stream, which is the quest to engage these customers and consumers, is central to this thesis. Research in this stream emphasizes that the non-transactional aspect of customer behaviour is important, and is becoming a major aspect of business. Verhoef et al. (2010) give the example of “leisure firms proactively ask recent customers to provide ratings on independent comparison websites. [...] Lays’ chips asked customers to develop a new chips flavor in a contest. The winner will receive 1% of the turnover of the resulting new product.” (Verhoef et al., 2010, p. 248). In this manuscript, an entire article is devoted to the different methods for engaging these downstream actors (Part 2, Chapter 5).

Customer engagement was conceptualized as a model in a widely recognized article entitled “Customer engagement as a new perspective in customer management” (Verhoef et al., 2010). The model is built around several articles in which behaviour plays an important role, customer-to-customer interactions are facilitated by the internet, and which show that engagement initiatives have an impact on the company, and on its overall value (Lehmann, 2004; Libai et al., 2010; Luo, 2009; Van Doorn et al., 2010). Another aspect put forward by this model is that of co-creation with the customer, mainly for the purpose of new product development (NPD) (Hoyer et al., 2010). This concept of co-creation is defined as “a collaborative new product development (NPD) activity in which [consumers] actively contribute and select various elements of a new product offering” and has been taken up by many authors (Hoyer et al., 2010, p. 283; O’Hern and Rindfleisch, 2017, p. 4; Verhoef et al., 2010, p. 249). All three articles use the same definition, but Hoyer et al. (2010) and Verhoef et al. (2010) use the term ‘consumers’ in their definitions while O’Hern and Rindfleisch (2017) use the term ‘customers’: here we can again emphasize the ambiguity that can exist in the use of these terms.

Verhoef et al. stress that “CM research has usually ignored the potential important role of customers in NPD” (Verhoef et al., 2010, p. 249). Yet, as some authors demonstrate, co-creation with the customer can have benefits in terms of performance (Hoyer et al., 2010; Kumar et al., 2019).

Figure 14 shows the framework proposed by Verhoef et al. (2010, p. 249) on customer engagement. The red circles correspond to the elements that are discussed in the rest of this thesis, namely customer engagement, the concept of co-creation and the subject of new product development (NPD).

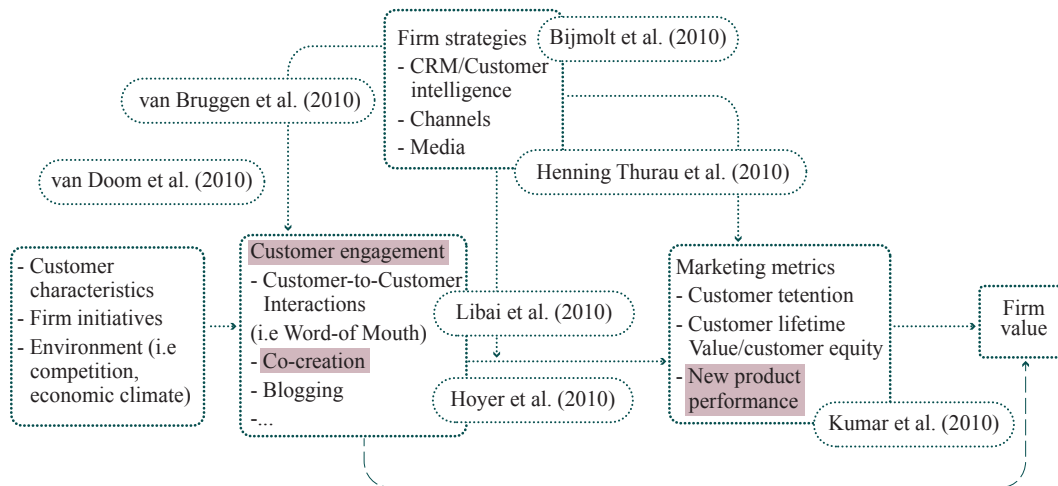


Figure 14: Framework of customer engagement (from Verhoef et al., 2010, p. 249)

The “conceptual framework of consumer co-creation” (Hoyer et al., 2010, p. 284) (Figure 15), is relevant for the continuation of this research. Indeed, here the focus is on the importance of the degree of co-creation, and on the different stages of the supply chain which are concerned by the degree of co-creation, namely, upstream, where idea creation, product development, marketing strategy and post-launch activities take place.

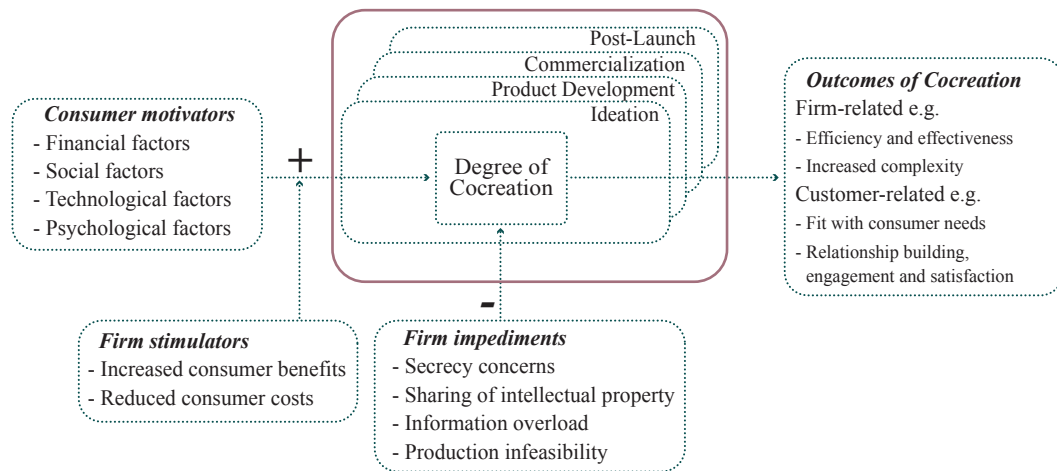


Figure 15: Framework of consumer co-creation (from Hoyer et al., 2010, p. 284)

These elements of customer engagement, co-creation, new product development (NPD), and the degree of co-creation in the different stages of the SC are largely taken up in the rest of this thesis. However, as this research takes place in the field of SCM and not marketing, and as it is more in line with the theoretical field of SCI, the issues of customer satisfaction, customer motivations and customer behaviour, which are more relevant to marketing, are not addressed in the rest of this thesis. Nevertheless, it seems important to look to concepts and theoretical fields in other disciplines such as marketing and innovation, where the subject of customer engagement and connection is widely addressed and can be beneficial for the field of SCM and SCI.

This literature analysis on integration, connection and engagement, whatever the field, i.e., marketing, innovation or supply chain management, emphasizes the importance of integrating, connecting and engaging the downstream actors, whether customers, consumers, or users (Bosch-Sijtsema and Bosch, 2015; O'Hern and Rindfleisch, 2017; Von Hippel, 2007; Zimmerling et al., 2017). To conclude, the definitions of these three concepts are observed from the perspective of two dictionaries (Cambridge and Larousse) (Table 6).

Table 6: Definitions of the terms *integrate*, *connect*, and *engage* from dictionaries

	<i>Integrate</i>	<i>Connect</i>	<i>Engage</i>
<i>Cambridge dictionary</i>	To combine two or more things in order to become more effective	To join or be joined with something else	To become involved, or have contact, with someone or something
<i>Larousse dictionary</i>	Inserting something into something, incorporating it, making it part of a whole	To unite things by relating them to each other	To bind someone morally, to place them in a situation that involves choices and responsibilities on their part

From the dictionary definitions, it can be seen that the action of integrating is defined as inserting something into a whole. In this research, it refers to the downstream actors who are integrated into the SC. From the Cambridge dictionary, there is a notion of efficiency, which is translated in the literature as performance (Flynn et al., 2010; Frohlich and Westbrook, 2001; Vachon and Klassen, 2006). The action of connecting allows two things to be linked together, to join them; in this research, this involves linking the downstream actors to the SC. Finally, the notion of engagement requires an implication on the part of others, taking responsibility and making choices. In this research, it is the downstream actors who are engaged and therefore have responsibility in the SC.

Integrating refers to the act of inserting, but does not necessarily require any action of the integrated actor. Integration involves mutually agreed' action, referred to as conventional action Figure 16, where the actor is inserted into the SC in order to bring efficiency and performance. Connection generates a link between two parties, referring to an action of union, but this does not necessarily mean commitment, so the connection concept could be approached through a transactional action, where there are side-by-side dimensions. Meanwhile, engagement calls for a relational action resulting in the involvement of the parties. This requires choices and responsibilities, where there is a dimension of interaction. Furthermore, according to the literature, the action of integration is performance oriented, and can mean either

internal or external integration. In this research, integration is the overall concept, and connection and engagement are the means to achieve this integration. The higher the expected level of integration, the more important it is to engage the actor. On the contrary, if the level of integration is low, it can be achieved through a simple connection. For a company to integrate its downstream actors, several methods exist. They are presented according to these two sub-components, connection and engagement. Figure 16 shows how these three concepts of integration, connection and engagement are perceived in this research.

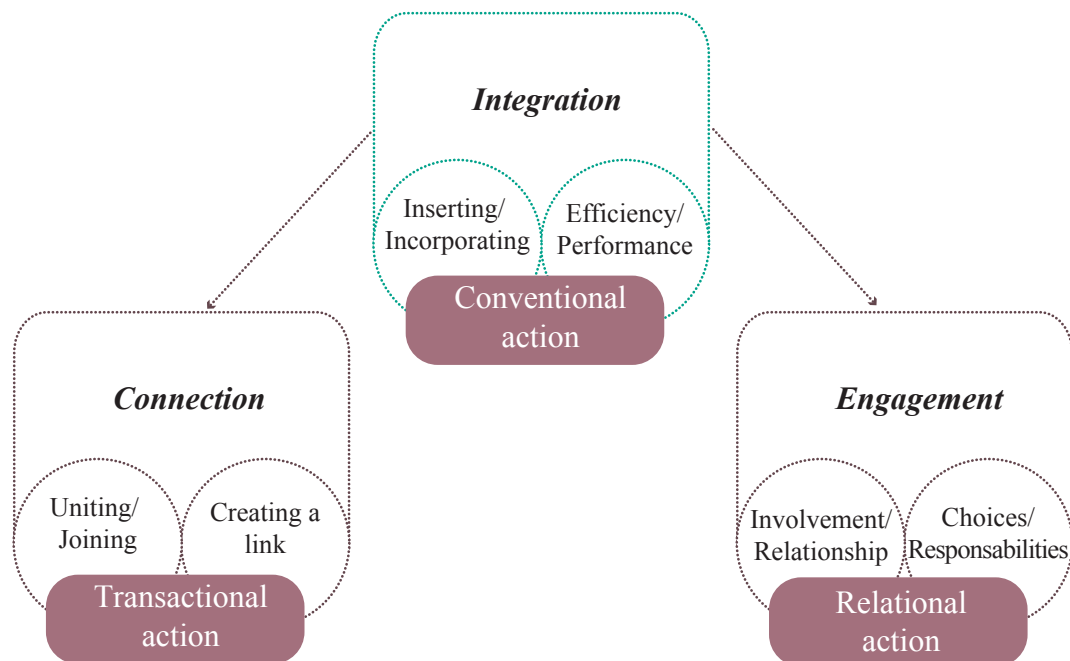


Figure 16: Concepts of the integration of connection and engagement

2.3 Integration methods for downstream actors

Integration methods are numerous and are used in the fields of SCM, as well as marketing and innovation. They will be defined and detailed in Chapter 5 of Part 2. The objective here is to understand how the integration of downstream actors operates in a B2B context. To illustrate this, a simple and fictitious example is presented in order to understand in a simple way how integration is achieved. A real-life example of Apple was presented in the introduction, and is used here to draw a parallel with

the literature. In addition, an example from the literature is studied, and in Chapter 5 of Part 2, several concrete cases from the literature are presented. Figure 17 proposes a framework of the different integration methods that are present throughout this thesis and the methods are observed according to the different actors - customer, consumer and user—and according to the level of integration, i.e., whether they are methods to connect or to engage.

As a reminder, the focus here is on how B2B companies integrate their downstream actors into their SC. Firstly, to integrate these actors it is essential to use recognized methods. For example, if a company's objective relates to sustainability and they want to integrate their consumers in a partial way in order to connect with them, they can use social networks, such as Instagram, to offer polls. A company that wants to integrate its consumers in a more complete way in order to enhance sustainability could try to engage them more fully by setting up a hackathon. To do so, it can call on people (consumers or users) from outside the company who wish to participate in this type of event - often people who have knowledge of computers, electronics or other areas of expertise. These people meet over a period of a few days and try to answer a question that is put to them. For example, the question might be: "how can we do without gold in a particular product, because it's a conflict metal?". The members of the hackathon will then look for possible solutions for a few days. At the end of the hackathon, the best project will be rewarded in exchange for user rights. This kind of method can also be carried out online through crowdsourcing (Djelassi and Decoopman, 2013; Howe, 2006) or idea competitions (Ebner et al., 2009; Mortara et al., 2013), both of which allow a larger audience to be targeted more easily (Djelassi and Decoopman, 2013).

The B2C example of an Apple concept called "Self Service Repair" (Apple, 2021), mentioned in the introduction, establishes the user as a central actor in its product repairs. As defined in Chapter 5, Part 2, the user toolkit method allows tasks normally carried out by the company to be transferred to the user, thus making the process cheaper and faster while maintaining high quality (Franke and Piller, 2004; Von Hippel, 2001). In this example, the users and consumers are very involved in

Apple's SC in terms of repair services, thus in the internal SC, but also in the reverse supply chain because the user is finally in charge of managing his or her smartphone. Whereas before, Apple managed the return of the product and its repair, now the user steps in. This example from Apple relates to a B2C context, but it can help us to understand how B2B companies can apply similar ideas to address sustainability issues related to rare metals and the IoT.

In the literature, Zimmerling et al. (2017) conducted a study on user integration for sustainable innovation, and they indicate that companies that integrate their users have a significant competitive advantage. The study covers three companies specializing in electric cars, the e-mobility charging network, and smart home technology. These companies used different methods of user integration at different stages of the innovation process. This research shows that user integration can bring benefits in terms of both sustainability and technological innovation, while reducing the risks associated with the development of new products.

In the upstream phase of strategy setting, the global site visit method was used to discover users' needs, desires and ideas. In the idea generation and testing phases (internal phase), the lead user, field trial (including surveys, focus groups, interviews, etc.) and idea contest methods were implemented. In the development phase (downstream phase), two out of three companies chose the field trial method, and one co-creation group, in order to elicit a maximum of ideas from users. In their study, Zimmerling et al. (2017) state that the idea competition generated more than 300 ideas on the theme of future mobility from internet users with advanced technological skills. The managers of the company concerned were satisfied with the results, admitting that interactions with external sources generated innovation. All companies set up field trials to see the evolution of users. These field trials allowed users to learn, discover, understand and influence the product or service in everyday use. This method is similar to 'living labs', which uses a place of innovation focused on the user and is based on an open innovation process in a real context, promoting the involvement of the consumer as well as all stakeholders involved (Birgitta Bergvall-Kåreborn et al., 2009). The results of the research by Zimmerling et al. (2017)

show that in addition to improving their knowledge about their users, companies also benefited from technical and technological contributions. Users brought in new ideas, components and features, giving them a role as co-developers. The companies themselves were surprised by the great result that this integration enabled. Innovation is an undeniable way to promote sustainable development (Carrillo-Hermosilla et al., 2010; De Medeiros et al., 2014), and it must integrate both internal and external knowledge to minimize technological uncertainties (De Marchi, 2012; Driessen and Hillebrand, 2013). Hence, it is essential to integrate the actors, including universities or R&D institutes (Castaldi et al., 2013), into the chain (Lee and Kim, 2011).

Figure 17 shows the different types of methods according to concepts related to integration, including connection and engagement, and according to the different downstream actors, namely, customers, consumers and users. The different methods are grouped according to the type of action they generate. For example, a co-creation box was created grouping together methods such as participatory design, the Triz method and the Key Account Team. In the figure, the box is placed according to whether it concerns engagement (high level of integration) or connection (low level of integration), it is also placed according to the actor concerned by this integration, i.e., the customer, consumer or user. Concerning the co-creation box, it relates to a high level of integration, is located in the engagement area, and involves customers. However, some boxes referring to certain methods may concern several types of actor and may have a medium level of integration, such as the opinions and views box. This includes the brainstorming, materiality exercises and employees as consumer methods. These methods can either be a source of engagement or connection depending on the level of integration desired.

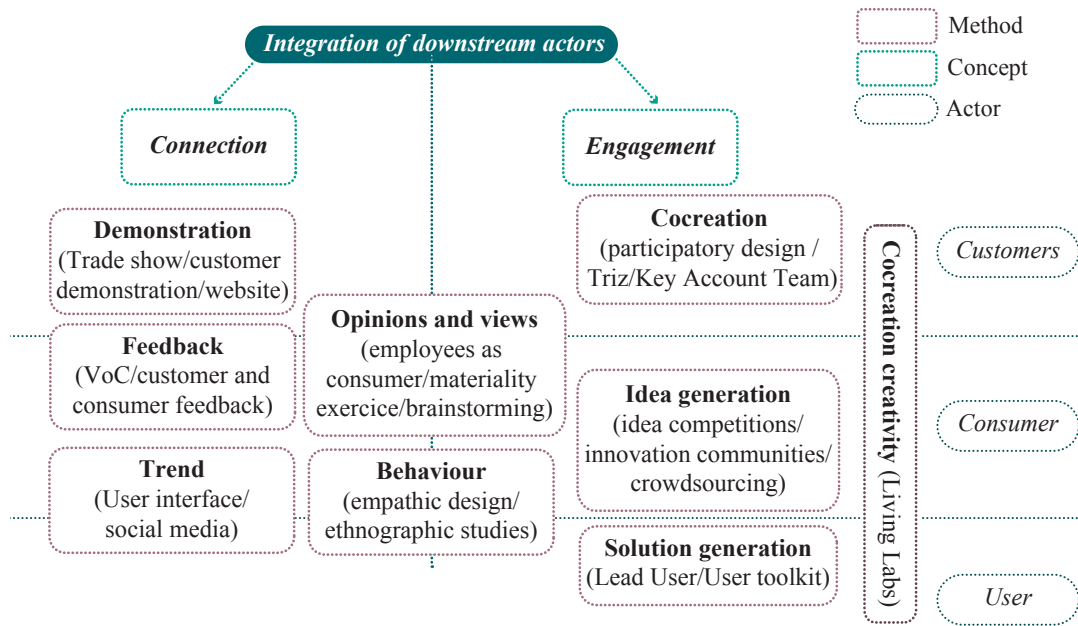


Figure 17: Methods framework according to actors and concepts

Summary Chapter 2

Chapter 2 focuses on the literature review. In the first step, it proposes to study the evolution of SCM in terms of SSCM, and SSCM throughout the SC, as well as its link with downstream actors. In the second part, downstream actors are presented via clear definitions to avoid ambiguity of the terms ‘customers’, ‘consumers’ and ‘users’ - the first issue raised in this thesis. The links and differences between the terms integration, engagement and connection are also discussed. In this research, the terms are interpreted as follows: integration is the main concept, and the connection and engagement of actors are a means to achieve this integration. The higher the level of integration, the higher the engagement, while connection with actors can be used when the level of integration is low. Finally, this chapter also presents the different integration methods according to the level of integration (engagement or connection) as well as according to the integrated downstream actor (customer, consumer or user). These methods are not defined one by one as this is carried out in Chapter 5 of Part 2. Instead, the methods are presented according to the types of actions they generate, such as creativity, co-creation or solution generation.

Chapter 3. *Methodology*

Chapter 3 presents the methodology studied throughout this thesis, first highlighting the quantitative aspect of the bibliometric and systematic analyses. Secondly, the qualitative methodology for the field study is presented. To explain the qualitative methodology, Grounded Theory, which helped to structure our analysis, is put forward. Subsequently, the development of the interview guide used to carry out the interviews is detailed. Finally, the triangulation of the data is outlined.

1. The quantitative approach to bibliometric and systematic analysis

The first two articles of this thesis follow an approach that could be called quantitative. Indeed, these articles dealing with the literature review in the field of SCM integration are in bibliometric form (Part 2, Chapter 4) and in the form of a systematic review for the second article on integration methods (Part 2, Chapter 5). In order to produce these articles and to adopt a robust methodology, the chosen methodology is based on renowned scientific articles proposing bibliometric articles in the field of SCM (Fahimnia et al., 2015, 2015; González-Benito et al., 2013;

Kazemi et al., 2019; Mishra et al., 2018a; Xu et al., 2018), and systematic literature review articles (Bastas and Liyanage, 2018; Koberg and Longoni, 2019; Lagorio et al., 2016; Melacini et al., 2018; Merli et al., 2018; Saenz et al., 2015; Seuring and Müller, 2008a; Wilding et al., 2012).

1.1 Methodology for the bibliometric analysis

A bibliometric article makes it possible to analyse quantitatively what has been published in the literature on the subject, and to follow its evolution in order to propose avenues for future research (Apriliyanti and Alon, 2017; Barbosa-Póvoa et al., 2018; Broadus, 1987; Feng et al., 2017; Kazemi et al., 2019; Merigó and Yang, 2017; Perera et al., 2019; Zupic and Čater, 2015). For the bibliometric article, the different steps proposed by the major authors in the field are followed (Figure 18) (Fahimnia et al., 2015; González-Benito et al., 2013; Kazemi et al., 2019; Mishra et al., 2018, 2017; Xu et al., 2018).

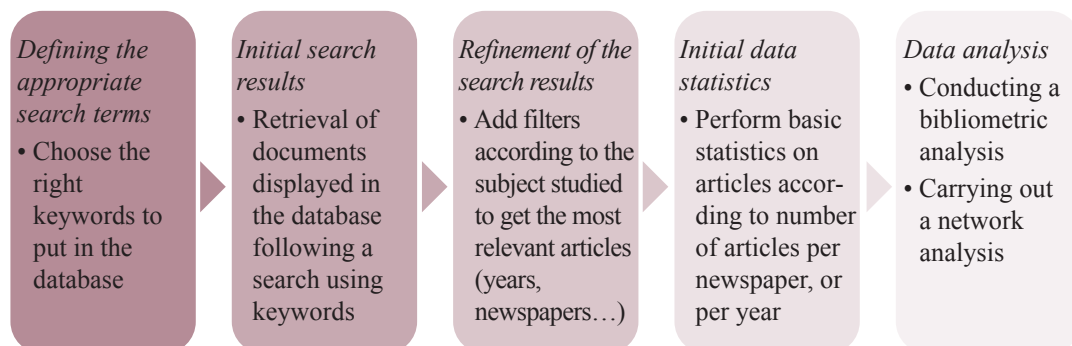


Figure 18: methodology for bibliometric analysis inspired by Fahimnia et al. (2015)

To carry out this process, the Scopus database was chosen as it is the most complete database for our field of study (Fahimnia et al., 2015; Kazemi et al., 2019; Marty, 2021). To analyse the quantitative data, Bibexcel was used, allowing numerous queries on the articles (Fahimnia et al., 2015, 2015; Xu et al., 2018). To use this software, the articles by Pilkington (2018) and Persson et al. (2009) were consulted. They give insight on how to operate the software. Finally, to carry out the network analysis and create the clusters, Gephi software was used (Fahimnia et al.,

2015, 2015; Xu et al., 2018). This software allows many analyses to be performed in visual form, such as clusters (Chapter 4, Part 2) or to display the most co-cited articles by cluster (Figure 19).

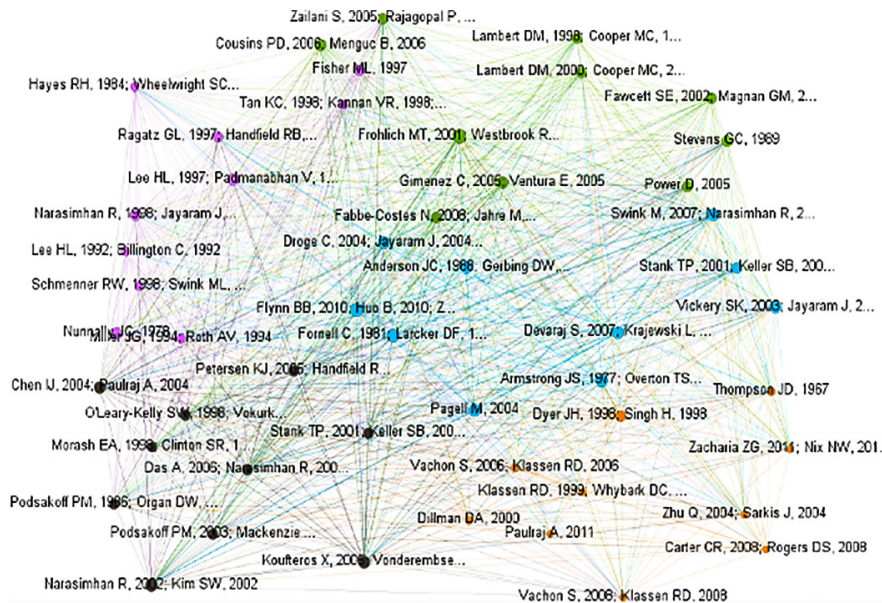


Figure 19: Query of the best articles by clusters in the Gephi software

For the construction of the article, several steps were followed to create the research design (Figure 20).

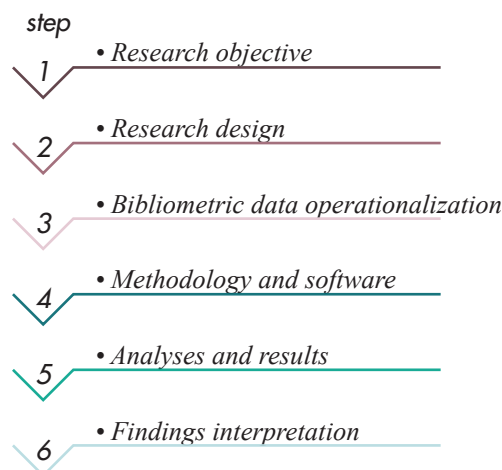


Figure 20: Research design of the bibliometric article

- The first step is to define the object of research. For our article, the aim is to take stock of what has been published on the integration of customers, consumers, and users in SCM and to propose avenues of research for the future.
- The second step is the research design, which consists of defining which approach will be chosen. This research carries out a bibliometric analysis combining co-citation analysis and visualization.
- The third step is related to the data - it is necessary to define which data is desired and on which data the article is based. The selection of articles is based on the titles, keywords and abstract of the articles. Only articles published in English were collected, which either rank in ABS or in the 20 journals most represented in the sample. Hence, books and conference papers were excluded.
- The fourth step relates to methodology and software. The article is based on the analysis of co-citations, and for the quantitative analysis part, Bibexcel software was chosen. For the visualization and clustering part, Gephi software was used.
- The fifth step deals with the analysis of the results, i.e., which queries are to be applied. The use of Bibexcel helps to analyse the evolution of literature by year, author's influence, affiliation statistics, keyword statistics, journal influence, top 10 most influential articles, and citation analysis. For the Gephi stage, the page rank of the best articles, the clusters, and the evolution of these clusters over time were observed and studied.
- The sixth step is the interpretation of results. It is necessary to verify whether the research objective has been achieved to see if major themes emerge and can become avenues of research for the future.

This bibliometric literature review allows us to highlight the main authors and journals dealing with our subject. But above all, thanks to clusters and visualization, it allows us to emphasize the main themes addressed by these authors, as well as the

evolution over time in the study of these themes, thus making it possible to draw up avenues for future research. To conclude, the theme of sustainability is clearly highlighted and should be the subject of further reflection in the years to come with regard to the integration of downstream actors.

1.2 Methodology for systematic literature review

The methodological approach used to carry out the systematic literature review is presented and supports Part 2, Chapter 5. As with the bibliometric research, the methodology of the systematic literature review is based on existing influential articles. (Bastas and Liyanage, 2018; Denyer and Tranfield, 2009; Hofmann and Bosshard, 2017; Koberg and Longoni, 2019; Lagorio et al., 2016; Melacini et al., 2018; Saenz et al., 2015; Seuring and Müller, 2008a; Wilding et al., 2012).

The advantage of conducting a systematic, non-narrative literature review is that it follows specific steps in order to make the results more valid and accurate (Hofmann and Bosshard, 2017). Many authors propose to follow a specific methodology (Bastas and Liyanage, 2018; Denyer and Tranfield, 2009; Hofmann and Bosshard, 2017; Koberg and Longoni, 2019; Lagorio et al., 2016; Melacini et al., 2018; Saenz et al., 2015; Seuring and Müller, 2008a; Wilding et al., 2012). Many choose this 5-phase methodology, adapting it to their research (Bastas and Liyanage, 2018). An adaptation of the methodology is also carried out in this thesis (Figure 21). In phase one, the main research question is defined, namely, “How can the customer be more connected to the supply chain to meet sustainability challenges?”. In phase two, the Scopus database is chosen. For phase three, consisting of the selection of papers and their evaluation, the keywords are defined and filters applied. Also in the third phase, for the evaluation, Bibexcel is used to carry out the statistical analyses of the articles. The fourth phase deals with the analysis and synthesis, and aims to define the categories and the main themes addressed. The fifth phase involves the creation of a comprehensive framework based on the categories found.

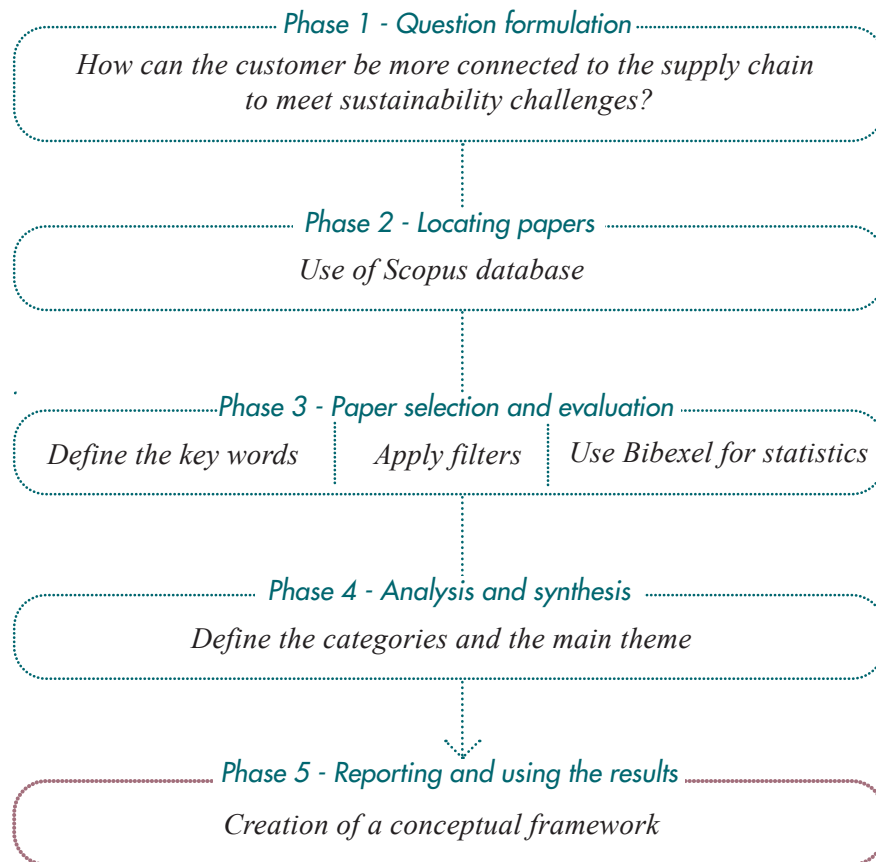


Figure 21: SLR methodology (adapted from Melacini et al., 2018, p. 26)

To support the research design for the systematic literature review, it is useful to go into more detail about phases 2, 3 and 4, with concrete explanations of the steps taken to achieve the analysis of the results. This includes the collection of materials and the approach to analysing the results. For this purpose, this second step of the methodology is based on the articles by Koberg and Longoni (2019) and Wilding et al. (2012), and is carried out in four steps (Figure 22).

Firstly, the material collection allows the research subject to be defined and to refocus the research on the most relevant articles. Then the second stage of the descriptive analysis uses Bibexcel software to generate the statistics, to highlight the evolution of the research subject, and to see the most cited articles, important keywords, and the main journals. In the third step, the identification of the categories is completed in two steps (Koberg and Longoni, 2019; Wilding et al., 2012). The first is carried out deductively based on the existing literature, with the research

supported by articles by Frohlich and Westbrook (2001), Danese and Romano (2011), and Fabbe-Costes and Jahre (2008) to identify our main categories. Then the articles are analysed inductively to confirm the elements of the deductive approach. Finally, the material evaluation is carried out by coding the articles according to the main categories found above, and then classifying them by major themes: integration methods, processes in which this integration was carried out, objectives of the integration, and the role given to the customer.

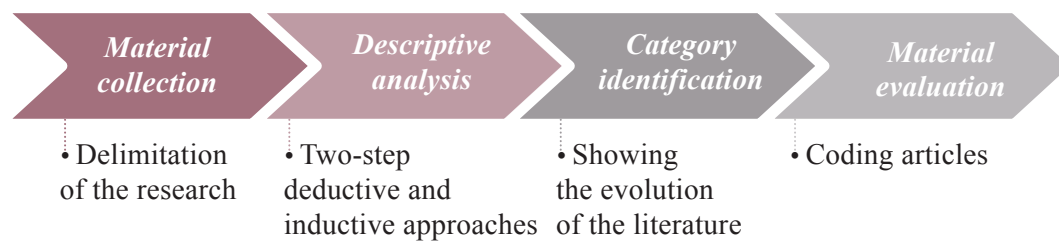


Figure 22: SLR steps (adapted from Koberg and Longoni, 2019; Wilding et al., 2012)

This systematic literature review resulted in a conceptual framework (Figure 35, Part 2, Chapter 5) that supports companies considering the integration of downstream actors by suggesting methods, depending on objectives, processes targeted and the role given to the customer.

2. The qualitative approach to the rare metals case study

As explained in Chapter 1 of this PhD thesis, a qualitative and inductive approach was chosen to carry out the fieldwork and to allow the IoT, nanotechnology and rare metals research context to be fully explored and interpreted (Kaufmann and Denk, 2011; Rauer and Kaufmann, 2015; Robert K Yin, 2003). The case study is covered in the third article of this thesis (Part 2, Chapter 6). The Grounded Theory (GT) approach is applied, as it is widely used in qualitative research (Birks and Mills, 2015; Flint et al., 2012b; Glaser and Strauss, 2017; Noble and Mitchell, 2016; Pidgeon and Henwood, 2004; Suddaby, 2006; Charmaz, 2006). The GT approach is first introduced, followed by a development of the interview guide and mind map, and finally the triangulation of the data with the business analysis is presented.

2.1 Grounded Theory for qualitative analysis

Grounded Theory (GT) is a set of principles that guide and support the research process (Birks and Mills, 2015; Charmaz, 2006; Glaser and Strauss, 1967, 2017; Noble and Mitchell, 2016; Suddaby, 2006). It is mainly used in qualitative research and is used to propose a new theory (Glaser and Strauss, 1967, 2017; Noble and Mitchell, 2016). In this research, GT is used for qualitative analysis following an inductive approach, but it should be emphasized that no new theory arises from this application of GT. The GT steps are used to enable a valid study that is accurate and reliable thanks to a consistent approach (Noble and Mitchell, 2016; Pidgeon and Henwood, 2004). The 5-step method proposed by Stuart et al. (2002) and taken up for SCM studies by Kaufmann and Denk (2011) is used. Generally speaking, GT supports observations and explorations on subjects where theoretical knowledge is limited or, as in this research, the knowledge is patchy (Birks and Mills, 2015; Charmaz, 2006; Glaser and Strauss, 1967, 2017; Glaser, 1992; Noble and Mitchell, 2016; Pidgeon and Henwood, 2004).

GT is mainly used in areas where little research has been done, and where there is little theoretical knowledge on the subject (Locke, 2007; Suddaby, 2006). The approach is interpretative (Goulding, 1998), allowing field observations to be used as a basis for drawing conclusions. “GT creates a holistic and inductive understanding of phenomena” (Flint et al., 2012, p. 867).

As several authors point out, supply chain research is sometimes criticized for its lack of objectivity and structure (Glaser and Strauss, 2017; Kaufmann and Denk, 2011). The ultimate aim of GT is to draw on data to create a theory, not to start from a theory and test it through data. It is increasingly used in the field of SCM because theories used in management science sometimes fail to explain phenomena in SCM (Flint et al., 2012a). More creative theories designed to study the interrelationship between consumers and companies can be developed using GT (Flint et al., 2012a; Glaser and Strauss, 2017). “The GT approach integrates the system and the individual by providing a process that recognizes, categorizes, and relates key individual and organizational variables in a theoretical framework.” (Flint

et al., 2012, p. 875; Birks and Mills, 2015; Glaser and Strauss, 2017; Noble and Mitchell, 2016; Pidgeon and Henwood, 2004; Suddaby, 2006). GT is used to propose a more reliable research process when the phenomenon studied is new or approached from another perspective. In view of these elements, the analysis was carried out through the prism of GT. Indeed, the research context on rare metals is recent, and GT enabled this new phenomenon to be studied from a new perspective of actor integration, while following a reliable process that allows results to be legitimized (Birks and Mills, 2015; Flint et al., 2012b; Glaser and Strauss, 2017; Noble and Mitchell, 2016; Pidgeon and Henwood, 2004; Suddaby, 2006).

Instead of starting from hypotheses, the researcher collects data without any preconceived ideas and then searches for meaning. After having collected the data, the researcher codes the data with the help of tools or software, these codes are then grouped into categories, allowing a concept to emerge. This GT approach follows a process of 5 distinct steps (Figure 23).



Figure 23: “The five-stage research process model” by Stuart et al. (2002, p. 420)

2.1.1 Definition of the research questions

The research questions defined here help to understand the context of the investigation (Kaufmann and Denk, 2011). The aim of these questions is to find out what is happening in the environment being studied (Charmaz, 2006; Glaser Barney and Strauss Anselm, 1967; Glaser, 1992; Noble and Mitchell, 2016; Suddaby, 2006). There is a lot of research on the issue of integration in SCM using GT (Chopra, 2019; Flint et al., 2012b, 2012a, 2012b; Kaufmann and Denk, 2011; Mello and Flint, 2009; Rauer and Kaufmann, 2015; Walsh et al., 2015). However, the specific focus of this research, namely, how to give a real active role to downstream actors, is little addressed. The same goes for the rare metals context, which is much discussed from

a technical perspective, but much less from the human, social and managerial angles, and even less through the prism of consumer integration. Hence, this research is moving towards a description and exploration of the field search, and the research questions are in the form of “What is there?”, “What are the key issues?”, “What is happening?” (Stuart et al., 2002, p. 422). Research questions can also be in the form of who, what, where, when, and why in order to understand, study, analyse, and interpret a phenomenon (Charmaz, 2006; Cucchiella et al., 2012; Tellis, 1997; Robert K Yin, 2003). Considering the IoT context in which this research takes place, and the exploratory nature of the research, the main research question is: How can B2B companies in the IoT sector integrate their downstream actors (customers/consumers/users) into their SCM to address sustainability challenges?

2.1.2 Instrument development

Due to the fact that little research has been carried out in this context, an inductive approach is followed (Kaufmann and Denk, 2011), as mentioned above. Indeed, after a thorough analysis of the literature, it seems that there is no existing theory that can be used to analyse this topic in an exploratory way (Eisenhardt and Graebner, 2007; Ozcan and Eisenhardt, 2009). To carry out this inductive qualitative approach and explore both context and subject, interviewing relevant actors was deemed the best way to allow them to express themselves freely and to enable the authors to understand and interpret the topic (Cucchiella et al., 2012; Gavard-Perret et al., 2012). The implementation of an interview guide based on open-ended questions such as “how” or “why” (Cucchiella et al., 2012; Robert K Yin, 2003) enables interviewees to reflect more broadly. Using a protocol is highly recommended when pursuing a reliable and valid study (Robert K Yin, 2003), and the same applies to the validity of the results, whereby the use of software for the transcription is an asset (Kaufmann and Denk, 2011).

The first step of instrument development is “providing focus” (Stuart et al., 2002, p. 424). Stuart et al. state that “The focus is important not only for setting the parameters of the study. At a more practical level, reminders of the study’s purpose helps the researchers to stay on target and keep information gathering as efficient

as possible.” (2002, p. 424). Secondly, although focus is essential, flexibility is also expected. Flexibility comes into play more during data collection as the researcher must remain flexible during the interviews in order to have access to the information sought, which is sometimes difficult to obtain from some respondents (Stuart et al., 2002). The third sub-step consists of “validity requirements” (Stuart et al., 2002, p. 425). Stuart et al. suggest that “To ensure construct validity, the researcher must look for multiple sources of evidence for each of the important elements or variables in the propositions, using the important technique of triangulation” (Stuart et al., 2002, p. 425). In this research, triangulation is carried out through an in-depth study of the websites and social networks of companies to allow correlation between what is said in the interviews and what is communicated by the companies to emerge. It was generally found that the companies all prided themselves on implementing sustainable actions, but that some interviewees emphasized that this applied mainly at the corporate level and much less at the product level. The fourth sub-step concerns the selection of interviewees, which is characterized by volume and diversity in order to limit bias as much as possible. Nineteen individual interviews were conducted with nine practitioners working in B2B companies in the context of IoT and rare metals, and ten end consumers. The nine practitioners came from different companies and occupied different positions including SC planner, SC manager, quality manager, production line planner, and sustainability manager. For the consumers, people of various ages (from 19 to 63), professions (students, engineers, HR managers, artists), environments (rural, urban), and socio-professional classes (students, executives and higher intellectual professions, middle managers, employees and service personnel), or some without a professional activity (or an activity that did not provide a full living) were chosen. This variety in the profiles of the interviewees makes it possible to seek the most representative sample possible in order to understand how this subject is perceived and what the important elements in relation to the context are. Concerning the duration of the interviews, they were all between 30 minutes to 1 hour. As they were semi-directive interviews, the interviewees were able to speak freely in order to address the themes as they wished, whilst the interviewers were sure to reframe the subject when the interviewees strayed.

2.1.3 Data gathering

To carry out these interviews, B2B companies using critical and rare metals in their products, mainly in the IoT sector, were targeted. As explained in Chapter 1, our research topic fits into the CDP Need for IoT. Interviewees were therefore chosen according to this context in order to understand and interpret what is occurring in the sector, and especially how people working in this sector perceive what surrounds them.

The focus is on this sector as it is in electronic applications that components such as rare earths and critical metals are used in smaller quantities and which are often less recycled. It is also a growing sector of activity (Massari and Ruberti, 2013; McLellan et al., 2016; Rauer and Kaufmann, 2015; Sauer and Seuring, 2017; Schueler et al., 2011; Son et al., 2018). Only 5-10% of the metals produced by Platinum Group Metals (PGM) contained in electronic applications is recycled (Hagelüken, 2012). Moreover, these companies are often far removed from the final consumer because their chain is made up of a large number of suppliers as well as several levels of customers from ranks 1 to 3 or 4 before the final consumer. Hence, it is more difficult for them to integrate their downstream actors (Lacoste, 2016). Furthermore, in this sector of activity it is even more difficult because these are technical products with a complex composition of which consumers are not necessarily aware (Kasulaitis et al., 2021). The chosen companies occupy various positions in the supply chain; upstream, for example, an equipment manufacturer in the semiconductor industry and material suppliers, or further downstream, for example, companies that manufacture chips for customers such as Apple, HP, Samsung, Bosch, and Cisco among others. The selected companies all have a connection with the subject of critical and rare metals as they integrate these metals into their activities. Moreover, the selected companies are recognized as leaders in their markets - they were chosen as their market is well established and they interact with each other (Cucchiella et al., 2012).

After contacting and soliciting more than fifty actors in this sector on several occasions, only nine of them agreed to participate. Thus, nine interviews were conducted with these different companies, which will not be named due to the highly

competitive nature of the sectors and the fact that we are dealing with sensitive information. The interviews took place either by videoconference or by telephone (due to the Covid-19 pandemic). The interviewees held various positions related to SCM, sustainable development, or critical and rare metals.

In addition, company websites, as well as documents such as the Sustainable Report and the Corporate Responsibility Report, were analysed. As Stuart et al. state “This multi-faceted approach to gaining the complete picture” (2002, p. 427) enables the triangulation of information and concepts (Jick, 1979; Schein, 1987).

After interviewing actors in the sector, it seemed that in order to gain a full picture of the issue of integration of downstream actors it was essential to interview consumers as well. It was felt that this would enable an understanding of how they approach the subject in the context of rare metals. These consumer interviews allowed us to enhance the research and also to make connections with the issues raised in the company interviewees (Part 2, Chapter 6). Ten interviews were carried out, lasting between 30 minutes and 1 hour, with a varied selection in terms of age (18 to 60 years old), socio-professional category, knowledge of the subject and personal values. Triangulation of company interviews, company website content, and consumer interviews made it possible to gather a significant amount of information, and to compare and group it together.

2.1.4 Data analysis

The interviews were all transcribed using Nvivo software and analysed with Excel for a more “fruitful analysis procedure” (Maher et al., 2018, p. 10). During the coding step, “concepts began to form patterns or clusters and as such, fit into categories” (Flint and Golicic, 2009, p. 847). When coding, a large number of categories appear and subcategories are then grouped into core categories. As Flint and Golicic (2009, p. 847) stress, “After a constant comparison by tacking back and forth among all data sources and interpretations, a core category emerged as it should in grounded theory”. In our study the main category is “sustainability through consumer integration in the context of rare metals”.

For example, all transcripts are made with NVIVO and then imported into an Excel file. The columns correspond to the different interviewees and the rows to the question answers. At the end of each line, a theme appears, then these themes are grouped together using colour codes. In order to refine the categories, the coding was carried out in five steps before identifying the final broad categories. These five stages include multiple sub-categories which are then grouped together to form categories. At the beginning of the analysis many themes emerged (represented by different colours), then as the analysis progresses, the themes are grouped together repeatedly to allow the main categories to be highlighted according to the themes covered, before the core categories emerge last.

The potential biases in this research are mainly due to the author's interpretation of what was said by the interviewees, both during the interviews and during the analysis of the results. As the interviews and the result analyses were conducted by only one researcher, it is likely that the interpretation may not be completely objective (Harrison et al., 2017; Meyer, 2001; Tellis, 1997; Yin, 1994).

2.1.5 Dissemination

In this last part of the methodology, the choice of a qualitative study following an inductive approach based on Grounded Theory was confirmed. As previously mentioned, there was limited literature on the topic and no theory that seemed to address the questions asked (Eisenhardt and Graebner, 2007; Kaufmann and Denk, 2011; Ozcan and Eisenhardt, 2009).

The research is based on 19 interviews. To support this research, several steps were followed and different types of data such as documents, interviews and observations were collected (Harrison et al., 2017; Meyer, 2001; Tellis, 1997; R. K. Yin, 2003; Yin, 1994). Figure 24 shows the process followed to conduct the field study (Tellis, 1997; Robert K Yin, 2003).

The first step was to design the research, to establish the main research question, pinpoint what would be studied, what kinds of questions would be asked, and how to proceed. The first field study phase also consisted of preparing the main interview

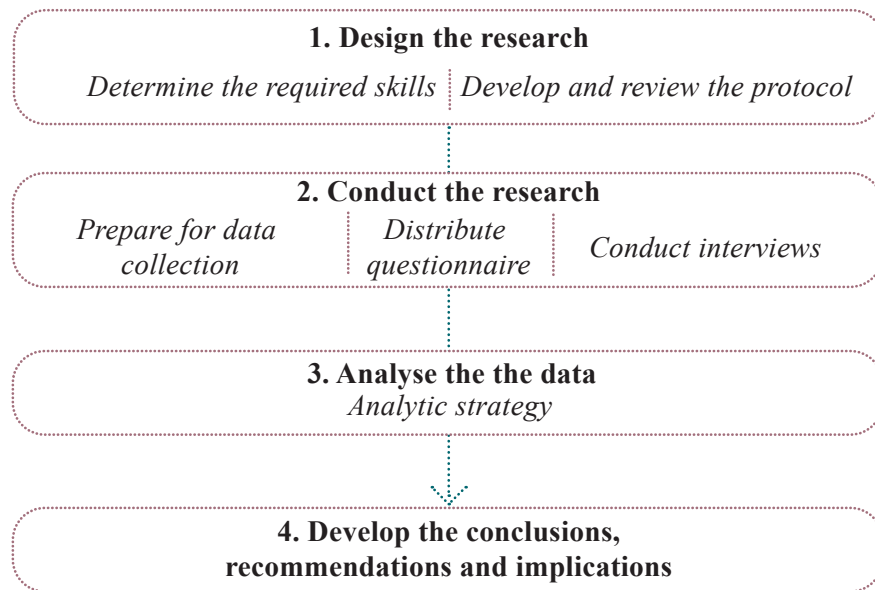


Figure 24: Field study steps (adapted from Tellis, 1997; Yin, 2003)

themes and questions, and a mind map of these different themes and questions was created to facilitate the interviewee's understanding and the interviewer's field of enquiry. The second stage consisted of conducting the research. The interview method was selected to collect data, and company websites and social networks were analysed. Several authors have proposed different sources of data that can be studied, including "documentation, archival records, interviews, direct observation, participant observation, and physical artifacts" (Tellis, 1997, p. 11; Yin, 1994).

However, since the above-cited research was published in the 1990s, internet research has emerged, and this is why it seems pertinent today to study social networks and websites (bearing in mind that on websites, numerous company documents, such as CSR reports, can be found). This second phase also included the distribution of the interview guides, following which the interviews took place. The mind map and the interview guide were sent to the people who had agreed to be interviewed as an attachment to the e-mail confirming the appointment. The first e-mail sent was only an initial contact that allowed us to establish the subject and the context of the study and to request a potential interview. The interviews were conducted from September to November 2020. After the interviews, some interviewees sent additional

information on certain questions, or documents distributed internally by the company to enable the study to be conducted in greater depth. The third phase corresponds to the analysis of the data material. The analysis of websites, official documents and social networks had been completed before the interviews. The interviews were then analysed, as well as additional documents shared by some interviewees. Regarding the development of a conclusion and recommendations in the fourth step, a map was created to allow for the interpretation of the results (Part 2, Chapter 6).

In qualitative research, a constructivist positioning can mean that researchers have an impact on the way the interviews are conducted and the way the results are interpreted. It is assumed that participants' responses are specific and influenced by their environment, culture or timeframe, and that the results that are found depend on the personal values and perceptions of the constructivist research (Charmaz, 2006; Flint et al., 2012b).

2.2 Development of the interview guide and mind map

The guide was created in an iterative way. Firstly, the interview guide was created for respondents from SCM companies in the rare metals and IoT sectors (Appendix 2, Figure 54), and then in a second step another interview guide was developed for consumers (Appendix 3, Figure 55). For both guides, the questions varied slightly, but the main themes remained the same.

Firstly, all the questions and elements that seemed important to address were written on a sheet of paper. Then, the different questions were grouped into major themes. The three main themes that stood out were sustainability, metals, and actors. Subthemes then appeared and the questions were placed under these subthemes. The questions were revised, irrelevant ones were removed and other questions were added after sharing the interview guide with other researchers. The interview guide is part of Article 3 of this thesis (Part 2, Chapter 6), which was co-authored with Professor Emeritus Martin Christopher. The first draft of the interview guide was shared with Professor Emeritus Martin Christopher, and he provided a fresh perspective by suggesting useful additional questions. The development of the interview guide was

not carried out in a linear way with one question following the other, rather, a mind map was developed on paper and evolved through discussions and re-readings. This mind-mapping step helped to better structure the thinking, and thus the proposal overall (Appendix 1, Figure 53).

Each interview guide begins with an introductory section explaining who the interviewer is, and what he or she does. Permission to record is requested and then the context of the interview subject is presented. The interviewee's profile is confirmed, i.e., their name, surname, profession, age and gender, but during the analysis of the interview the answers are anonymized. The mind map and the interview guide give basic contextual information that needs to be presented to the interviewees, then major themes (sustainability, metals, and actors) and sub-themes are identified. For metals, two sub-themes are distinguished, namely, raw materials and rare metals. The same applies for actors - downstream actors and the integration subthemes are differentiated. Four to twelve questions per subtheme are asked. The interview guide for the SCM company respondents contains a total of 35 questions (Appendix 2, Figure 54). For the interview guide, each theme includes a topic that sets out the main objective that the theme seeks to target. For example, for the theme of rare metals, the objective for interviews in companies is: To know the company's policy regarding the issue of critical or rare metals/To understand the management and operation of the SC of these metals/To observe the feelings and opinions of the interviewee in relation to this topic. For consumers, the objective of the questions on this theme are: To observe the respondent's feelings and opinions on this topic/To know if it is a subject he or she is familiar with/To know how this topic is dealt with in the company, according to the respondent.

The interview guide for consumers is slightly different. There are still three main themes; sustainability, rare metals, and integration of downstream actors, but there are no subthemes, rather main questions with sub-questions. Consumers do not have the same issues as companies in relation to raw materials, for example, so only one question is asked to consumers, whereas for companies, raw materials represent a complete sub-theme with several questions. For consumers, the interview guide

contains a total of 21 questions. For example, on the theme of rare metals, one main question is: “Are you aware of the subject of rare metals? If so, what does it mean to you? How did you find out about it?” As the first question is rather closed (expecting a yes or no answer), sub-questions are added to allow the interviewees to speak more fully on the subject (Appendix 3, Figure 55).

In both interview guides, some questions emerged as more relevant than others when administering the interviews. Indeed, some questions on rare metals seemed more difficult to answer than others for the company interviewees. For example, in relation to the question: “How do your management policies vary according to the different types of raw materials?”, some respondents, due to their position in the company, did not necessarily have the answers. Furthermore, on the sustainable development theme, which is composed of five questions for companies and consumers, company interviewees took a lot of time to answer the first question by going into a lot of detail, so question 1 groups together the answers to the other 4 questions. However, since the interviews were conducted in a semi-directive form, we let the interviewees express themselves at length on the important themes. As a result, the theme of sustainable development was mostly covered at greater length by all interviewees (companies and consumers) than the other two themes. This outcome already constitutes a result in itself. The observation highlights the fact that sustainable development seems to be an important and easy subject to tackle for the interviewees, whereas the theme of rare metals is much less so due to a lack of general knowledge on the topic. Hence, on the subject of rare metals, the questions were reiterated and reformulated several times in order to gather information.

2.3 Triangulation of the data with the company analysis

Before carrying out the interviews, the companies were analysed, allowing the triangulation of data (Ammenwerth et al., 2003; Jick, 1979; Meyer, 2001; Schein, 1987; Stuart et al., 2002; Tellis, 1997). In this regard, the different companies that exist in the IoT and rare metals sectors operating in B2B were sought out, and the focus was on French companies located in the Isère region. This is because such companies tie in with the Need for IoT project’s motivations but also because

Grenoble's organisations in this sector are highly competitive and some are among the world leaders in this field. World-renowned companies were chosen that are not only based in Isère but that have subsidiaries and production plants abroad as well. Some of these companies are also linked to the Need for IoT project as partners. A total of five different companies were studied. Once the companies had been selected, their websites were meticulously examined. This phase took a number of hours, as each page was read in its entirety and the elements were collected. The CSR reports were retrieved for each company from their websites or other internet sources, and actions taken to date were analysed. For each company, a summary was made including their core business, answering the question '*what*', including turnover, number of employees worldwide and their different business locations.

Their positions in the supply chain were studied to answer the question '*where*', i.e., are they upstream or downstream in the chain. The central elements of the themes were analysed in these documents (as for the interview guide), namely, sustainability, rare metals and the integration of downstream actors. Depending on the different companies, there was more or less information on the different themes. As seen in the interviews, the theme of sustainable development was widely addressed by the majority of companies. Subsequently, the objective was to find out how companies communicate on this subject, how they perceive these themes and how they influence or impact them; here the aim was to answer the question '*how*'. This question of '*how*' obviously implies the question of '*why*' - each company's internal website explains why they adopt a sustainability or integration-focused approach and offers an explanation of how they do it. The question of '*how*' was pursued further by looking at the web pages that explain their downstream actor integration methods or actions in terms of rare metals and sustainability. Some of the companies go into great detail on their methods of integrating downstream stakeholders, for example, by underlining and developing the use of the living lab or voice of customer methods. All these elements collected from the companies' websites were integrated into a word document detailing each company's *what*, *where*, *why*, and *how*. The final document was about twenty pages long. The elements were then grouped for each company in a table detailing the *what*, *where*, *why*, *how*. For the *how* aspect, each

integration method was indicated, as well as the elements proposed by the companies in terms of sustainable development and rare metals.

Following analysis of the websites and official reports available on the internet, the social networks were analysed, namely, Facebook, Instagram, LinkedIn and Twitter. LinkedIn is the most useful social network concerning the themes studied, as this social network is much more focused on the company's professional profile. Posts, short videos, and photos were retrieved, and elements relating to sustainability, rare metals, and the integration of downstream actors were retained. Once again, the most common theme was sustainability, followed by metals and then the integration of downstream actors. A list of all these elements were detailed by company in a large Word file (about 10 pages long) and the data was added to the pre-existing table of websites.

The final table is two pages long and details each company's *what, where, why, and how*. The information in the table was grouped together and analysed by colour-coding the integration methods, elements related to rare metals, and sustainable development actions. These elements afforded a better idea of the companies in which the interviewees worked. Secondly, the elements made it possible to highlight important elements for our research, such as the methods of integration of downstream actors, and the actions implemented in terms of sustainable development and rare metals. For example, some companies detailed their concerns about the 3TGs and how they were working around this problem. Other companies detailed integration methods such as VoC, sharing the questions that are asked of the customer, or a quick video showing idea competition events. This data gives a clearer idea of what companies are doing in terms of sustainability, rare metals and IoT, as well as integration of downstream actors even before the interviews.

Summary Chapter 3

Chapter 3 focuses on methodology. In the first step, it proposes to study the quantitative approach for the bibliometric and systematic literature reviews. The methodology for the bibliometric analysis is presented, based on key authors. Then the different steps to be followed are provided: defining the appropriate search terms, initial search results, refinement of the search results, initial data statistics, and data analysis. The database and software used are also specified (Scopus for the database, Bibexcel for the quantitative statistics and Gephi for the visualization and creation of clusters). The methodology used to conduct the systematic literature review, also based on key authors, is outlined. The process of carrying out the review is presented, as well as all the steps involved (question formulation, locating papers, paper selection and evaluation, analysis and synthesis, reporting and using the results) and the methodological presentation (material collection, descriptive analysis, category identification, material evaluation). The second part of this chapter focuses on the inductive approach and qualitative method used to analyse B2B companies operating in the rare metals and IoT context. Firstly, Grounded Theory is presented, highlighting a consistent methodology to be followed (including a definition of the research question, instrument development, data gathering, data analysis, dissemination of data). The second part of this chapter focuses on the inductive approach and qualitative method used to analyse B2B companies operating in the rare metals and IoT context. The interview guide and its elaboration are detailed as well as the mind map. Finally, the notion of triangulation is addressed through the study of websites, official documents and social networks of the companies studied. This chapter therefore covers the different methodologies used in the articles of this thesis which are presented in Part 2 of this dissertation.

Conclusion PART I

This first part serves as an anchor for this thesis. It first allows the subject to be contextualised by embedding it in the thematic of the IoT, which continues to grow due to an increased digitalization and an orientation towards green energies such as solar panels, wind turbines and electric cars (Lu et al., 2013; Mauger et al., 2017). Indeed, in 2020, Argeron et al. stated “there are already 26 billion ‘things’ enabled with the ‘Internet of things’” (Ageron et al., 2020, p. 133). This increase in the use of IoT and nanotechnology has had several important effects, including European countries becoming increasingly dependent on countries that produce both the raw materials and the finished products (Al-Mansour and Al-Ajmi, 2020; El Baz and Ruel, 2021; Geitzholz, 2021). This dimension of dependence has taken on even greater importance in light of the COVID-19 crisis, highlighting the importance of the sovereignty of European countries, including France, in terms of supply and manufacture, as well as the disruption risk to SCs (El Baz and Ruel, 2021). Beyond this geopolitical vision, the IoT also raises issues due to the composition of its products. Extraction of the rare metals used in these products takes a heavy toll on the environment as well as on people (working conditions, forced child labour, etc.). Hence, IoT products have an effect on sustainability throughout their SC, leading to the emergence of the Need for IoT project and the perspective in which this thesis is embedded. In addition, consumers themselves are increasingly concerned about environmental and social issues. As stated by Samuel and Carré (2018), improving collaboration between different actors is essential to meet societal and environmental challenges. Downstream actors thus become actors in SCs and have an active role to play (Belhaj and Paché, 2021; Zimmerling et al., 2017). However, it would seem that companies manufacturing IoT products are having more difficulty taking into account these consumer demands and expectations. This IoT context and the importance of the consumer have led to the emergence of our research problematic - **Supply chain integration in B2B companies: leveraging downstream actors to address sustainability challenges in the context of the IoT**. From this, the following key question emerges: **How can B2B companies in**

the IoT sector integrate their downstream actors (customers/consumers/users) into their SCM to address sustainability challenges? To understand this issue, a literature review was proposed, focusing on the SSCM literature and its link to the integration of downstream actors. The downstream actors were also defined in order to clarify who the consumer, customer and user are. The issue of integration is also addressed through the concepts of engagement and connection. The third chapter of Part I sets out the methodological framework that supports this article-based thesis. Firstly, the methodology used for the initial bibliometric article is discussed, then the methodology used for the systematic literature review is presented to support the second article of this thesis. Finally, the inductive approach and qualitative method are presented to support the fieldwork which features in Article 3. Part I sets the scene (Figure 25), before presenting the articles that constitute this thesis and are presented in Part 2. Figure 25 provides a general diagram to conclude the first part of this thesis in visual form. It shows the context, the involvement of this thesis in the Need project, and the motivations for the research. It also details the subject of the literature review, the gaps, the problematic, and the methodologies employed, as well as the general epistemological positioning allowing the emergence of the research questions and articles.

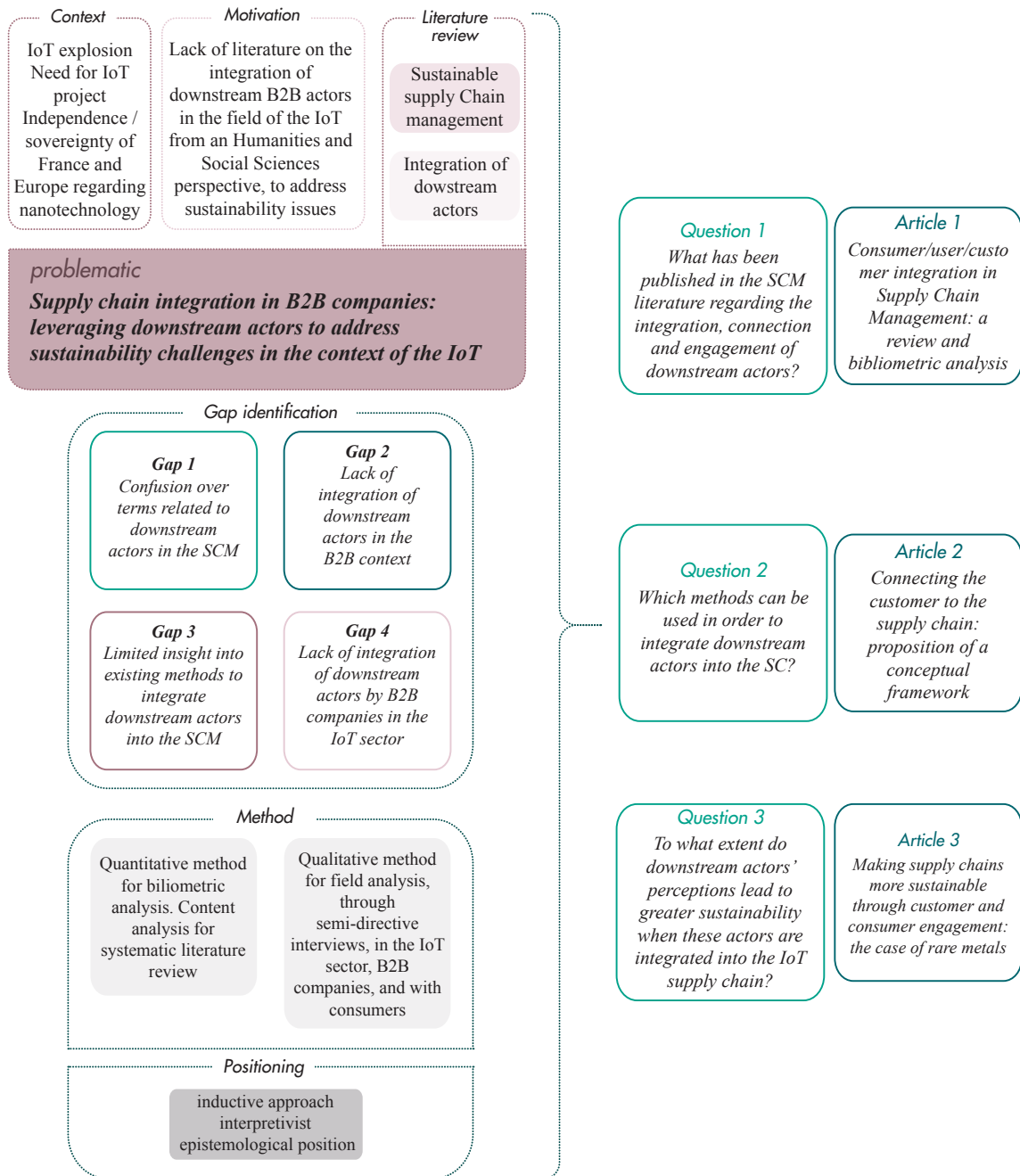


Figure 25: General conclusion of Part 1

PART II: ARTICLES

The second part of this thesis presents three research articles which are designed to address the problematic: Supply chain integration in B2B companies: leveraging downstream actors to address sustainability challenges in the context of the IoT. Each chapter of Part II corresponds to an article. Chapter 4, entitled “Consumer/user/customer integration in supply chain management: a review and bibliometric analysis” presents in bibliometric form the evolution of the literature on the integration of downstream actors into SCM. It proposes to observe the main themes studied by the most recognized authors, articles and journals, highlighting essential themes such as information systems and sustainability. Chapter 5, entitled “Connecting the customer to the supply chain: proposition of a conceptual framework” looks at the different methods of integrating downstream actors and proposes a comprehensive framework for selecting methods according to the processes targeted, the objectives sought, and the role given to the downstream actor. Chapter 6, which is a field case-study based on interviews, puts into perspective the elements found in the literature

on downstream actor integration and the important link with sustainability, as well as the integration methods seen in Chapter 4. Chapter 6 is entitled “Making supply chains more sustainable through customer and consumer engagement: the case of rare metals”. Following a qualitative analysis of the field of B2B companies in the IoT sector, alongside consumers, it proposes a mapping of the methods used according to the desired level of sustainability, the upstream or downstream nature of the process targeted via integration, and a distinction between the methods according to the customer and consumer.

PART I: GENERAL INTRODUCTION		
Chapter 1 Contextualization of the research topic	Chapter 2 Literature review	Chapter 3 Methodology
PART II: ARTICLES		
Chapter 4 Consumer/user/customer integration in Supply Chain Management: a review and bibliometric analysis	Chapter 5 Connecting the customer to the supply chain: proposition of a conceptual framework	Chapter 6 Making supply chains more sustainable through customer and consumer engagement: the case of rare metals
PART III: GENERAL CONCLUSION		
Chapter 7 Discussion of the results	Chapter 8 Contributions	Chapter 9 Limitations and future research

Chapter 4. *Consumer/user/customer integration in Supply Chain Management: a review and bibliometric analysis*

In Chapter 4 of Part II, a bibliometric article is presented. This article is in the form of a scientific research paper that has been published in the Supply Chain Forum: An International Journal (Marty, 2021). It deals with the topic of the integration of downstream actors, i.e., consumer, user and customer, in SCM. Following the methodology of a bibliometric article, it highlights metrics on the most represented authors, articles, journals, and keywords, and also proposes an analysis of the co-citation in cluster form, allowing the main themes to emerge in a visualized format.

ABSTRACT

The integration of actors into Supply Chain Management (SCM) is currently becoming more and more crucial. All actors, including suppliers, manufacturers, customers, consumers and users have a role to play in the company's performance. Customers, consumers and users have become major actors in the Supply Chain (SC). Their active integration into the SCM is becoming a new challenge for companies. This article aims to take stock of what has been done on the integration of customers, consumers, and users in SCM, in the literature, and to propose future avenues of research. A bibliometric analysis is conducted to study the integration of downstream actors. The analysis provides details on the most cited articles, published authors and influential journals using Bibexcel, and then Gephi is used to create a network. This article first proposes a quantitative analysis of the literature by highlighting the best authors, articles and journals on the integration of downstream actors in SCM. Subsequently, a network analysis reveals five clusters and the challenges to come. Finally, we suggest how and to what end these actors might be integrated. This bibliometric analysis proposes to explore this subject in depth, by identifying key research topics such as sustainability and information systems, interrelations and the evolution of publications over time.

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Keywords: Supply Chain Integration, Consumer, User, Customer, Supply Chain Management, Bibliometric analysis.

1. Introduction

Companies are increasingly aware of the importance of integrating their partners into their Supply Chain Management (SCM) (Shaw, 2000) since long-term relationships with partners create competitive differentiation (Narasimhan and Kim, 2002).

The integration of upstream SC actors has been widely studied and discussed in the literature, demonstrating that the suppliers integration into SCM could be beneficial (Rich and Hines, 1997; Walton et al., 1998). Over the years, the literature has highlighted that upstream SC integration is no longer the only source of performance and that to achieve excellence, it is necessary to integrate both upstream and downstream stakeholders (Frohlich and Westbrook, 2001). Similarly, the integration of downstream actors, such as logistics partners, retailers, and customers within SCM, has gained in importance and numerous studies stress the importance of integrating consumers into the company's processes (Christopher, 2016; Djelassi and Decoopman, 2013; Frohlich and Westbrook, 2001; Jeanpert and Paché, 2016; Maull et al., 2012; Ramaswamy and Gouillart, 2010; Reaidy et al., 2021; Reyes and Bhutta, 2005; Wright et al., 2006; Yee et al., 2010). Authors notice that companies may have numerous motivations to integrate their consumers, i.e. customer intimacy (Yee et al., 2010), consumer empowerment (Wright et al., 2006) or co-creation of value (Ramaswamy and Gouillart, 2010). Ta et al. (2015) conclude that growing collaboration with the end of the chain (the consumer) represents a fundamental change in SCM that requires new reflections and '*rethinkings*' of the SC concept among researchers and professionals to better satisfy the different SC partners. In this perspective, a review of downstream SCI literature has to be made in order to understand the major issues tackled in research and highlight recent evolution.

This study proposes a bibliometric analysis on the SCI literature from a downstream standpoint. Descriptive statistics are made to cross-reference the authors, fields and topics identified in this literature. A network analysis is then proposed, highlighting different key elements, such as clusters, the most prestigious articles, and the different areas covered by the articles. and the evolution of the integration of

downstream actors (customer/consumer/user) over time. This article also emphasizes fields of interest and opportunities for future research. Therefore, this article proposes to complement the literature on the subject by digging deeper and refocusing on customer/consumer/user SCI to provide objective and robust results. A review of the literature is first proposed on the integration of customers/consumers/users in SCM. The methodology is then presented. A bibliometric analysis is subsequently carried out on a database of 678 articles, followed by a co-citation network analysis. The results are then discussed according to the major issues tackled in research and recent evolution.

2. Literature Review

In the current context and in view of the events linked to the SARS-CoV-2, the integration of stakeholders into the SCM is essential to gain resilience, flexibility and responsiveness. SC integration aims to improve and facilitate exchanges, allowing more efficient decision-making while improving the visibility of SC activities and thus anticipating bottlenecks and increasing overall performance and competitiveness (Frohlich and Westbrook, 2001; Lee et al., 1997; Narasimhan and Jayaram, 1998; Narasimhan and Kim, 2002; Power, 2005; Stevens, 1989; Vickery et al., 2003).

Much research has been conducted on the integration of suppliers, concluding that this upstream integration creates an effective competitive strategy and provides greater flexibility and coordination both internally and externally (C. W. Lee et al., 2007; Petersen et al., 2005; Rich and Hines, 1997; Walton et al., 1998). From an environmental sustainability perspective, Walton et al. (1998) highlight that regulations are not sufficient to achieve acceptable performance and that most companies integrate their suppliers and buyers “*to meet and even exceed the environmental expectations of their customers and their governments*” (p. 2). Petersen et al. (2005) indicate that supplier integration can be beneficial in the context of new product development, allowing access to supplier expertise and better quality of information exchange earlier and more upstream in the new product development process. The integration of upstream actors, such as suppliers or buyers, can respond to different issues such as sustainability or new product development.

Customer integration emerges as a new challenge for companies as it enables the collection of a large number of indispensable data, improving the company's overall performance, as well as the performance in terms of customer satisfaction, product diversification and product innovation (Flynn et al., 2010; Koufteros et al., 2005; Pagell, 2004; Reaidy et al., 2021; Swink et al., 2007). In addition, some authors mention that this integration, which is essential, should go further downstream until the last actor—the consumer or end user (Reaidy et al., 2021). This integration of the consumer and end user has gained great importance, as they have increasingly played a more active role within the SCs of companies, creating “*value not only just for themselves but also for firms and other consumers*” (Ta et al., 2015, p. 133). This has been especially observed in the context of New Product Development (NPD) and innovation and in sustainability issues (Birgitta Bergvall-Kåreborn et al., 2009; Bogers et al., 2010; Bosch-Sijtsema and Bosch, 2015; J. Füller et al., 2014; Leminen et al., 2015; Morrison et al., 2000; Zimmerling et al., 2017). Indeed, SCI is an important determinant of sustainable supply chain management (Paulraj, 2011; Vachon and Klassen, 2008, 2006; Zhu and Sarkis, 2004) and supposes “*a strong collaboration between all supply chain stakeholders, towards a sustainable activity*” (Barbosa-Póvoa et al., 2018, p. 2). Some studies also exist in the field of SCM (Jeanpert and Paché, 2016; Reaidy et al., 2021) showing that this integration can have many positive impacts, such as better distribution process (Jeanpert and Paché, 2016) or allow access to quality information for better planning (Reaidy et al., 2021).

The consumer has long been perceived as a passive actor in the SCM, but recent research shows that he has an important and active role to play (Reaidy et al., 2021). The article “Consumer integration in supply chain management: a taxonomy” focuses on a qualitative exploratory approach and defines consumer integration as “the collaboration of a company with a consumer, leading the company to involve the consumer actively and reflexively in its industrial processes and logistics (design, source, make, deliver, plan, returns) and considering consumer needs to better meet them” (Reaidy et al., 2021, p. 6).

The main contribution of their empirical research, focused on “on the processes, actions, and practices deployed in SCM” (Reaidy et al., 2021, p. 1), underlines “that the consumer can now be considered as a link and a full-fledged partner in the supply chain, with a participatory and active role, similar to that of suppliers and customers.” (Reaidy et al., 2021, p. 13). Our research aims to explore this topic further by confirming that despite the importance of integrating the consumer, the latter is less integrated than the customers, as mentioned by Reaidy et al. (2021). Moreover, our article proposes a quantitative analysis of the literature to highlight the different clusters of research on this subject and brings out the global challenges faced by SCs and mainly that of sustainability.

The authors point out that research could be done focusing on other geographical areas and not only France, and over a longer period of time. It is in this continuity that we wanted to widen this field of research by carrying out a bibliometric analysis on the integration of all the downstream actors, customer, consumer, user. The articles constituting the database of our work are written by authors from all over the world and we also observe the evolution of this research topic over the years, revealing that sustainability is now at the core of SCI research.

Comprehensive reviews have been proposed on SCI about performance (Fabbe-Costes and Jahre, 2008; Van der Vaart and van Donk, 2008), and framework and dimensions (Alfalla-Luque et al., 2013). As indicated by Asgari et al. (2017), bibliometric analyses could also use databases other than Web of Science. Therefore, we propose bibliometric analysis by using an alternative database (Scopus). Moreover, we deepen the existing network analysis by using PageRank analysis, clustering data and emphasizing cluster evolution. Finally, we focus on the SCI from a downstream perspective (customer/consumer/user) with the aim of deepening the work done by Reaidy et al. (2021).

The aim of this article is, firstly, to observe which actors are the most integrated, presuming that the very downstream actors, i.e. the final consumer or user, are more difficult to integrate. Secondly, we aim to discover which areas are being studied areas in the field of SCI, which are the emerging fields, and which merit further

interest, for example, sustainability and information systems as a support to SCM, and finally, how integration can occur.

3. Research Methodology and Data Statistics

The objective of a bibliometric study is to analyse and study quantitatively a certain number of documents in a chosen field, allowing us to understand the evolution of this field over time (Apriliyanti and Alon, 2017; Barbosa-Póvoa et al., 2018; Broadus, 1987; Feng et al., 2017; Kazemi et al., 2019; Merigó and Yang, 2017; Perera et al., 2019; Zupic and Čater, 2015). Our bibliometric analysis follows a globally standardized structure conducted in the field of SCM (Fahimnia et al., 2015, 2015; González-Benito et al., 2013; Kazemi et al., 2019; Xu et al., 2018).

Figure 26 represents the research methodology and research design used in this article.

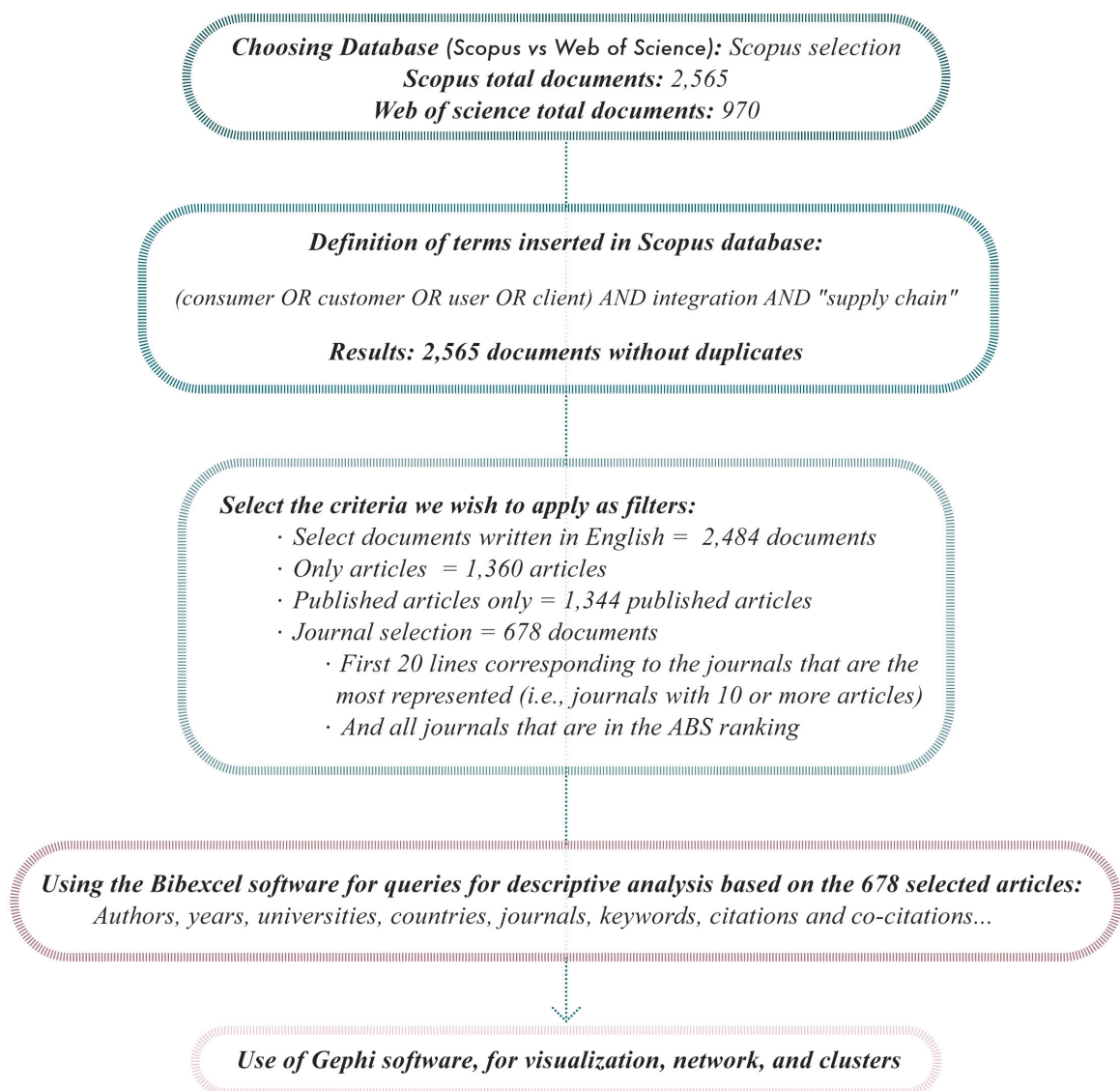


Figure 26: Research methodology and research design

3.1 *Defining terms and database selection*

The terms were searched for in the Web of Science and Scopus databases, in the article title, abstract and keywords, in order to select the database that we felt was the most relevant and complete.

To begin, we started by testing terms such as “consumer integration” AND “supply chain”. As the results were too weak to carry out a bibliographical study, we chose to widen and add to our primary search by splitting the first two search terms, e.g. “consumer integration” becoming “consumer” AND “integration”. Consequently, we found more results: we obtained a total of 1,102 documents, including 627 articles for Web of Science, and 3,025 documents, including 1,689 articles for Scopus. We have therefore chosen Scopus which seems more complete for our field (Fahimnia et al., 2015; Kazemi et al., 2019) as “scopus has been used and recommend as a good source of supply chain peer reviewed articles” (Fahimnia et al., 2015, p. 103).

This first step of term testing enables us to identify that the terms “*user integration*” as well as “*consumer integration*” are underrepresented compared to “*customer integration*”, which represents 75% of all articles found in Scopus, a point we raised in the literature. Moreover, as we broaden our search for the term “*client*”, a synonym for customer in English, we note that the word client is less mentioned than customer, consumer or user.

In this section we define the terms customer, consumer and user in order to avoid confusion.

The Cambridge Dictionary defines the customer as “a person who buys goods or a service”, the consumer as a “person who buys goods or services for their own use”, and the user as “someone who uses a product, machine, or service”¹.

.....

1 (“CONSUMER | meaning in the Cambridge English Dictionary,” n.d.; “CUSTOMER | meaning in the Cambridge English Dictionary,” n.d.; “USER | meaning in the Cambridge English Dictionary,” n.d.)

According to the definitions in the Larousse Dictionary², “the customer is a person who receives commercial supplies or services from a company for payment”, whereas the consumer “is a person who buys any products for his use” and “the user is a person, a group that makes use of something, that uses a device, a service”.

In the literature, the notions of end consumer, user and customer are frequently interchanged and used indifferently, which makes it difficult to discern and understand the scope of the subject. Indeed, Kaulio proposes an article on methods of integrating the consumer into product design processes, indicating, “in this paper, the word ‘customer’ is employed as a synonym for consumer or user” (Kaulio, 1998, p.142). Few articles correctly define terms, and only some works dedicated to marketing definitions mention the differences.

In the literature, the consumer is defined as “a buyer or user of a product or service” (Yadin, 2002, p.85), but the author explains the complexity of this role in the following example: “Children are consumers of household and other products, but do not usually buy them. However, they can heavily influence purchases made by the parent or householder, and much advertising is aimed at them for this purpose.” (Yadin, 2002, p.85).

The customer is defined as “one of the parties to a legally binding contract to purchase goods or services” (Yadin, 2002, p.106), but as the author makes clear, the customer is not necessarily the user of the product. The end user is defined as “the actual user of a product, as distinct from its purchaser or specifier” (Yadin, 2002, p.135).

Sampson and Froehle (2006) use the definition provided by Bennett (1995) which states that the customer can be defined as “the actual or prospective purchaser of products or services” (Bennett, 1995, p.73).

2 (“Définitions : consommateur, consommatrice - Dictionnaire de français Larousse,” n.d.; “Définitions : utilisateur, utilisatrice - Dictionnaire de français Larousse,” n.d.; Larousse, n.d.). Translations author’s own from the French, 2021.

Therefore, it can be said that the user has not necessarily carried out the act of purchasing goods or services, whereas consumers buy for their own consumption, and customers, conversely, buy either to resell or to offer to a third party.

3.2 Initial results

Once our database and terms were chosen, we opted to enter them by adding them all at the same time using the OR function, enabling us to eliminate duplicates. (Consumer OR customer OR user OR client) AND integration AND “supply chain”

2,565 documents were collected at the end of this first query in Scopus.

3.3 Refining the initial results

From this first query, we decided to implement several filters, applicable in Scopus. We selected only published articles written in English from journals that are either in the ABS ranking or the 20 top journals most represented in our sample of articles, corresponding to journals that have published ten or more articles (Fahimnia et al., 2015).

- Selecting only documents written in English = 2,484 documents
- Only articles = 1,360 articles
- Only published articles = 1,344 published articles
- Journal selection = 678 documents
 - First 20 lines corresponding to the journals that are the most represented (i.e., journals with 10 or more articles).
 - And all the journals that are in the ABS ranking

Thanks to these refinements, we obtained 678 articles to use as a basis for further data analysis.

3.4 Data analysis

Data analysis was conducted on these 678 articles in two steps, first using the BibExcel software and then Gephi (Fahimnia et al., 2015, 2015; Xu et al., 2018). The bibliometric analysis using BibExcel software allowed us to highlight important

information (Perera et al., 2019) such as the main authors, most represented journals, most frequent keywords, most-cited authors, co-citation, among others. For the network analysis, we chose Gephi “*due to its capability to work efficiently with large data sets and providing a range of innovative visualization, analysis and investigation options*” (Fahimnia et al., 2015, p. 104). To carry out this work on BibExcel, we first integrated the file in RIS format from Scopus and applied the procedures proposed by Pilkington, (2018) and Persson et al. (2009) to carry out the appropriate requests. The last step on BibExcel allows the creation of a .NET file that is then necessary to create the network mapping and clusters in the Gephi software for a more in-depth analysis of the co-citations.

4. Bibliometric analysis

4.1 Evolution of literature regarding the integration of actors into SCM

The 678 articles in the database were published between 1996 and 2020. The quantity of literature on this subject increased during this period. In 2019, 64 articles were published in this field. As the data was collected in January 2020, there are only six articles for that year. However, given the average rate of research on this subject, it can be assumed that the topic will continue to grow and to elicit interest from researchers. Figure 27 shows the evolution of the literature, with the year 2020 removed so as not to bias the coefficient of determination R^2 , which confirms that the volume of literature seems to be increasing. The growth follows a linear curve overall ($R^2 = 0.88$). We can therefore deduce that this is a subject that is both growing and linear over the years.



Figure 27: Evolution of literature

4.2 Authors' influence

Through BibExcel, we were able to analyse authors' influence. A frequency of occurrence was established, showing that, among the 10 contributing authors, Huo, B. is the author of the most articles, having published 19 articles, followed by Zhao, X. and Wong, C.W.Y., who published 14 and 7 articles respectively. These three authors collaborate extensively together: of the 19 papers, Huo, B. wrote 10 with Zhao, X., 3 with Zhang, M., and 1 which includes all three co-authors. Similarly, Wong, C.W.Y. and Boon-itt, S. co-authored three papers.

Table 7 also shows the total number of citations in the articles written by the authors, as well as the average H-index of the journals from which these articles originated. For example, the 19 articles by Huo, B. are cited 2,720 times, and the average H-index of the journals relating to these articles is 131. It can be observed that some authors, such as Gunasekaran, A., are not very present in our database, despite proposing authoritative articles that feature in very well-ranked journals. Just five of his articles are present in our database and have been cited 852 times, whilst the average H-index of the journals is 143.

Table 7: Top ten contributing authors

Author	Number of articles	Total citations	Average H-Index of journals
<i>Huo, B.</i>	19	2,720	131
<i>Zhao, X.</i>	14	2,350	150
<i>Wong, C.W.Y.</i>	7	633	162
<i>Zhang, M.</i>	6	368	140
<i>Jermisittiparsert, K.</i>	6	11	17
<i>Romano, P.</i>	5	405	105
<i>Boon-itt, S.</i>	5	567	124
<i>Gunasekaran, A.</i>	5	852	143
<i>Kumar, S.</i>	4	211	109
<i>Hong, P.</i>	4	163	84

4.3 Affiliation statistics

Consistent with authors' influence, Xi'an Jiaotong University (with which Huo, B., the most influential author, is affiliated) is the fourth most represented organization. Similarly, the Chinese University of Hong Kong, connected to Zhao, X. and the Hong Kong Polytechnic University connected to Wong, C.W.Y., are the second and the third most contributing organizations. As Fahimnia et al. (2015) and Mishra et al. (2017) explain, it can be assumed that the most represented authors have a direct impact on the organizations most present.

This query also shows which countries are the highest contributors. The United States is in first place, with 299 authors and co-authors having written the articles present in the database, followed by the United Kingdom with 146, and in third place China with 110. By analysing the articles proposed by the most contributing countries, we notice that the predominance of the subjects studied varies according to country. Indeed, the articles written by authors from the United States focus mainly on the dimension of information technologies and on everything that allows the integration of actors through new technologies and web technologies. The articles

from this country also focus on integration in operational and strategic processes, and the links between them. In the case of the United Kingdom, the themes most addressed correspond to integration into the supply chain from a global point of view, with a structural and multidimensional aspect, and the construction of this integration into the SC. As for the articles from China, they focus on the impacts of integration on quality and performance.

4.4 Keyword statistics

BibExcel also makes it possible to identify the most recurrent words, both in the keywords and in the title of articles. Top 20 keywords and used words in titles search results highlight that the terms “*Supply Chain Management*”, “*Integration*”, “*Industry*” and “*Logistics*” are predominant. We noted that “*customer satisfaction*” is in the top 5 most frequent keywords, while the term “*customer*” does not appear in the titles—in fact, it is ranked in 21st place, while the term “*consumer*” appears in the 100th position, “*user*” is 827th and “*client*” 1000th. Therefore, it can be assumed that despite the keywords searched for (where customer is mentioned once) in Scopus, SC, integration and SCI are much more discussed in the literature than customer/consumer/user and customer integration.

In view of the definitions of the customer, consumer and user given in section 2.1, it seems logical that the term customer is much more present in the titles than consumer or user. The customer is the closest downstream actor to the company and is therefore easier to integrate. Conversely, the consumer is much further downstream and the user even more so, making the interactions more complex. It would seem that the further downstream the actor is from the company, the more complicated integration is, whereas the closer the actor is, the simpler it is to integrate them. Therefore, it seems easier for B2C companies to integrate consumers and users compared to B2B companies.

The terms most related to SCI are “*performance*”, “*competition*”, “*optimization*” and “*costs*”. All these terms appear in the top 20 words in titles, while the term

“sustainability” is in 61st position. Sustainability in SCM is a topic that is increasingly being studied and is expected to grow in the coming years.

4.5 Journal influence

Regarding the journal’s influence, we based the analysis on Bradford’s law, as many bibliometric articles in the field of SC do (Arantes et al., 2016; El Baz and Iddik, 2021; Montecchi et al., 2021). This involves dividing the journals into three different categories – “the core area, the relevant area and the non-related area” (Gong et al., 2019, p.6). The three groups contain one third of the total number of articles. The core area corresponds to a limited number of journals which offer the most relevant articles. As Bradford states, “In practice one-third of the contents of special libraries is usually related definitely to their scope. The remaining two-thirds comprising literature on border-line and less related subjects.” (Bradford, 1934, p.180).

In our study we have a total of 678 articles from 88 journals, with each area composed of about 226 articles. Arantes et al. suggest that “under this law, the most relevant research are found on a small number of journals” (Arantes et al., 2016, p.2). In our case, the core area is composed of six journals whose popularity, citation and prestige indicators are presented in Table 8; the articles in the second third are from 17 journals and the articles in the last third are from 65 journals (Figure 28).

Table 8: Most influential journals from the core area based on Bradford's law

Journal from the core area	Number of articles	H-index	Impact Factor	SJR (SCImago Journal Rank)
<i>International Journal of Production Economics</i>	63	185	7.885	2.406
<i>Supply chain management : an International journal</i>	57	92	4.725	3.75
<i>International Journal of Production Research</i>	40	142	4.577	1.909
<i>International Journal of Physical Distribution and Logistics Management</i>	23	111	5.212	1.742
<i>Journal of Operations Management</i>	23	191	4.619	3.649
<i>European Journal of Operational Research</i>	22	260	5.334	2.161
<i>Journal of Cleaner Production</i>	22	200	7.246	1.937
<i>Production Planning and Control</i>	21	76	3.605	1.331

CORE AREA
RELEVANT AREA

However, the boundary between the two categories—the core area and the relevant area—is not clearly defined. Indeed, the first two journals in the relevant category (*Journals of Cleaner Production* and *Production Planning and Control*) are also very representative of the core category, and have a total of 22 and 21 articles respectively. The next papers in the relevant area then fall below the 20 articles.

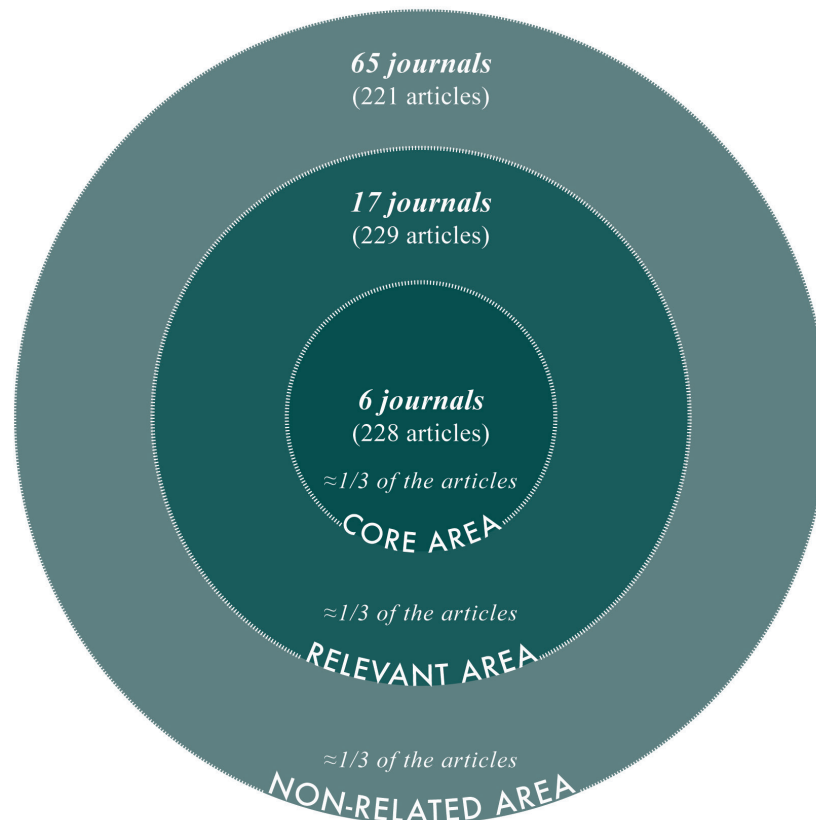


Figure 28: Distribution of journals by articles according to Bradford's law

4.6 The most influential articles

To measure the most influential articles we considered different criteria, such as the number of local citations, i.e. the number of articles in the database that cite a specific article, the global citations, i.e. the number of times the article is cited in total (data from the Scopus database), and the ranking by PageRank (Table 9).

Citation analysis provides information on citation frequency, i.e. which articles are most cited in a field and their popularity over time. As a result, the more an article is cited, the more valuable it is in its area of research (Garfield, 1972; Pilkington and Meredith, 2009).

Concerning the global citations, a frequency occurrence was performed on the 678 articles according to the number of citations in Scopus. Two articles stand out; Frohlich and Westbrook (2001) and Flynn et al. (2010) were cited 1,354 times

and 1,177 times respectively. The article written by Frohlich and Westbrook (2001) focuses on the integration of suppliers and customers and “investigated supplier and customer integration strategies” (Frohlich and Westbrook, 2001, p.185). The article by Flynn et al. (2010) is a study that is part of a “developing body of literature on supply chain integration (SCI)” (Flynn et al., 2010, p. 58). These authors are also largely present in the bibliographies of the articles (see Section 4 concerning co-citation).

Regarding the measurement of the articles’ prestige, Brin and Page (1998) introduce the page rank system. The page ranking method allows the popularity as well as the prestige of an article to be measured (Ding et al., 2009). The page rank algorithm quantitatively measures the popularity of a web page. As an example, paper A is cited by the papers T_1, \dots, T_n , with d corresponding to the damping factor, and a scale between 0 and 1 representing the fraction of random walks that keep spreading along with the citations. $C(T_i)$ corresponds to the number of citations of paper T_i cited by other papers. Since A is in a network of N papers, the PageRank of A is calculated as follows:

$$PR(A) = \frac{(1 - d)}{N} + d \left(\frac{PR(T_1)}{C(T_1)} + \dots + \frac{PR(T_n)}{C(T_n)} \right)$$

Note that if $C(T_i) = 0$, then $PR(T_i)$ will be divided by the number of articles instead of $C(T_i)$. The value of d was set to 0.85 in the original Google PageRank (Brin and Page, 1998). However, it would be more appropriate to define $d = 0.5$, according to Chen et al. (2007), in order to perform a citation network analysis.

The analysis of the Page Rank, the local citations and the global citations lead to the conclusion that the Frohlich and Westbrook (2001) and Flynn et al. (2010) articles are the most represented (based on local citations), the most popular (based on global citations) and the most prestigious (based on PageRank).

Table 9: The 10 most influential articles

Authors (year)	PageRank	Local citations	Global citations
<i>Frohlich MT, 2001; Westbrook R, 2001</i>	5,11E-03	127	1,354
<i>Flynn BB, 2010; Huo B, 2010; Zhao X, 2010</i>	4,50E-03	95	1,177
<i>Narasimhan R, 2002; Kim SW, 2002</i>	4,26E-03	67	418
<i>Fornell C, 1981; Larcker DF, 1981</i>	4,26E-03	76	/
<i>Swink M, 2007; Narasimhan R, 2007; Wang C, 2007</i>	3,97E-03	68	433
<i>Vickery SK, 2003; Jayaram J, 2003; Droge C, 2003; Calantone R, 2003</i>	3,92E-03	52	716
<i>Chen IJ, 2004; Paulraj A, 2004</i>	3,90E-03	48	1,171
<i>Koufteros X, 2005; Vonderembse M, 2005; Jayaram J, 2005</i>	3,86E-03	51	478
<i>Droge C, 2004; Jayaram J, 2004; Vickery SK, 2004</i>	3,86E-03	46	375
<i>Pagell M, 2004</i>	3,84E-03	50	458

5. Network Analysis: Co-citation Analysis and data clustering

Many tools exist to perform network analyses, such as VOSviewer, HistCite, Pajek or Gephi. We have chosen Gephi (Fahimnia et al., 2015, 2015; Xu et al., 2018) because it allows us to create high-performance visual graphs and is compatible with the Net file imported from BibExcel. Gephi is an open-source software which enables working in real time on a large database. Its ergonomic interface allows the software to be mastered quickly, and the large panel of filters and queries enables users to complete work by integrating clusters and by proposing a visual result with mapping (Bastian et al., 2009; Fahimnia et al., 2015). The nodes present in Gephi correspond to the articles and the edges between the nodes are the citations. Gephi could not integrate the source file retrieved from Scopus (in RIS format), so we used BibExcel to get the Net file and then create the network on Gephi.

Co-citation analysis explores connections between authors, subjects, journals, or keywords, illuminating how these groups relate to each other. This analysis can highlight the main research groups within a particular field and how they are changing

over time (Fahimnia et al., 2015; Pilkington and Liston-Heyes, 1999; Small, 1973). A co-citation analysis map is made up of nodes, corresponding to the articles, and links corresponding to the cooccurrence of the nodes. Articles are co-cited when they appear in the bibliography of the same article (so when A and B are cited by C). The more often the documents are cited together, the more likely it is that they are linked to their field of activity (Hjørland, 2013). The analysis of the co-citation with Gephi informs us that there are 725 nodes (i.e. 725 articles) in this co-citation study and 61,085 links. The different algorithms proposed by Gephi allow various page layouts. In the case of the Force Atlas layout, the nodes repel each other and the edges attract (Fahimnia et al., 2015, 2015). Many of the characteristics and parameters can be changed manually, such as node size, gravity, and repulsive force, among others (Bastian et al., 2009). The Force Atlas layout (Figure 29) highlights the most connected nodes because they cluster towards the centre, unlike the least connected nodes that go outward.

To group the articles into categories, we used the data clustering available in Gephi. The articles with the most similarities are grouped under the same cluster (a colour is assigned to it), and the nodes within the same group are denser than those in different groups (Clauset et al., 2004; Radicchi et al., 2004). Modularity is based on the Leuven algorithm in Gephi, and the value of the index varies between -1 and +1 (Blondel et al., 2008). The equation is as follows:

$$Q = \frac{1}{2m} \sum_{ij} \left[A_{ij} - \frac{k_i k_j}{2m} \right] \delta(C_i, C_j)$$

where A_{ij} represents the weight of the edge between nodes i and j , k_i is the sum of the weights of the edges attached to a node ($k_i = \sum_j A_{ij}$), c_i is the community to which vertex i is assigned, $\delta(u,v)$ is equal to 1 if $u=v$ and 0 otherwise, and finally $m = (\frac{1}{2}) \sum_{ij} A_{ij}$. We applied this algorithm to our 725 nodes, creating seven different groups. The number of articles in each group varies from 218 for cluster 3, to 52 for cluster 5. We chose to remove 3 clusters because they were composed of only two, three and four articles and their page rank ranged from to $3.13E^{-4}$ to $8.25E^{-4}$.

We ended up removing 9 articles, with a total of 716 nodes. The five main clusters are shown in Figure 29. It can be seen that the clusters are very close to each other and this is also reflected in the modularity index which is 0.144, indicating a strong interrelationship between clusters

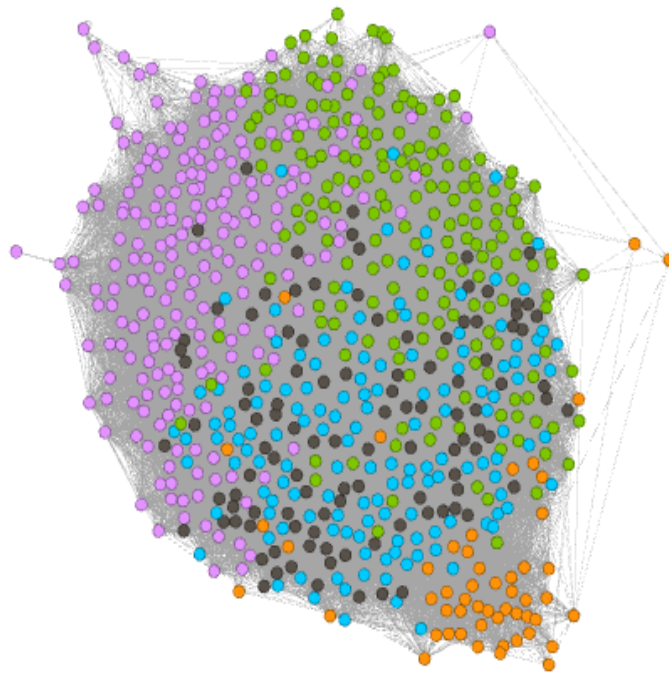


Figure 29: Structure of five clusters using Force Atlas layout

In each cluster, the papers are therefore forming a convergent research group as they are likely to focus on the same subject area (Hjørland, 2013). We decided to identify the top ten lead papers in each cluster, and the areas of research focus (Table 10) as other bibliometric analysis papers recommend (Fahimnia et al., 2015; Xu et al., 2018).

Table 10: The five major research clusters and their area of research focus

Area of research focus	Authors	Cluster	Number of Articles	Weight (%)
Initial concept for SCI - Theoretical Development for SCI	<i>Cousins and Menguc, 2006; Fabbe-Costes and Jahre, 2008; Fawcett and Magnan, 2002; Frohlich and Westbrook, 2001; Gimenez and Ventura, 2005; Lambert et al., 1998; Lambert and Cooper, 2000; Power, 2005; Stevens, 1989; Zailani and Rajagopal, 2005</i>	1	196	27
Dimensions/Scope of SCI - Research and conceptual framework for SCI	<i>Anderson and Gerbing, 1988; Armstrong and Overton, 1977; Devaraj et al., 2007; Droge et al., 2004; Flynn et al., 2010; Fornell and Larcker, 1981; Pagell, 2004; Stank et al., 2001b; Swink et al., 2007; Vickery et al., 2003</i>	2	143	20
Modelling SCI - Measure to assess SCI	<i>Chen and Paulraj, 2004; Das et al., 2006; Koufteros et al., 2005; Morash and Clinton, 1998; Narasimhan and Kim, 2002; O'Leary-Kelly and J. Vokurka, 1998; Petersen et al., 2005; Podsakoff et al., 2003; Podsakoff and Organ, 1986; Stank et al., 2001a</i>	3	110	15
Drivers/Domain of SCI - Information Systems as drivers of SCI	<i>Fisher, 1997; Hayes and Wheelwright, 1984; Lee et al., 1997; Lee and Billington, 1992; Miller and Roth, 1994; Narasimhan and Jayaram, 1998; Nunnally and Bernstein, 1978; Ragatz et al., 1997; Schmenner and Swink, 1998; Tan et al., 1998</i>	4	219	30
Sustainability and SCI - SCI as an antecedent / determinant of environmental management	<i>Carter and Rogers, 2008; Dillman, 2000; Dyer and Singh, 1998; Klassen and Whybark, 1999; Paulraj, 2011; Thompson, 2003; Vachon and Klassen, 2008, 2006; Zacharia et al., 2011; Zhu and Sarkis, 2004</i>	5	53	7

Although these articles are in separate clusters, it can still be noted that they are strongly connected to each other (by many edges). Moreover, we can observe that a few different authors compose the majority of the clusters such as R. Narasimhan, H. L. Lee, S. Vachon and R.D. Klassen, P.M. Podsakoff. We can, therefore, underline the fact that a small number of authors are widely represented in the most prestigious and most cited articles in this field.

Clusters 1 and 2 overlap with the theoretical development of SCI. They contain the two most cited papers—Frohlich and Westbrook (2001) and Flynn et al. (2010). Although they both contribute to the theory building of SCI, cluster 1 is more exploratory in nature whereas cluster 2 extends the existing body of literature. Cluster 3 delineates empirical studies of SCI. In this cluster, authors were mainly interested in modelling and testing measurement models to find out how some companies obtain better returns from SCI and why some integration initiatives are more successful than others. Cluster 4 is focused on the drivers of SCI and more specifically, on information systems. Cluster 5 deals with a more recent and emerging research area, namely the sustainable SC.

6. Discussion

6.1 The evolution of research areas/clusters over time

The evolution of clusters over the years (Figure 30) enables us to observe and understand the evolution of this field over time, moving from a more theoretical, sense-making phase to an emergent area of SCI in the context of Sustainable Supply Chain Management. Such as the cluster 5 (orange) dealing with sustainability in SCI, which explodes from 2000 to 2010 and is becoming more and more studied in SCM.

The 10 best articles in Cluster 1 date from 1989 to 2008. In this cluster, the oldest articles deal with product integration, then with integration from a strategic point of view, whilst the most recent articles move towards a vision of global integration with a performance objective. For Cluster 2 the top 10 articles date from 1977 to 2010; the evolution

of this cluster reflects a vision of integration moving from external to internal integration, while the more recent articles focus on the combination of integration types, whether internal, external or transversal. The top 10 papers in Cluster 3 date from 1986 to 2006. The evolution of this cluster translates into a transformation from an operational management perspective to a strategic management perspective. Cluster 4 is the most represented, with 219 articles. The 10 best articles in this cluster were published between 1978 and 1998. It is interesting to see that this cluster on drivers and information systems does not present any more articles from the year 2000 on. Nevertheless, the subject of information systems in SCM is still very much present. We can assume that a change in the keyword paradigm is likely to be present. A brief search on Google Scholar shows that there are more than 18,000 articles between 2010 and 2021 with the query [Supply chain integration and ERP]. The same applies to the block chain, which allows better traceability and connection between the actors. By carrying out the [Supply chain integration and blockchain] query, more than 17,000 articles emerge for a much shorter period of time (2017–2021). The top 10 articles in Cluster 5 date from 1998 to 2008, with the first articles focusing mainly on the environment, while the most recent ones open their research to sustainability by including social and economic aspects.

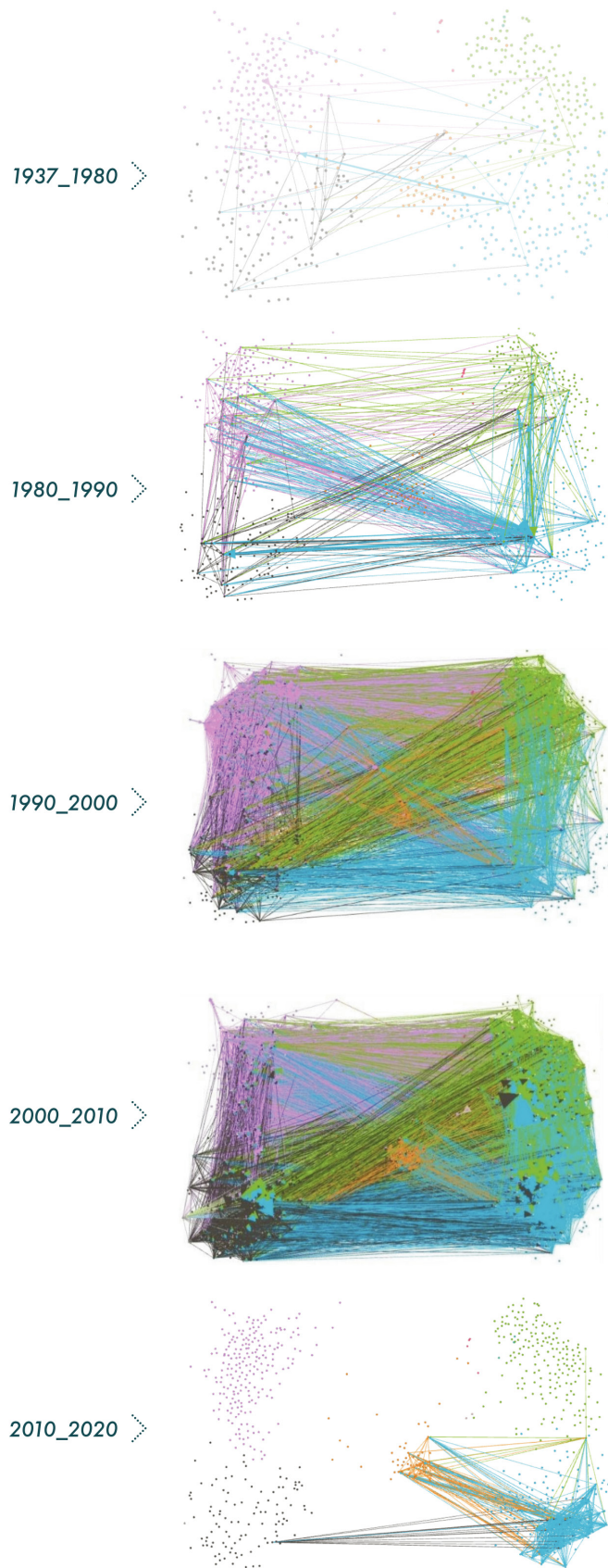


Figure 30: Evolution of research clusters over time

It is interesting to note here that the main authors of each of the clusters published articles before 2010. Moreover, this cluster study seems to mean that today, either little research focuses on this field of study, or few articles are cited by other articles. Does it mean that this field of study is being less frequently addressed by researchers? We believe that this subject is still being addressed, but that today, integration into SCM is very much recognized and the majority of companies are practising it. We assume that future discoveries in the field of SCI will focus more on digital tools or methods such as ERP, blockchain, or integration methods such as crowdsourcing.

6.2 Sustainability: as a fundamental challenge

“The term sustainability, which increasingly refers to an integration of social, environmental, and economic responsibilities” is a major challenge for the coming years (Carter and Rogers, 2008, p. 361). As shown by the clusters and the analysis of their evolution, sustainability is at the core of Supply Chain Management research and has evolved strongly over the last ten years. In view of the environmental situation and the increasingly relevant issues, as well as an increase in awareness on the part of consumers and users, this subject should take on greater importance in the coming decades. Many challenges related to supply chains have an environmental impact and are now being studied by researchers and companies, such as transport and the last kilometre issue, improving production processes and making them more sustainable, or focusing on the raw materials in product design.

The integration of all actors in the supply chain is essential if companies wish to develop more sustainable products and practices (Barbosa-Póvoa et al., 2018). Not just customers, but also consumers and users have an important role to play. Consumers and users are themselves becoming more and more attentive to sustainable development issues on a daily basis and are questioning not only their consumption habits but also company practices. As a result, companies close to their consumers are attaching great importance to the development of sustainable products and processes (Seuring et al., 2008). The creativity of consumers and users, their power of proposal, and their numbers can have a very beneficial impact in enabling companies

to find concrete solutions that respond to today's environmental, social, ethical and economic challenges. Many authors study the different integration methods that exist to involve users and consumers in order to propose more sustainable products (Birgitta Bergvall-Kåreborn et al., 2009; Bogers et al., 2010; J. Füller et al., 2014; Leminen et al., 2015; Morrison et al., 2000; Zimmerling et al., 2017). Methods such as crowdsourcing, user toolkits or living labs helps integrating consumers, customers and users to tackle sustainable challenges, either by placing the information system at the centre of the method or just as a support tool. There are also methods for integrating actors that do not necessarily require the use of information systems, such as brainstorming, lead-user methods or participatory design. Nevertheless, these methods can nowadays be supported by technology and facilitate the understanding and creativity of participants. IT-related tools and integration methods can be used to address environmental issues and develop new, more sustainable products, or to improve the sustainability of the different SC processes. Future research could be conducted to observe and analyse the different methods of integration of downstream actors, as well as those that can tackle environmental and social issues.

7. Conclusion

This article presents a review of the literature and a bibliometric analysis of the integration of downstream actors in the domain of SCM. Hundreds of articles have been published on this topic, with a growth in publications since the 1990s (678 articles on the subject between 1996 and 2020 were collected). The aim of this preliminary work is therefore to outline the more influential and significant articles and to enrich the literature on SCI while showing its evolution over time. This research has shown that a high concentration of the most influential articles are written by a minority of authors. Moreover, the more productive authors are also the most cited authors, and also come from the most represented universities.

Regarding author co-citation analysis, we can see that all the articles in this field are strongly linked (clusters are close and share many citations and co-citations) and that most influential articles are often cited and co-cited among themselves. Our study outlines the existence of five core reference clusters. These clusters structure

the areas of research focus on theoretical, conceptual and empirical studies to show the importance of integrating SC for improving performance. They also contribute to highlighting the evolution of the research area by outlining the emergence of new topics in the domain of SCI. In this regard, Cluster 5 opens up sustainability, which has recently become and will continue to be a key subject, especially in the domain of SCM.

This article enriches the existing literature on the subject of the integration of downstream actors in SCM, by carrying out a bibliometric analysis with a more quantitative approach, while other authors have analysed the subject through qualitative and empirical research (Reaidy et al., 2021). Furthermore, this bibliometric analysis shows that the further downstream the SC actors are, the less research exists and the more complex it is to integrate them. Indeed, the term “customer” is ranked 21st for words used in titles, “consumer” and “user”, which are much further down the chain, appear in 100th and 827th position. This point was also mentioned by Reaidy et al. (2021) and is confirmed by our research.

Concerning the topic of sustainability in SCI, our bibliometric analysis confirms that the subject has gained attention. Other challenges such as “performance”, “competition” et “optimization” appear in the top 20 most used words in the titles. The term “sustainability” only appears in 61st position. However, as we had also assumed, this can be explained by the fact that sustainability is a topic that is now gaining momentum and that was not directly related to SCM in the past, but which we believe will be increasingly seen at the centre of research. This article therefore provides a contribution concerning the emergence and importance of the challenge of sustainability in SCM, and which integration methods can help to offer more sustainable products or processes.

The limitations of this article mainly relate to the lack of multidisciplinary. Indeed, our research relates only to the field of SCM, whereas the integration of downstream actors such as customers, consumers and users is also addressed in marketing, innovation, and service, among others (Griffin and Hauser, 1993; Liedtke et al., 2015; von Hippel et al., 2011). We could, therefore, extend the search by

adding terms according to the domains. By expanding our terms, numerous other contributions would be identified, contributing to modifying our results and outlining different core research areas. There may also be opportunities to conduct a complementary study concerning the existing tools and methods of integrating these actors and/or the processes by which customers/consumers/users are mainly integrated. Alternatively, a study on the content of the articles could be very useful for identifying knowledge gaps on this subject and possible improvements. Finally, we could extend this research by including other databases or focusing on a specific journal.

Chapter 5. *Connecting the customer to the supply chain: proposition of a comprehensive framework*

This fifth chapter focuses on methods of integrating downstream actors, mainly customers. This article has been accepted in the European Journal of International Management and should soon be published. Following a systematic analysis, this article proposes a comprehensive framework to select the appropriate method according to the targeted process, the ultimate objective and the role given to the actor.

ABSTRACT

Customers are increasingly seeking to become actively involved in the way that products are designed, sourced, manufactured and distributed. Moreover, they are concerned about ethical and environmental issues to a much greater extent than before. As a result, it is imperative that companies find ways to effectively integrate their customers into supply chain management (SCM) processes. This study explores the options that exist for organisations to proactively connect their customers to their supply chains.

In this article, the researchers conduct a systematic literature review of the methods used to integrate the customer into SCM processes according to company objectives. A descriptive analysis is carried out and categories and dimensions are identified in the selected articles in order to propose a comprehensive framework. This framework highlights the most appropriate methods for companies to better integrate their customers into their SC.

Keywords: Supply Chain Management, Customer engagement, Integration methods, Systematic literature review, Sustainability.

1. Introduction

As supply chains (SC) become more complex and interdependencies between players in extended supply chains increase, so too does the need for greater flexibility and responsiveness in order to enhance resilience. One such source of resilience is strong supply chain relationships, both with suppliers and customers. Organisations that are closely connected to their upstream and downstream partners are better able to anticipate and respond to demand-side shocks. Recent events related to the Covid 19 pandemic have highlighted the urgent need for greater connectivity and integration.

Many authors stress the importance of integrating upstream and downstream actors into SCM, whether to reduce risks, increase performance, or improve sustainability (Flynn et al., 2010; Frohlich and Westbrook, 2001; Vachon and Klassen, 2006). Some authors focus on the integration of suppliers (Cassivi, 2006; Park et al., 2010; Petersen et al., 2005), others focus on the integration of actors further downstream such as the customer or consumer (Griffin and Hauser, 1993; Morash and Clinton, 1998; Rese et al., 2015) and some on internal and external integration (Flynn et al., 2010; Frohlich and Westbrook, 2001).

In all cases, it is important to know how to integrate these actors, thus the question of integration methods is central. Certain authors have studied the different methods of integrating these downstream actors, such as laddering and Voice of Customer (VoC) (Gonzalez et al., 2008; Lee and Lin, 2006; Soroor et al., 2012), or methods based on the use of the Internet and new technologies, such as crowdsourcing (Carbone et al., 2017; Howe, 2006). By “using web-based tools, a large number of employees, community members, potential customers and users can contribute to the innovation process with their ideas, triggered by competing with other individuals, and often also by incentives in terms of different prizes and rewards” (Bergendahl and Magnusson, 2014, p. 531). In our study we have called these methods ‘user interfaces’.

Methods for connecting downstream actors to the SC can offer companies a competitive advantage, for example, the lead user method allows companies to benefit from the expertise of these users and to solve technical issues (Franke et al., 2006; Von Hippel, 1986), while the TRIZ method aims to find solutions for specific and complex problems (Al'tshuller, 1999; Yamashina et al., 2002; Yang and Chen, 2011). As for the crowdsourcing method, it can generate a great variety of ideas for the creation of new products, given that crowds are a cheap and potentially skilled labour force (Howe, 2006). The different methods of customer integration analysed in this article are presented in Table 11.

Table 11: Customer integration methods

Method	Definition	Author
VoC	<i>The Voice of Customer (VoC) method is implemented by companies to ensure that they offer products that perfectly meet the needs of their customers. This method collects a lot of data and feedback from customers to increase customer satisfaction by improving the quality of products and manufacturing processes. In a first step, surveys of social networks or customer complaints are used as data, which are then analysed and monitored. This method is directly related to Quality Function Deployment (QFD), based on VoC, which is used in most company departments to improve processes as a whole, positioning the customer as an input.</i>	(Griffin and Hauser, 1993)
Customer interviews	<i>The customer interview is part of the VoC method. It is very much appreciated because it allows the creation of a close relationship with customers, a better overview of their activities, and in particular, the ability to address any problems that are usually not mentioned. The format of the interviews is flexible due to the open-ended questions, and the interviewer sometimes gets useful unexpected or unsolicited information.</i>	(Cooper and Dreher, 2010)
Laddering	<i>"Laddering refers to an in-depth, one-on-one interviewing technique used to develop an understanding of how consumers translate the attributes of products into meaningful associations with respect to self, following Means-End Theory".</i>	(Reynolds and Gutman, 1988, p. 2) (Gutman, 1982)
Brainstorming	<i>Brainstorming is conducted as a group rather than individually, making it more effective for generating creative and collective ideas to solve a problem.</i>	(Camacho and Paulus, 1995)
Lead user	<i>The lead user is a consumer who expresses his or her needs before 'normal' consumers. Lead users are experts in a field where the market has not yet proposed solutions to their needs. Firstly, lead users must be selected based on previously established indicators, then they participate in the creation of the concept, and finally the product is tested.</i>	(Von Hippel, 1986) (Urban and Von Hippel, 1988)

User toolkit	<i>User toolkits promote understanding of user needs in relation to the conceptualization and appearance of a product. Toolkits have two main benefits; firstly, they enable a task usually carried out internally to be carried out externally, making it cheaper and faster, often resulting in better product quality through a process of "learning by doing". Secondly, this method gives access to "sticky user information".</i>	(Von Hippel, 2001) (Von Hippel, 2001, p. 5)
Idea contest / Idea competition	<i>This method is carried out online thanks to computer and internet technology. Competitions allow the participant to be very creative and to propose very good quality solutions, enabling companies to find technical solutions. The results are judged by experts and the best solutions are rewarded, mainly to enable the company to recover the rights to the idea. The user is therefore encouraged to participate in the company's innovation process, through creativity and interaction with the company.</i>	(Terwiesch and Xu, 2008) (Piller and Walcher, 2006) (J. Füller et al., 2014)
Crowdsourcing	<i>The crowdsourcing method is conducted online and is based on a large and unknown population (the 'crowd'), allowing companies to generate ideas. Crowdsourcing is used in any project and in any organization, at different stages (conceptualization of new products, technical problem solving, design, marketing, etc.). This method allows organizations to limit the boundaries between themselves and their users or consumers while learning about their needs and developing new skills and knowledge.</i>	(Howe, 2006) (Brabham, 2008) (Leimeister et al., 2009)
Living labs	<i>"The definition of Living Lab given by the network is that "a Living Lab is an open innovation environment in real-life settings in which user-driven innovation is the co-creation process for new services, products, and societal infrastructures. Living Labs encompass societal and technological dimensions simultaneously in a business-citizens-government-academia partnership"</i>	(Bergvall-Kåreborn and Stahlbrost, 2009, p. 2)
Empathic design	<i>Empathic Design is based on the observation of consumers in their daily life, and open questions. This method provides information about consumers which they might not have spontaneously evoked under other conditions.</i>	(Leonard and Rayport, 1997)
Participatory design	<i>The participatory design method puts users at the centre by giving them an active role, involving them in the development and design of a new product.</i>	(Spinuzzi, 2005)
Innovation communities	<i>"An innovation community is an informal network of likeminded individuals, acting as universal or specialised promoters, often from more than one company and different organisations that team up in a project related fashion, and commonly promote a specific innovation, either on one or across different levels of an innovation system".</i>	(Fichter, 2009, p. 360)
TRIZ	<i>TRIZ means Theory of Inventive Problem Solving. The objective of the TRIZ method is to find technical solutions for problems in product or process development, mainly for engineers. Consumers' needs are observed, rather than integrated as such, and are often included at the beginning of the process. The result of this method is a list of innovative but technical and conceptual solutions for a specific problem.</i>	(Yamashina et al., 2002) (Edvardsson et al., 2010).

Companies use these various methods to meet several objectives, whether to improve quality, or to propose product innovations, sustainable innovations, or technical innovations. For example, the article by T.-R. Lee et al. (2007) focuses on the VoC method in the context of Logistics Service Providers (LSPs) in Taiwan. Using this method, they found that “the best quality improvement strategy for the five different types of LSP companies in Taiwan is ‘increasing efficiency with information technology’” (T.-R. Lee et al., 2007, p. 278).

For the lead user method, the article by Zimmerling et al. (2017), which focuses on green innovations, observes the implementation of different methods of integrating downstream actors in companies. The method is used in the upstream phase by “one of Austria’s leading energy providers [regarding the] charging stations for e-vehicles” (Zimmerling et al., 2017, p. 4). As explained by the authors, “the company performed a lead-user study including a lead-user workshop with 25 participants who all had ample experience with e-mobility, charging or energy storage. The aim of the lead user study was to gain insights into customer needs and wants as well as ideas for corresponding solutions.” (Zimmerling et al., 2017, p. 4).

Regarding user toolkits, in the framework of an open innovation research project in the German automotive industry, Rese et al. (2015) show that the user toolkit method can be a useful asset. They report that by using this method “the quality of users/customers’ innovative ideas is rated significantly higher” (Rese et al., 2015, p. 10). Furthermore, the authors confirm that in the case of Audi, toolkits “allow customers to experience innovative products via the Internet and enable them to come up with new ideas” (Füller and Matzler, 2007, p. 385; Rese et al., 2015, p. 14).

Concerning living labs, a research study entitled “PHL [postharvest losses] in tomato value chains in Nigeria” by Plaisier et al. (2019, p. 1) outlines that their use allows practical solutions to be found by integrating Nigerian users and their communities directly. Thanks to this method, the authors propose, test and experiment with one solution, namely, “replacing the raffia baskets with plastic crates during tomato transport” (Plaisier et al., 2019, p. 15) thus limiting tomato losses.

As for the crowdsourcing method, which is based on Internet-related technologies, it seems to be a solution that allows organisations to outsource certain tasks that have hitherto been their responsibility by involving a community (“crowd”) online (Mladenow et al., 2014). For example, the Galaxy Zoo project, which is an online astronomical project, enables Internet users to participate in the classification of millions of galaxies using images provided by the Sloan Digital Sky Survey program. The project aims to ensure that “each and every galaxy [is] classified by 30 separate users. The importance of multiple classifications is that it will enable us to build an accurate and reliable database, that will meet the high standards of the scientific community” (Holley, 2010, p. 6; Masters and Team, 2019).

Zimmerling et al. (2017) highlight the advantage of using a combination of these different methods by giving the consumer an active role, according to the upstream or downstream processes (design, manufacturing, marketing, sales, etc.). They underscore the benefits in terms of technical and environmental innovation, but also the economic benefits.

Integrating downstream actors into the SCM can have clear benefits for companies. In the literature, customers have often been perceived as having a passive role whereas they can have an important role such as creating sustainability, technical solutions and economic gains while reducing the risks associated with new product development (Halldórsson et al., 2019; Zimmerling et al., 2017). Indeed, the customer may be “viewed as a sustainable co-producer” (Halldórsson et al., 2019, p. 3). In their research, the authors suggest that “future research might consider the analysis of further cases and their comparisons with cases in which users have not been heavily involved in the green innovation process” (Zimmerling et al., 2017, p. 7). Furthermore, Halldórsson et al. (2019) state that “future studies can provide important insights by expanding the activity focus of this study and focus on actors’ decisions, behaviours and interactions that enable increased quality of waste” (p. 16).

A thorough analysis of the literature reveals several articles proposing frameworks of different customer integration methods, and most of them concern the context of innovation, with very few in the field of SCM (Edvardsson et al.,

2012; Piller et al., 2010; Zogaj and Bretschneider, 2012). Some authors propose the following avenues for future research: “evaluate and incorporate further customer integration methods such as passive methods to integrate customers” (K. Füller et al., 2014, p. 8); as well as “modelling the effect of customer co-creation and the scarce resource of ‘innovative users’” (Piller et al., 2010, p. 22).

These different studies, proposing matrices of integration methods, focus either on aspects of method implementation, such as cost, duration, and infrastructure requirements (K. Füller et al., 2014), or on the degree of freedom (open task or narrow task), degree of collaboration and the stage of innovation (Piller et al., 2010), the type of information retrieved by the implementation of these methods (Zogaj and Bretschneider, 2012), or the benefits and problems of implementing specific methods (Rese et al., 2015). Some authors stress the importance of focusing on sustainability aspects for future research “to gain more insight on the role of end-users in green innovation processes” (Zimmerling et al., 2017, p. 7). These different elements indicate that current studies do not propose a framework that questions the methods according to customer roles, processes targeted and different objectives, including the importance of sustainability.

Moreover, in the field of SCM, studies focus more on the integration of the supplier than the customer (C. W. Lee et al., 2007; Park et al., 2010; Petersen et al., 2005) and it would seem to be easier to integrate suppliers than customers. Indeed, Edvardsson et al. (2012) explain that supplier integration contributes to innovation and process flexibility and is well implemented in companies, but they indicate that companies have issues connecting to customers. Nevertheless, they emphasise that “companies can with various methods capture the information directly from customers” (Edvardsson et al., 2012, p. 1). Moreover, downstream actors such as customers or consumers, who have long been perceived as passive actors (Ta et al., 2015), are increasingly willing to be active and to take part in SC decisions and actions in order to respond, for example, to environmental issues (Halldórsson et al., 2019). In this regard, this research focuses on the integration of downstream actors.

In view of these gaps in the literature and avenues for future research, we have chosen to address the following research question: How can the customer be more connected to the supply chain to meet sustainability challenges? In this perspective, a systematic literature review has been carried out, analysing a number of articles proposing to integrate customers through different methods and focusing on the level of integration and the objective of that integration, including sustainability, alongside the processes targeted.

The present study aims to help companies to find solutions and methods to integrate their customers according to their objectives and processes. The methods for connecting with downstream actors (mainly customers, as well as consumers and users) in SCM processes have been little discussed, despite the fact that companies are seemingly taking greater interest in the topic. We assume that the further away the customer is from the target process, the more complicated it is to integrate them. The notion of sustainability is also widely addressed as it is essential for SCs to respond to the ethical and environmental challenges of tomorrow.

This study therefore provides a systematic literature review of the different methods of customer integration, methods that can also be applied to other downstream actors in an SC, such as consumers and users. A thorough reading of the literature was carried out in order to identify relevant articles. The aim was to study the integration methods objectively, with descriptive statistics on articles, journals and keywords of the selected articles. The second phase proposes a comprehensive framework to highlight the integration methods to be used depending on the companies' challenges and the process targeted by the integration. The value of this research is firstly that it provides a more global perspective than other classifications as it looks at integration methods through the prism of various processes, the level of integration, the role of the customer and the objectives. Secondly, it enriches the academic research in the field of SCM as most of the classifications are in the domain of innovation, whereas integration is essential in SCM processes. Thirdly, this research also helps companies to identify the most suitable methods for their needs by considering many different factors.

In the next section, the methodology is detailed, then the results are presented, including data analysis, identification of categories and a synthesis and analysis of the themes. Subsequently, the results are discussed and a comprehensive framework is displayed. Finally, a conclusion is proposed.

2. Research methodology and data statistics

Our study is based on the methodology of existing systematic literature reviews in SCM (Koberg and Longoni, 2019; Seuring and Müller, 2008a; Wilding et al., 2012). It aims to answer the following question: How can the customer be more connected to the supply chain to meet sustainability challenges? The following research methodology provides a reliable research design to address this question.

Concerning the methodological aspects, this systematic literature review combines both a quantitative analysis to describe the sampled articles and a qualitative content analysis of the sampled articles to define the categories and to identify “patterns, themes and issues” (Seuring and Müller, 2008, p. 1,700). This method of content analysis can help “to identify the conceptual content of the field and can contribute to theory development” (Seuring and Müller, 2008, p. 1,700). In addition, this content analysis “offers one sound methodological frame for conducting rigorous, systematic and reproducible literature reviews” (Wilding et al., 2012, p. 545). The methodology is presented in Figure 31 following the four steps proposed by Melacini et al. (2018).

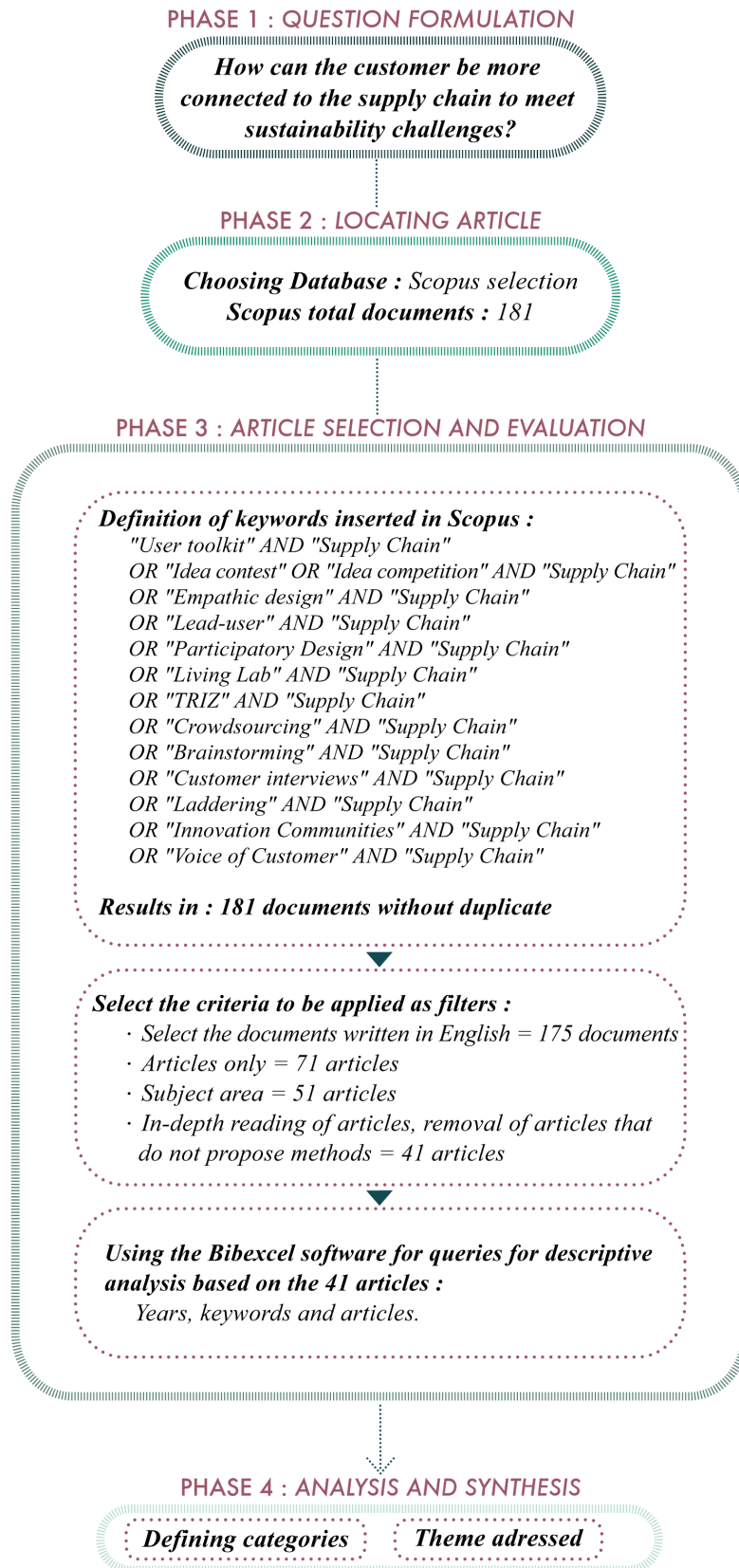


Figure 31: Research methodology and research design

2.1 Material collection

Prior to the material collection, a detailed analysis of the literature concerning customer integration in the supply chain was carried out. To perform this analysis, the query “Voice of Customer” AND “Supply Chain” were searched for in Google Scholar and Scopus, and after an in-depth analysis of the articles’ contents, we found five articles and a book that cover the majority of the customer integration methods used as our key words for our research (Edvardsson et al., 2012, 2010; K. Füller et al., 2014; Piller et al., 2010; Rese et al., 2015; Zogaj and Bretschneider, 2012). These method keywords were searched for in the titles, keywords and abstracts of the articles in the Scopus database. Keywords were then entered into Scopus in the form of Methods and Supply Chain, for example “Voice of Customer” AND “Supply Chain”.

2.1.1 Initial results

The different methods were used as keywords in Scopus, under a single query, separated by the OR comparison operator to avoid duplicates. This query led to the selection of 181 documents, and various filters were then applied to narrow down the topic. Some of the methods we developed in the literature review were not found in our systematic analysis, such as user toolkit, empathic design and idea contest. We assume that these are not necessarily studied in the field of SCM but more in the field of innovation, as the result is null when concatenated with the term ‘AND ‘Supply Chain’’. We will revisit some of these methods in the discussion, because despite the fact that they have not been studied in SCM yet, they can be very useful for connecting with customers.

2.1.2 Refining the initial results

To ensure the most relevant items were retained, several filters were applied. Only articles written in English whose fields are related to management sciences were selected.

- Select the documents written in English = 175 documents
- Articles only = 71 articles
- Subject area = 51 articles
- Removal of articles that do not propose methods = 41 articles

These different filters made it possible to select only those articles that were closely related to our search topic, with a total of 41 articles.

2.2 Descriptive analysis

The quantitative analysis of the most cited articles, keywords, journals, and years, were carried out using Bibexcel and the protocol suggested by two authors, Pilkington (2006) and Persson et al. (2009). Bibexcel is commonly used in bibliometric research in many fields and is widely used in SCM (Fahimnia et al., 2015, 2015; Marty, 2021). This software allows a large number of database queries to be performed automatically and efficiently (Perera et al., 2019). In general, in the framework of systematic literature reviews, the first part deals with descriptive analysis and the software used to carry out the queries is Microsoft Excel (Bastas and Liyanage, 2018; Melacini et al., 2018). Since Bibexcel provides the same basic queries as Microsoft Excel, but automatically and very effectively, we chose to use this software to carry out the queries for the descriptive analysis of the data.

2.3 Defining categories

The categories were identified following the method suggest by Seuring and Gold (2012) and taken up by Koberg and Longoni (2019), combining deductive and inductive approaches. Firstly, for the deductive approach, we rely on articles focusing on integration in the SCM, as there are no articles that are specific to customer integration methods. The first article studied is Frohlich and Westbrook's (2001), which proposes five types of integration - inward-facing, periphery facing, supplier facing, customer facing, and outward-facing - thereby highlighting two categories referring to either narrow or broad integration. The articles from Danese and Romano, 2011; Fabbe-Costes and Jahre (2008) use these same categories under other names such as 'limited' or 'extended' or 'high' and 'low' integration. These two

categories are then refined by the inductive approach in the content analysis of our material in an iterative way.

The articles were classified into two categories in relation to SCI. As it is essential to select articles dealing with customer integration in SCM, articles that do not directly address this topic were eliminated during the data collection phase. These categories in the supply chain integration (SCI) literature were confirmed by our sample of articles. These two categories are “low level of integration” and “high level of integration”. Articles with limited customer integration were classified as a low level of integration, whilst those with extended customer integration were classified as a high level of integration. To correctly differentiate between the two categories, we analysed the vocabulary used in the articles.

2.4 Material evaluation

In this step, we coded the selected items according to the categories of the previous step, i.e., either high integration or low integration, by deductively relying on the existing literature (Seuring and Müller, 2008a). “Structural dimensions and related analytic categories” were identified using an inductive approach, allowing new categories, such as objectives, methods, customer roles, or processes to be drawn from the material (Lagorio et al., 2016; Seuring and Müller, 2008, p. 1,701), since “when using an inductive method, [these dimensions] are developed from the material by means of generalization” (Seuring and Müller, 2008, p. 1,701). Once coded, the items were then categorised according to the method of integration used, the processes in which the integration is carried out, i.e., either upstream, internal or external, the objectives, and the customer’s roles.

3. Results

3.1 Data analysis

3.1.1 Keyword statistics

The frequency of keywords and words used in titles are also studied. The first words are related to SCM, which is one of the key elements of this work. “Co-creation” and “customer satisfaction” are also in the top 20 keywords. Some terms are highlighted, such as “quality”, “technique”, and “sustainability”. These themes, which can be found in the articles, will be part of the dimensions of the comprehensive framework we propose.

3.1.2 Influential articles and citation evolution

Thanks to BibExcel it is possible to retrieve the most influential articles, based on the number of global citations they have in Scopus (Figure 32). The topic of sustainability is covered by 3 articles out of 10 (Kumar et al., 2016; Lam and Dai, 2015; Stonebraker et al., 2009). In those articles, the issue of sustainability is central to actors’ integration in the SCM. The most cited article by far is Wu et al. (2015) with 326 citations. In this article, we can see the importance of consumers and their significant role as co-creators and collaborators in terms of design, thanks to information systems. These actors are no longer passive and no longer seen solely through the prism of customer satisfaction, but as real participants in the SC. Sustainability and the customer’s role will have an important place in the continuation of our analysis and will be discussed in the results and in the comprehensive framework.

Figure 32 shows the evolution of the number of citations over the years. The number of citations is generally fairly constant between 0 and 100 over the entire period studied, i.e., from 1998 to 2020. Nevertheless, we notice that 2015 is significantly higher than the other years with a total of 375 citations. For this year, the database contains only three articles, but two of them are among the most cited articles, including the article by Wu et al. (2015) and that of Lam and Dai (2015). These articles address the issues of integration based on innovation through information

systems and sustainability issues, respectively. This analysis of Figure 32 highlights that integration through Internet interfaces and integration to tackle sustainability challenges are paramount. The notion of sustainability is further addressed in the discussion section.

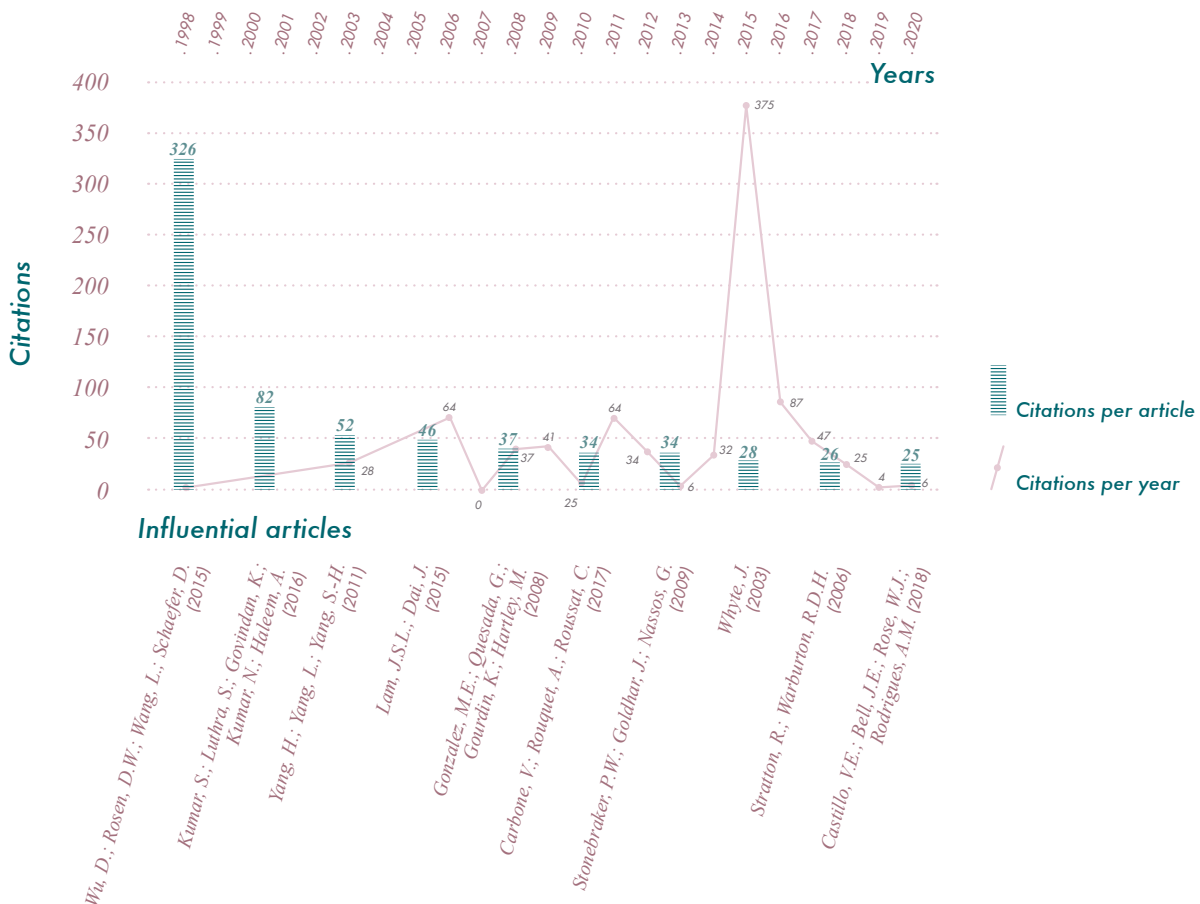


Figure 32: Evolution of the literature in number of citations according to years and top 10 articles

3.2 Category identification

The article database was studied using content analysis. As mentioned previously, two main categories were identified - “low level of integration” and “high level of integration”. For articles with a low level of integration, the most represented terms are customer satisfaction, customer service or customer loyalty; these terms appear mainly for certain types of methods. For the articles with a high level of integration, the terms used are customer involvement, customer engagement, customer as co-creator, and co-creation value; similarly, these terms appear for specific methods that require a high level of commitment from actors. Table 12 shows

the number of articles in our two categories. It shows that out of the 41 articles, 25 of them deal with a low level of integration, and 16 of them deal with a high level of integration.

Table 12: Categories for customer integration addressed in the articles

Dimension	Number of articles
high integration	25
low integration	16
TOTAL	41

As shown in Figure 33, the oldest article dates from 1998 and is entitled “A world-class continuous quality improvement program: The fastener supply corporation case” (Min, 1998). Integration methods in SCM is a subject that has been in focus since the 2000s and fairly consistently since 2015. The analysis of Figure 33 shows that research over the years has focused more on low than on high integration. Moreover, as pointed out by some authors, downstream actors have long been perceived as rather passive actors, but we can see from Figure 33 that since 2015, more research has focused on extensive customer integration, but this remains weak and the rest of our analysis focuses on proposing solutions to achieve broad customer integration (Bosch-Sijtsema and Bosch, 2015; Halldórsson et al., 2019)

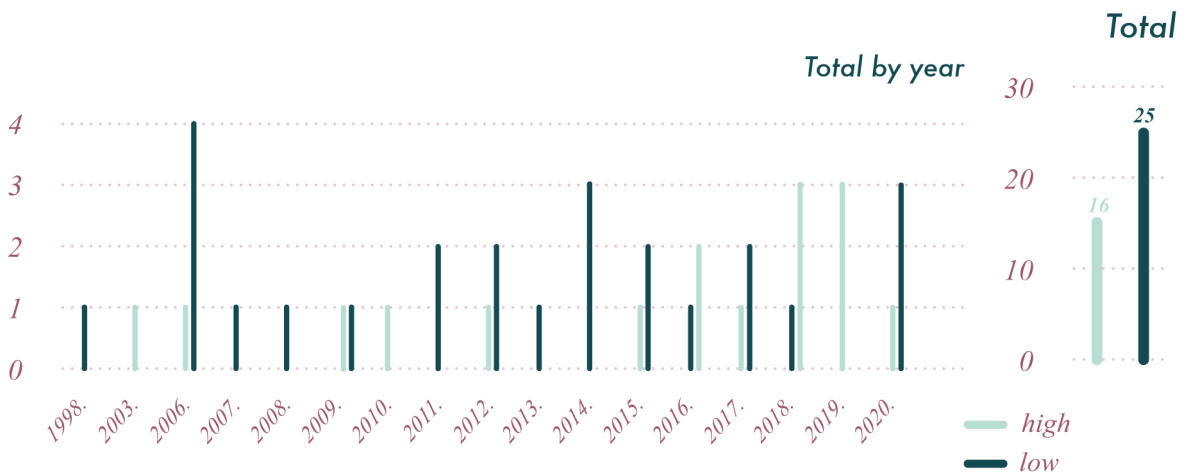


Figure 33: Distribution of the articles according to the two categories

3.3 Thematic summary and analysis

This section presents a summary of the results, following the in-depth analysis of the 41 articles in the database. Our objective is to propose a comprehensive framework that allows companies to use the right integration method according to the objectives and processes targeted, depending on the more or less active role given to the customer. To achieve this, we read each of the articles in our database and identified four dimensions. Firstly, the SC process that was targeted in the article to implement the integration. Secondly, the objectives of this integration, i.e., why the article proposes an integration method - whether for performance, sustainability, to limit risks or to improve quality. Thirdly, the customer's role and whether it is rather active or passive. Finally, we identified the methods. For the first dimension, this was the targeted process of integration. In the SC, there are upstream processes, including the design, product development and R&D phases and then there are the internal processes, including all the manufacturing, procurement and sourcing stages. Finally, there are the downstream processes, including distribution, transport, marketing and reverse logistics. The second dimension that we consider important is the company's objective in terms of integration. We have identified six objectives in the articles. The third dimension corresponds to the customer's role, which we have divided into two categories: articles that propose to give customers an active role, by fully integrating them and considering their ideas, skills and knowledge; and articles that give customers a more passive role, i.e., asking them for simple feedback, or measuring their level of satisfaction. Finally, the fourth dimension corresponds to the different methods that can be used. We have covered ten methods (detailed in the introduction of this article, except user interface, which refers to an online interface allowing the customer to communicate directly with the company).

This detailed analysis of these four dimensions allows us to develop a comprehensive framework in the discussion section that should help companies to know which integration method to use depending on the process, objective and customer role. This work highlights the gaps in the literature and the fact that no existing article gathers and studies all the methods according to the different objectives, processes targeted and customer role, thereby allowing us to propose future research orientations.

3.3.1 Integration according to processes

Of the 41 articles, 18 deal with integration methods in the downstream process, 12 with internal processes and 11 with upstream processes (see top left-hand corner of Figure 34). These results are preliminary indications that customers are better integrated into downstream processes and that it seems easier to integrate these downstream actors when the company is physically closer to them. Indeed, it would seem that the further downstream the actor is from the target process, the more complicated it is to integrate them. For example, it is easier to get customer feedback on a product through a satisfaction survey than to integrate them into the upstream phases of product creation. Appendix 4 provides a list of the 41 articles according to the different processes, including the title of the articles, the authors and the year of publication (Table 18).

3.3.2 Integration according to objectives

Concerning the objectives of integration, out of the 41 articles, 13 deal with quality, 7 with performance, 7 with sustainability, 6 with innovation, 5 with risk management and 3 with technical objectives (see top right-hand corner in Figure 34). Indeed, as the customer is always closer to the final product, the main focus is on quality with a view to ensuring customer satisfaction. Conversely, the question of risk is more often managed upstream with the integration of suppliers rather than customers. Appendix 5 lists the 41 articles according to the different objectives (Table 19).

3.3.3 Integration according to the customer's roles

The dimension concerning the customer's role has been divided into two parts: on the one hand, we observe articles that propose integration where the customer's role is rather passive, and on the other hand, articles proposing integration where the customer's role is active (see bottom left-hand corner in Figure 34). Out of 41 articles, 22 assign a passive role to the customer and 19 assign an active role. The articles assigning a passive role to the customer do not require a high level of integration

- the customer's role is limited to giving feedback via surveys or interviews. The customer is essentially listened to for feedback on a product or their opinion on a brand. The expected feedback is informational. Whereas, in the case of articles that give an active role to the customer, customers here are asked to share knowledge, skills and expertise, offering real value for the company because they are not just giving information but taking part in the process. The role of the customer has a strong link to the method used. Indeed, some methods, such as laddering or VoC, give a rather passive role to the customer, while methods such as the living lab or lead user methods give an active role to the customer. Appendix 6 summarizes the 41 articles according to the customer's roles (Table 20).

3.3.4 Integration according to methods

As far as methods are concerned, we have identified ten: brainstorming, crowdsourcing, innovation communities, laddering, lead user, living lab, participatory design, TRIZ, user interface, and VoC (see bottom right-hand corner in Figure 34). The VoC method is the most represented with 21 articles dealing with this topic, followed by crowdsourcing with 5 articles, and brainstorming with 4 articles. The method we have called 'user interface' refers to the electronic platforms using the Internet that allow customers to be connected directly to the company. The VoC method is a method that gives a rather passive role to the customer - it allows feedback to be collected from the customer on a given topic. It is simpler to implement than methods requiring an active role for the customer, such as the lead user method, where the customer must share and transmit expertise and knowledge with the organisation. Appendix 7 presents a list of the 41 articles according to methods (Table 21).

Figure 34 is a schematic diagram summarising the previous section on material evaluation which includes the four dimensions, namely, processes, objectives, client roles and methods. Figure 34 highlights the elements found in our systematic analysis and synthesises the 41 items in each dimension according to the number of occurrences. This figure enables creating the comprehensive framework which we propose for discussion, highlighting the interactions along these four dimensions and the categories.

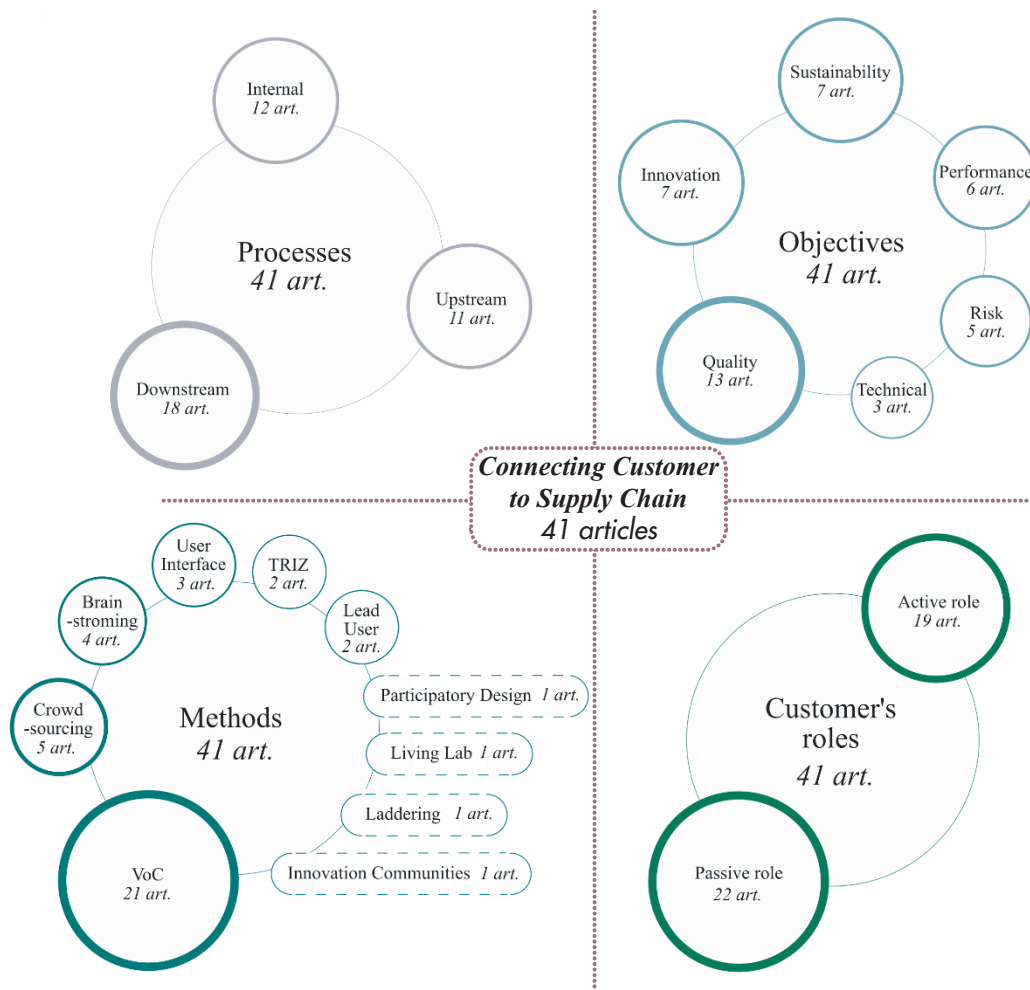


Figure 34: Connecting the customer to Supply Chain according to processes, objectives and methods

4. Discussion

This review aims to identify ways to further connect customers in SCM according to processes, objectives, customer roles, and methods. We have highlighted two important categories, namely, a high level of integration and a low level of integration. In addition, this literature review also highlights four other dimensions; processes, objectives, customers roles and methods. In this part of the discussion, we look at how these dimensions interact and what connects them. We therefore propose a comprehensive framework that details which methods can be used depending on the company's process, objective, the role the organisation wishes to give the customer, and the level of integration required. We then discuss the centrality of sustainability in SCM, as well as the importance of integrating customers, as well as consumers and users in this context.

4.1 Connecting the customer to the SC according to their roles, the processes, objectives and integration methods

4.1.1 Objectives in relation to the processes

The objectives that we have identified in the articles are more or less present in certain processes. For example, the objective of quality, present in 14 articles, is mainly present in the downstream processes (in 10 articles out of 13), and internally (3 articles out of 13). On the other hand, the innovation and technicality objectives are largely present in the upstream process (7 articles out of 11). The internal process is mainly concerned with performance, risk management and quality objectives. An important point to note is that the objective of sustainability is present in all processes, showing here the significant development of sustainability and the fact that it is a central topic for the SC.

4.1.2 Objectives according to the customer's roles

The customer has a more active role when the objectives targeted by companies are related to technical aspects, or innovation and sustainability. Indeed, as several authors point out, the customer can really have a role of co-producer for these different objectives and to do so, he or she must be fully integrated, engaged and connected to the targeted processes (Halldórsson et al., 2019; Hoffmann, 2007; Zimmerling et al., 2017). The customer has a much more passive and informative role for aspects such as quality, performance or risks. In fact, the customer often simply has to give an opinion and feeling about a product through feedback or surveys; in this case what is more important for the company is “customer satisfaction” (Lalwani et al., 2006, p. 6).

4.1.3 Objectives according to the methods

The methods vary according to the objectives. Some methods are specific to the technical objective, such as the TRIZ method or the methods of empathic design or innovation communities, which target an innovation objective. Some methods are multi-purpose, such as crowdsourcing and the living lab, which can target both an

innovation and a sustainability objective. Organisations can therefore use specific methods for certain objectives and can also combine them with other methods to target several objectives (Zimmerling et al., 2017).

4.1.4 Processes according the customer's roles

Overall, the customer always has a more active role when integrated into the upstream processes (10 out of 11 articles). This is due to the fact that the upstream processes concern the design, R&D or new product development phases. It is more difficult to integrate customers in these upstream phases, but nevertheless, when they are integrated, they have a real active role as co-producers (Lacoste, 2016).

Conversely, in downstream processes, customers are more passive (13 out of 18 articles). Downstream processes mainly concern marketing, distribution and transport, in which case the customer provides information and feedback on the products. Nevertheless, it is important to underline here that it can be different regarding reverse logistics. Indeed, in this precise context the customer, consumer or user will play a key role - "the consumer is viewed as a sustainable co-producer" (Halldórsson et al., 2019, p. 3). As for the internal process, concerning manufacturing or operation management, the customer has a more passive than active role (8 articles out of 12). Here the customer's role will be more active if the objective is, for example, sustainability, and more passive if the objective is quality.

4.1.5 Processes according to the methods

Some methods are used more in the downstream process, such as the VoC or laddering methods, which allow the collection of customer opinions. On the other hand, the methods that are most present upstream are those that require a high level of customer involvement, such as the living lab method or the lead user method. These methods are present upstream because the expertise and knowledge of the customers are required mainly during the conception, design and creation phases. For the internal process, we find the VoC methods which do not require a high level of customer involvement, but also the crowdsourcing method which gives the customer an active role.

4.1.6 Methods according to the customer's roles

Only two methods give a rather passive role to the customer, namely, VoC and laddering. All other methods require an active role for the customer, some more so than others. For example, the living lab method or the lead user method will integrate the customer on a long-term basis, requiring full integration and involvement to share skills and knowledge, whereas crowdsourcing mobilises the customer on a one-off basis by bringing in an innovative idea.

4.2 Comprehensive framework proposition

The comprehensive framework proposed in Figure 35 is based on the categories (high or low level of integration), and the dimensions (processes, objectives, customers' roles and all the methods seen in the introduction). This framework is intended to be generalisable in order to help companies find out which methods to use to further connect their customer, depending on the processes, objectives, expected level of integration and the customer's role.

The comprehensive framework is composed of four distinct building blocks, namely the SC processes, the objectives, the global methods (i.e., those that are and can be used for several objectives), and the specific methods that are used only for a targeted objective. The role of the customers, processes and methods are differentiated according to our two key categories, which highlight the level of integration, namely a low level of integration and a high level of integration.

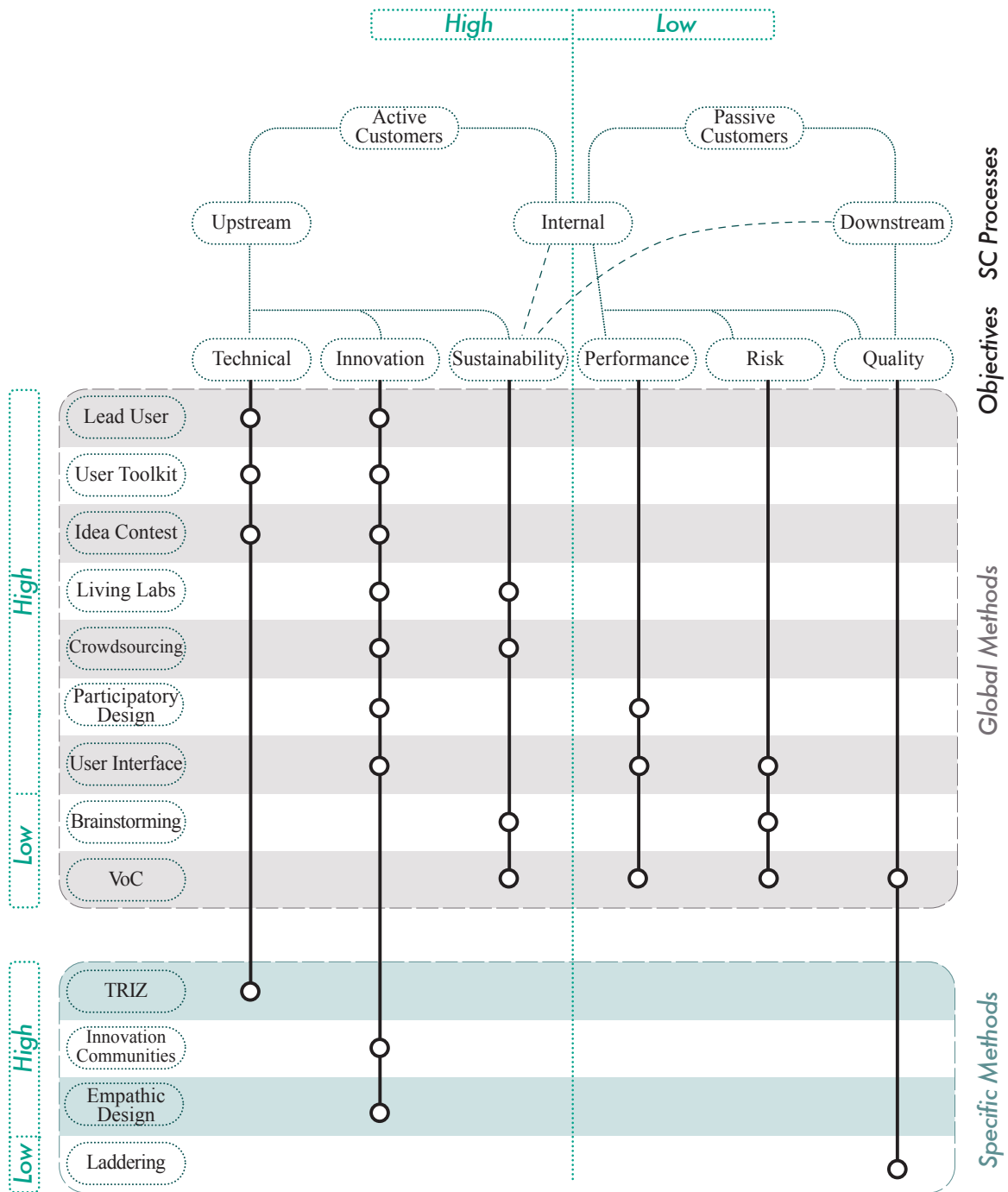


Figure 35: Connecting the customer to the SC framework

For instance, if a company wants to create a new technical product, it could actively integrate its customer through the lead user method, by implementing a high level of integration. If the company wants to create more sustainable products, it can use the living lab method upstream and then downstream methods such as brainstorming or VoC, which also allow it to analyse the quality of the product.

It is important to mention that these methods can be used in combination in the different SC processes to achieve several objectives. For example, an organisation can first use the crowdsourcing method to collect a large number of innovative ideas, then set up the living lab method to turn the idea into reality. Subsequently, once the product is designed, follow-ups can be carried out using brainstorming, and finally the VoC method when the product is manufactured for distribution, in order to get feedback on the product. As Zimmerling et al. (2017) have shown, if the different methods are well implemented, the benefits are measurable in terms of performance, technicality, innovation and sustainability, while limiting risks. As for sustainability, as we know, it is now at the centre of the SC and must be implemented for both products and processes. The integration of downstream actors, including the customer, but also the consumer and the user, is a key issue in order to be able to offer products that are more respectful of the environment and ethical working conditions. This comprehensive framework can help companies to find ways to connect more with their customers to meet the challenges of tomorrow.

The sustainability challenge is very important for companies, as “consumers’ demand for corporate social responsibility (CSR) is much stronger today than it was in the past” (Sul and Lee, 2020, p. 867). Moreover “Customers may also pressure firms to offer products and services embodied with socially responsible and environmental friendly features, and may boycott products of those firms which are not willing to do so” (Berg et al., 2018, p. 479). This is why it is essential to integrate customers. Companies “could take advantage of CSR [Corporate Social Responsibility] activities by deliberately collecting valuable knowledge from their stakeholders and integrating it into their innovation processes” (González-Ramos et al., 2018, p. 404). Sustainability is now a central element of SCs as SC-related

activities have an impact on the environment. Transport, distribution, consumption of raw materials, and manufacturing activities all have impacts in terms of energy consumption, emission of air pollutants, and reduced availability of resources, among others. The integration of all actors, including not just the customer but also consumers and users, seems to be essential in order to overcome these problems and offer more sustainable products. Certain methods, such as the living lab, can help to achieve this objective. For example, Plaisier et al. (2019) highlight a project carried out in Nigeria to reduce postharvest losses in tomato production using the living lab method. To achieve their aims, they gathered the different actors involved and addressed the different issues. One of the elements highlighted was the use of plastic packaging that alters the quality of the product. At the end of this project, 89% of the participants replaced plastic packaging with wooden crates, thus limiting losses. This article stresses that the use of the living lab method makes it possible to find more sustainable and eco-friendly solutions, while at the same time making it possible to perform better. As some authors have shown, the use of actor integration methods and different combinations can be extremely beneficial in providing more responsible and sustainable products while minimising risks (Arnold, 2017; Zimmerling et al., 2017).

5. Conclusion

5.1 Contribution to literature

This systematic literature review presents a way for companies to further connect their customers to their SC. To our knowledge, there has thus far been no systematic literature review on this subject, and yet the integration of customers and downstream actors is of growing importance to companies, which is why this area of study was chosen. The 41 articles of this study were published between 1998 and 2020.

The descriptive analysis of the 41 articles allows us an overview of the research carried out to date on the topic of customer integration methods in SCM, in a quantitative way that minimises bias. This is an emerging topic that is not widely

covered in the SCM field but has already been addressed in the fields of innovation, marketing and industrial marketing (Lacoste, 2016; Wagner, 2009). This analysis, and particularly the analysis of key words, highlights the theme of sustainability, which is then taken up in the dimension of objectives, as well as in the discussion.

The analysis of several prestigious articles in the field of SCI has allowed us to identify two major categories deductively, which were then confirmed inductively through the study of the 41 articles. These two categories are “high level of integration” and “low level of integration”, and they further categorise the dimensions we found in the proposed comprehensive framework.

As indicated in the introduction, previous research has already proposed matrices bringing together the various integration methods, but mainly in the field of innovation. These frameworks propose to observe the methods through the types of information, the implementation modalities or the different degrees of collaboration (K. Füller et al., 2014; Piller et al., 2010; Zogaj and Bretschneider, 2012). Our research extends this literature by focusing primarily on the SCM domain, but mainly by looking at methods through other dimensions such as objectives, target processes, and customer roles. By answering the research question, “How can the customer be more connected to the supply chain to meet sustainability challenges?”, we propose to enrich the existing literature in a holistic way, by proposing a multidimensional framework that is applicable to the SCM domain and which considers sustainability as a key element and a central topic in future research.

5.2 Implications for industry

The different dimensions emerged following a detailed study of the 41 articles, and we have listed four of them, namely SC processes (upstream, internal, downstream), objectives (quality, innovation, sustainability, performance, risk, technicality), the customer’s role (active or passive) and the integration methods. Concerning processes, the downstream process is more represented, followed by the internal and then the upstream, thus confirming our initial assumption that the customer is more difficult to integrate upstream (Lacoste, 2016). Concerning the objectives,

the main one is quality. The latter is often observed in downstream processes, and the integration of customers when pursuing a quality objective is simpler, whereby methods such as VoC, including surveys, can be implemented. It seems that this is the most easily achievable objective through customer integration. The technical objective is the least represented. This often takes place upstream in the process and requires a great deal of involvement and commitment on the part of the client when they are integrated by the company. The methods can be more challenging to put in place and the integration phase can be longer. As for the methods, there are 10 in our analysis and we have classified them according to the active or passive role of the customer. The most common method is VoC, which is often implemented in downstream processes with a view to quality, and the customer often has a fairly passive role. This confirms once again that it seems easier to integrate the customers when they are closer to the targeted process, i.e., downstream, and when their role is not fully active.

In view of these different elements, categories and dimensions, a comprehensive framework is proposed with the main objective of enabling companies to connect their customers more to their SC process. All dimensions are included, and the methods are completed by the three other methods studied in the literature review, which are not present in our sample of 41 articles, because they are used more frequently in the field of marketing and innovation. We have added them because they are very useful for addressing technical and innovation objectives. Each of the dimensions and methods are classified according to our two main categories, namely “high level of integration” and “low level of integration”, allowing us to give a global scope to our comprehensive framework. Finally, the notion of sustainability is discussed as we believe it is at the core of tomorrow’s concerns and a central element of SCs at a time when environmental and ethical issues have become pressing.

Organisations, and especially managers, can use the comprehensive framework in Figure 35 to further connect their customers to their SC. We recommend that organisations follow several steps to better integrate their customers. Firstly, they need to define the objective they want to achieve so that they can focus on certain

methods. Secondly, they need to know what level of integration they want, i.e., low or high. This obviously depends on the objective, but also on the constraints of the organisation, whether in terms of available time, data confidentiality or financial constraints. These elements will make it possible to define which integration process to target, i.e., whether to integrate the customer upstream, internally or downstream. The further upstream the integration, the higher the level of integration. Finally, we recommend that organisations use several methods in combination, because today, a product delivered to the market must respond to environmental issues as well as being innovative, sometimes technically advanced, and of good quality, while providing overall performance for the company.

5.3 Future research directions

Since the 1990s, the integration of stakeholders into SCM has been widely addressed with a view to overcoming risks or increasing performance, but also to innovate and propose sustainability solutions (Flynn et al., 2010; Frohlich and Westbrook, 2001; Vachon and Klassen, 2006). The integration of upstream actors has been widely discussed by many authors in order to respond to these different performance, risk limitation and sustainability issues (C. W. Lee et al., 2007; Rich and Hines, 1997; Walton et al., 1998). However, the integration of downstream actors such as the customer is also essential (Griffin and Hauser, 1993; Morash and Clinton, 1998; Rese et al., 2015). Yet, the question of which methods can achieve this integration is less addressed in the SCM field compared to the fields of innovation (Da Mota Pedrosa, 2012; Edvardsson et al., 2010; Petersen et al., 2003) and marketing (Vargo, 2008; Vargo and Lusch, 2004; Wilson et al., 2016). Future research should broaden the study scope by including areas such as marketing and innovation. To do this, the main search query could include only the term “customer integration”, and the concatenation with “supply chain management” could either be removed, allowing all areas to emerge, or completed with the area of innovation and marketing. This could extend the scope to many disciplines and allow for differences to be analysed. A first descriptive analysis step could thus make it possible to observe which fields deal more with this subject and which deal with it less. A more in-depth

analysis of the contents would also make it possible to highlight new methods that are perhaps not present in this analysis of the SCM. It would be helpful to observe and question why they have not yet emerged in the SCM sector.

Secondly, regarding the comprehensive framework built on the literature, even though many methods have been tested in companies, including VoC, the living lab (Plaisier et al., 2019, p. 15), crowdsourcing (Holley, 2010, p. 6; Masters and Team, 2019), user toolkits (Rese et al., 2015), and the lead user method (Zimmerling et al., 2017), it might be interesting to see whether the application of these different methods corresponds well to the targeted processes, proposed objectives and roles of the customers. It would be relevant to carry out a quantitative analysis of the companies using these methods and to quantify the appropriateness of the methods in relation to the processes, objectives and roles. A more qualitative analysis of companies in the SCM field could also provide an opportunity to question how these methods are implemented and what are the best practices to achieve the objectives of performance, sustainability, innovation and others. This research could also investigate the constraints and barriers that companies may face when implementing methods to connect their customers to their SC processes. The analysis of these barriers and constraints would allow a good practice guide for the integration of customers into SC processes to be proposed.

Finally, the theme of sustainability is prominent and will become even more so in the years to come. Some authors stress the importance of observing and understanding “the contemporary focus of on-going GSCM [Green Supply Chain Management] research” (Maditati et al., 2018, p. 158). We therefore believe that this research could open up new avenues on the subject of sustainability, for example, by studying the impact of the implementation of these methods on sustainability aspects within companies.

This article enriches the literature on the subject of customer integration methods, which is a topic that is still little addressed and where the customer often has a rather passive role. Secondly, it proposes managerial contributions, by proposing a comprehensive framework allowing companies to connect their customers to their

SC process more through different methods depending on the objectives. This study also shows the important and growing role of the notion of sustainability, which is key to the majority of challenges, whether in terms of reducing risks, increasing quality or improving innovation.

However, our research has several limitations. First, the sample for the study is small as this systematic analysis is focused on the SCM field. Future research could broaden the study scope by including disciplines such as marketing and innovation. Secondly, regarding the comprehensive framework, since our research focuses on a sample of 41 articles, “some relevant studies may not be part of this sub-sample” (Meditati et al., 2018, p. 159). For example, the article by Zimmerling et al. (2017), which is a sound example of research on integration methods for sustainability, is not included in the sample as it is not in the field of SCM. Therefore, it is possible that some dimensions have not been studied because they are not present in the sample. These may refer to new methods or new objectives. Furthermore, the inductive approach leading to the emergence of the different dimensions may also be limited, as some aspects, such as barriers and constraints to implementation, or key success factors, have not been studied. Finally, this framework is based on literature and it would be appropriate to compare each dimension and the links between these dimensions to companies’ practices. Highlighting and exploring the potential constraints that companies might experience when implementing methods to integrate their customers into their SC would also be an interesting avenue for future study.

Chapter 6. Making supply chains more sustainable through customer and consumer engagement: the case of rare metals

The sixth chapter of this second part features the article that deals with the field analysis. Based on a qualitative methodology and using interviews with company employees and consumers, this article deals with the issue of sustainability in B2B companies operating in the IoT and rare metals sector. It aims to observe how companies in this sector integrate their downstream actors with a view to sustainability issues connected to the use of rare metals and other IoT issues. This article also questions the perceptions that consumers have of these issues. A mapping is carried out in order to propose different methods, depending on the different actors, the upstream or downstream character of the targeted process, and the expected level of sustainability.

ABSTRACT

The dramatic growth in customer connectivity and the Internet of Things has increased the demand for rare metals, but the extraction, refining and production of these materials can be environmentally damaging. Customers and consumers, meanwhile, are increasingly concerned about sustainability and want their voices to be heard. How can customer and consumer engagement be improved to enable a greater degree of ‘co-creation’ in the search for greener products and the supply chains that support them? To answer this question, we first define the terms related to rare metals and their challenges; we then review the different methods of customer and consumer engagement proposed in the literature. Secondly, through interviews with companies in the Internet of Things sector and with consumers we analyse the downstream actors’ engagement in the context of rare metals through integration methods. The results propose a mapping of the different methods that enable co-creation for sustainability objectives.

Keywords: supply chain management, sustainability, customer, consumer, engagement, rare metals

1. Introduction

Companies and Supply Chains (SCs) are increasingly operating in uncertain environments where resilience is essential, as we have seen with the COVID-19/SARS-CoV-2 pandemic (Ivanov and Das, 2020). Sustainability is also a very important issue for companies and SCs where resilience and adaptability are crucial. In the field of Supply Chain Management (SCM), sustainability has become an increasingly important topic over the last 20 years, and it is receiving more and more attention from companies and researchers (Fahimnia et al., 2015; Srivastava, 2007). “There is a challenge in developing products and services to increase or maintain the satisfaction of consumers while decreasing environmental impacts.” (Michaud et al., 2017, pp. 9–10). Consumers, too, are questioning and becoming more engaged with sustainable development issues. As a result, organizations that sit close to their consumers within the supply chain (SC) are very attentive and attach great importance to sustainable development (Seuring et al., 2008). Nevertheless, consumers are increasingly aware that not only the finished product but the entire SC is concerned when it comes to sustainability (Seuring et al., 2008). Business to business (B2B) companies must therefore also become involved in sustainable development, despite being ‘further upstream’ or, in other words, further away from consumers. The current context of globalization, competitiveness and increased consumer awareness, as well as stricter regulations, further increase the pressure on companies and SCs (Fahimnia et al., 2015; Seuring et al., 2008). Sustainable development strategies and greener SCs therefore seem necessary (Fahimnia et al., 2015) if companies are to address “diminishing raw material resources, overflowing waste sites and increasing levels of pollution” (Srivastava, 2007, pp. 53–54). These problems are especially pressing for companies that use rare and critical metals, such as semiconductor manufacturing companies.

Issues related to material resources, waste and pollution affect many sectors, particularly the new technology field, which includes the Internet of Things (IoT) and green technologies, such as electric cars, wind turbines and solar panels. This field requires the use of very specific raw materials, such as rare metals, which raises concerns related to the availability and durability of materials, and ethical

and geopolitical stakes. Moreover, consumers around the world are increasingly demanding sustainable products (Seuring et al., 2008) and therefore, for the products they use most frequently, they are likely to become more concerned with the sustainability of related elements in the SC.

To satisfy the end consumer and to gain a competitive advantage for themselves, companies could deliver sustainable products by integrating downstream actors (i.e. the end consumer) into their SC (Narasimhan and Kim, 2002; Shaw, 2000). The engagement of downstream actors (mainly consumers and users) in this way can also enable companies to offer sustainable and technical innovations (Wagner, 2009; Zimmerling et al., 2017). Co-creation that involves consumers in different ways (Lusch and Vargo, 2014), through different integration methods, is widely used to offer more sustainable products (Hoffmann, 2007; Zimmerling et al., 2017). However, the engagement of downstream actors is more common—and seemingly simpler—in the business-to-consumer (B2C) sector than in B2B (Lacoste, 2016).

Some authors working on the links between sustainability and co-creation propose to raise a question for future research, “Are consumers and other stakeholders willing and HOW will they be enabled to take an active role in the sustainability value creation process permanently?” (Arnold, 2017, p. 22). It is in this perspective that our work takes place and that we seek to answer the question of how, by focusing on integration methods. In this article, we study the methods that B2B companies use to enhance downstream actor (customer and consumer) engagement in their SCs to meet sustainability objectives, focusing specifically on companies in the new technologies sector that use rare metals. We focus on integration methods in order to respond to the following research question: How can customer and consumer engagement be improved to enable a greater degree of ‘co-creation’ in the search for greener products and the supply chains that support them? To do this, we first present a literature review in which we describe rare metals and the related challenges, as well as demonstrating the importance of downstream actor engagement in addressing sustainability concerns. We also detail the associated methods of engagement. In the second part of this article, we describe our methodology: a qualitative approach using

a case study based on interviews with consumers and employees from companies that use rare metals. The third part present the results. Finally, we discuss our results and offer a conclusion.

2. Literature review

2.1 Rare metals

In light of the existing literature, we group in the ‘rare metals’ theme, the ‘rare earths’ as comprising 17 metallic elements with similar properties: the 15 lanthanides as well as yttrium and scandium (Humphries, 2013; Schueler et al., 2011). In addition, we take ‘rare metals’ to include so-called critical materials, a term that groups together a list of metals and varies from one country to another or from one company to another. The material’s criticality is calculated according to two parameters: economic importance and supply risk (European Commission, 2020, 2016). Finally, we include ‘conflict minerals’, such as tin, tantalum, tungsten and gold, also known as the 3TGs (Barume et al., 2016), which are defined as such because their exploitation “may help finance armed groups in the DRC [Democratic Republic of the Congo] region” (Kim and Davis, 2016, p. 7). These metals are not, as their name suggests, rare. They are fairly abundant in the Earth’s crust, but deposits are rarely sufficiently concentrated for profitable exploitation (Maniglier, 2020; Massari and Ruberti, 2013), though concentration levels vary between countries (Massari and Ruberti, 2013). These metals are widely used in industry as well as in innovative industries, especially renewable energies and high tech.

The problems posed by rare metals, critical metals, rare earths and conflict minerals are mainly related to reserves and production, supply and prices, possible commercial conflicts, alternatives, substitute metals, recovery and recycling (which is expensive and polluting), other environmental issues and ethical issues (such as forced labour or child labour, or the financing of militias), and “a lack of clear and defined environmental regulatory structures.” (Mutumi and Simatele, 2017, p. 300) (Maniglier, 2020; Massari and Ruberti, 2013; Pitron, 2018). To offer more sustainable end products, companies using rare metals therefore need to rethink the entire SC. In

this article, we argue that one way to do so is to co-create with customers, consumers and users by integrating them into the SC.

2.2 The engagement of downstream actors (customers, consumers and users) in companies' SCs

There are many downstream actors. It is important to dissociate the customer from the consumer and the user. A customer is a downstream actor who buys a good or service for resale. The consumer buys a good or a service for his own use. The user is not necessarily the one who bought the product, but will be its user³.

Companies' SCs are composed of many actors spread over distant territories, and with a strong increase in competition and globalization plus increasingly demanding consumers, the integration and engagement of these actors is essential to perform. "Companies usually integrate internally first, and then, extend the integration process to other supply chain members." (Gimenez, 2004, p. 14). By carrying out internal and external integration, companies can gain a competitive advantage (Narasimhan and Kim, 2002) by creating sustainable partnerships with their SC members (Shaw, 2000). The engagement of actors in "a participatory process" can "augment the quality of environmental and societal decisions" (Chakraborty et al., 2019, p. 187).

"Early user integration or co-creation can be a possible way to develop new sustainability innovations and introduce them into the market successfully" (Arnold, 2017, p. 3).

This engagement can take place within the framework of the "sustainability-related innovation" concept (Wagner, 2009, p. 315). Wagner (2009), indicates that within this framework, open innovation and user engagement are revealing. Open innovation is defined by Chesbrough et al. (2006, p. 1) as "a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology". From this perspective, the user or consumer can play a key role in sustainable product

³ "CONSUMER | meaning in the Cambridge English Dictionary," n.d.; "CUSTOMER | meaning in the Cambridge English Dictionary," n.d.; "USER | meaning in the Cambridge English Dictionary," n.d.

development and can be “an actor in the innovation process” (Coulbaut-Lazzarini and Danteur, 2017, p. 59); indeed, Zimmerling et al. (2017) point out that this can give companies a significant competitive advantage. In their study, Zimmerling et al. (2017) explain that users were involved in the various phases of product creation, from the basic product strategy to market launch, and that they were truly “considered as user co-developers” (Zimmerling et al., 2017, p. 6). As stated by Arnold (2017), to ensure long-term sustainability, the co-creation process must address the whole SC. Co-creation is defined as follows “Co-creation is a way of sharing, combining and renewing each other’s resources and capabilities between firms and active users to create value through new forms of interaction, service and learning mechanisms” (Arnold, 2017, p. 4).

Furthermore, Zimmerling et al. (2017, p. 1) stress that “user integration can not only be high for rather incremental green innovations but also for genuinely new innovation in highly technological industries”. This observation is fully consistent with our work on the technology companies we interviewed and that are operating with components such as rare metals, which have complex technological applications.

The concept of integration is widely discussed in the literature related to SCM. Many methods integrate and engage downstream actors by enabling collaboration, for example, with creative groups or through brainstorming methods (Diehl and Stroebe, 1991, 1987; Goncalo and Staw, 2006; McLeod et al., 1996; Nijstad et al., 2002). Other methods include crowdsourcing, which enables companies to gather a lot of ideas at a low cost (Howe, 2006). There are also more technical methods requiring a greater initial investment, such as the ‘lead user method’, which can involve establishing expert users or providing toolkits that offer users a set of tools to help them solve their own problems. (Franke et al., 2006; Von Hippel, 1986). These methods help generate creativity, improve quality and solve research and development (R&D) problems. Integration in the form of co-creation is also used by more and more companies as a way to meet customers’ and consumers’ needs. In many cases, such methods are used to improve the sustainability of companies’ products as well as to respond to ethical, ecological and environmental issues by

developing sustainable products through educating both consumers and companies and through empowering consumers (Hoffmann, 2007). In the field of sustainable innovation, these methods can be used in different combinations and at different stages of the SC, enabling companies to gain a competitive advantage by limiting the risks associated with creating new products and thus offering both technical and sustainable innovations (Zimmerling et al., 2017).

The potential to co-create with users through the methods discussed above is used widely in the B2C sector (Hoffmann, 2007; Zimmerling et al., 2017) but seems less common and more complex to implement in the B2B sector (Lacoste, 2016). Given the relative lack of literature on co-creation in the B2B sector, the present article focuses on B2B companies that are upstream, or even very upstream, from the end user of a finished product with rare metals as a component (in minute quantities).

2.3 Integration methods for customer and consumer engagement

The main methods that we identified through interviews and on company websites are defined below. Companies and consumers often use different terms for the same method, but the relevant definitions in the literature are very similar to those described by the interviewees.

- Participatory design aims to involve the actor in the process of developing new products (Spinuzzi, 2005). This method was presented by the interviewees as a co-creation method.
- The voice of customer (VoC) method is a way of collecting customer feedback, often through surveys. This method is less proactive, but it provides companies with a very clear view of what satisfies customers and where bottlenecks might be. VoC is particularly interesting because it can be used in both sales and R&D, as well as in production, among other areas (Griffin and Hauser, 1993).
- The brainstorming method brings together several actors in an open discussion to generate new ideas; the group dynamic enables companies to find better solutions (Camacho and Paulus, 1995).

- The idea competition concept motivates people from outside the company (mainly users or consumers) to come up with creative or technical ideas, depending on the request made by the company (Terwiesch and Xu, 2008). Experts judge the proposals and the winner is rewarded in exchange for the usage rights (Piller and Walcher, 2006).
- The lead user method utilizes expert users (i.e. those who are more advanced than standard users and have needs that are not yet met by products on the market). By integrating lead users into the design phases of new products, companies can therefore benefit from competitive advantages mainly in terms of technicality and innovation (Von Hippel, 1986).
- ‘Living labs’ seek to bring together a wide variety of actors (suppliers, customers, consumers, students, laboratories, public authorities) in a dedicated space to facilitate exchange and creativity, often with a view to sustainability, thus decompartmentalizing companies (Birgitta Bergvall-Kåreborn et al., 2009; Liedtke et al., 2015).

3. Method and analysis

For this study, we chose to follow an inductive approach based on Grounded Theory (GT), using the methodology proposed by Stuart et al. (2002) and taken up by Kaufmann and Denk (2011) for SCM studies (Figure 36).



Figure 36: The five-stage research process model from Stuart et al. (2002, p. 420)

When there is limited theoretical knowledge on a subject, GT allows for observational and exploratory research to be carried out (Locke, 2007; Suddaby, 2006). The data collected in the field are analysed in an interpretative manner (Goulding, 1998), and it is participants’ perspectives that enable a holistic and inductive understanding of the phenomena (Charmaz, 2006; Flint et al., 2012b). “Inductive approach is used frequently in case studies” as mentioned by Hilmola et al. (2005, p. 299)

To implement this approach, we followed the five steps proposed in Figure 36.

Firstly, we addressed the following research question: How can customer and consumer engagement be improved to enable a greater degree of ‘co-creation’ in the search for greener products and the supply chains that support them?

For the second step, we decided to follow an inductive approach based on a qualitative study as there is limited literature on the subject (Eisenhardt and Graebner, 2007; Kaufmann and Denk, 2011; Ozcan and Eisenhardt, 2009). To carry out this research, we created an interview guide with open-ended questions, such as ‘how’ or ‘why’ questions (Cucchiella et al., 2012; Robert K Yin, 2003), as well as a mind map for the main themes. This guide was created following the protocol proposed by Yin (2003) and with an in-depth analysis of the selected companies’ websites and social media networks to triangulate the information collected during the interviews.

For the third step, we carried out employee and consumer interviews that lasted between thirty minutes and one hour. For the employees, we focused on those working for B2B companies in various stages of the SC that use critical and rare metals in their products, mainly in nanotechnology and the IoT sector. We also intentionally selected companies that are recognized as leaders in their markets (Cucchiella et al., 2012). We interviewed nine employees in various positions related to SCM, and they will remain anonymous because of the sensitive information involved and the highly competitive nature of the sector. For the consumers, we focused on a varied group in terms of age, professional and social categories, knowledge of the subject and personal values; ten consumers were interviewed. After these 19 interviews, we felt that we had reached a saturation level as the elements overlapped and the last interviews did not provide any new insights to challenge the elements we had already collected.

Table 13 shows the distribution of respondents. The type of person interviewed is indicated (i.e. either company employee or final consumer), the gender, age group and profession are also provided.

Table 13: Distribution of the respondent population

ID	Type of person interviewed	Gender	Age range	Profession	Duration of the interview
1	Company employee	M	50-60	SC planning	1:04:32
2	Company employee	M	50-60	SC manager	1:15:96
3	Company employee	F	50-60	Quality manager	36:52
4	Company employee	M	50-60	Production line manager	1:00:32
5	Company employee	F	40-50	Communication and CSR reporting manager	46:31
6	Company employee	F	40-50	SC planning for new product	33:19
7	Company employee	F	40-50	SC planning for new product	35:12
8	Company employee	F	40-50	Sustainability manager	42:27
9	Company employee	M	40-50	Technology and design general manager	35:49
10	Final consumer	F	50-60	Manager of a France service area	39:42
11	Final consumer	F	Under 20	Student in geography, development and urban planning	28:57
12	Final consumer	F	40-50	HR and quality support officer	40:20
13	Final consumer	M	60-70	Artist / Painter	31:40
14	Final consumer	M	20-30	Head of real estate operations for the Ministry of Foreign Affairs	54:14
15	Final consumer	F	30-40	Flood risk management engineer	44:26
16	Final consumer	F	20-30	Law student	35:57
17	Final consumer	F	20-30	New product development technologist	47:54
18	Final consumer	M	20-30	Student engineer in industrial engineering	34:11
19	Final consumer	M	30-40	Time planner engineer	35:51

For the fourth step, relating to the results, we analysed the data using NVivo's transcription software to increase the reliability and validity of the results (Kaufmann and Denk, 2011); we also colour-coded our results using Excel and Post-it notes to make the categories more precise (Maher et al., 2018). Through this process, we initially found ourselves with a large number of categories and subcategories, which we then grouped into core categories. As Flint and Golicic (2009, p. 847) stress, "after a constant comparison by tacking back and forth among all data sources and interpretations, a core category emerged as it should in Grounded Theory". In our study, the main category was revealed to be, 'sustainability through consumer and customer engagement'.

For the fifth step, we would like to draw attention to our choice of a qualitative study in the form of a case study that follows an inductive approach based on GT. The constructivist and, more precisely, interpretative approach of this research can have an impact on the conduct of the interviews and the analysis of the results. As part of this constructivist approach, we also accept that interviewees as well as researchers are influenced by their environment, culture and personal knowledge (Charmaz, 2006; Flint et al., 2012b). Given that we intend to observe a recent phenomenon and one that depends on the individual context, needs and issues of each of the companies and interviewees, this approach seems to us to be the most appropriate.

4. Results

In this section, we will report the core category found through the analysis of the results, first in relation to the employee interviews and second in relation to the consumer interviews. The main category that emerges from the analysis of the results is the engagement of downstream actors for a sustainability objective in the context of rare metals.

4.1 Engagement of downstream actors for a sustainability objective in the context of rare metals for company employees

Before tackling the subject of integration, we first asked employees about their relationship with sustainability in their company, and their interest in rare metals. The majority of them underlined that their company makes a lot of effort regarding sustainability but mainly from a corporate point of view (recycling, limited CO2 emissions, green buildings, etc.), but a slightly lesser amount of effort is put into the components of the products. Regarding rare metals, most of them are aware of the very important stakes involved, either in terms of environment, ethics or criticality of supply.

Regarding Engagement of downstream actors, the interviewees cite a large number of methods used by their companies to integrate or facilitate the engagement of customers and consumers in the SC. These methods will be presented in the discussion section.

In order to identify the core categories in this theme, we grouped together first the methods that involve a strong (i.e. closer) collaboration, and second those that require a light (i.e. more superficial) collaboration. After grouping the different methods in this way, we realized that methods involving strong collaboration tend to involve upstream collaboration, whereas those involving a light collaboration tend to be carried out downstream.

Methods involving light (downstream) collaboration: VoC, audit, websites, intranet and social media, and trade shows, among others, mainly achieve collaboration through generating feedback on a product or on the quality of a product or process, or by communicating information about a product or process.

Methods involving strong (upstream) collaboration: Materiality exercises (described below), hackathons, brainstorming and co-creation processes are among the methods used in upstream collaboration, often before, at the beginning of or throughout the creation of a product. One of the companies, for example, set up 'Key Account Teams' to be really close to their customers:

[The] KAT (key account team), identified five or six key customers, and we structured our team to include a salesperson, two technical experts, a quality person and an information system support person. These people see this customer every fortnight in order to respond to all requests as quickly and efficiently as possible. This enables us to have a mirror organization in relation to a customer. (Interviewee 3).

The so-called materiality exercise involves many stakeholders, such as suppliers, customers and employees. The company using this method explained that it does not involve consumers in this process, but that it views the tens of thousands of employees surveyed through this method as consumers. Nevertheless, the company questioned whether employees position themselves more as employees than consumers when answering the questions. This exchange thus prompted the company to explore whether to view employees as consumers in the future.

In analysing this theme, it is interesting to note that interviewees working in B2B companies all indicate that they feel consumers are very distant from their companies and that it is easier to integrate the customer than the consumer. Moreover, another important point—emphasized by three of the nine interviewees—is that, as far as their companies are concerned, the consumer is not aware of being a consumer because everyone is potentially a consumer. As soon as someone has ‘a telephone, a computer, a car dashboard’, they become a consumer of the companies in this study. However, the consumer is not necessarily aware that their product contains these components.

When we present our company to a person, or for example to secondary school students who come to visit us, we tell them that around them, in all the connected objects they may have in their house or around them, there are at least 500 [products of our company] in their immediate environment. (Interviewee 7).

Nevertheless, some are aware of the importance of consumer engagement as a way of gaining insights into their needs.

4.2 Engagement of downstream actors for a sustainability objective in the context of rare metals for consumers

We asked the consumer interviewees what sustainable development means and how important it is to them. The vast majority of them emphasize that it aims to make ‘the planet work in the right way’. Four out of ten mention the importance for future generations, with three of them referring to their children or future offspring. Many of them take actions on a daily basis, such as recycling, composting, not driving, and saving water in the shower. Two interviewees go even further by practising a zero-waste lifestyle. One interviewee expresses that sustainability guides her way of consuming, living and seeing the future.

However, when it comes to rare metals, consumers are not very familiar with their impact. Despite their lack of knowledge, they recognize that it is a very important subject.

Regarding engagement of downstream actors, all the interviewees indicate that it is very important to facilitate the engagement of downstream actors (mainly customers, consumers and users). They give three main reasons for this: to best meet their needs; to avoid creating unnecessary needs; and to create a closer link to them through communication.

In terms of the integration methods, the two main categories are seeing consumers as actors (for an upstream engagement in the SC), and a more passive approach on the part of consumers (for a downstream engagement in the SC). These findings overlap with the two categories found for businesses.

Concerning the **passive consumer (downstream) category**, the interviewees propose methods such as the use of social networks (including through comments and quizzes), ratings on applications, feedback surveys on products and communication via websites.

As for the **consumers as actors (upstream) category**: some interviewees show great creativity, for example suggesting the possibility of collaborating in a more cooperative way, meaning that the consumer is a full member of the company.

Perhaps all the consumers should be involved in the financial interest of the company. You know, like the board of directors. (Interviewee 13).

Others propose methods such as participatory ethnography, through which the company would observe people's daily lives, how they consume and how they operate and interact with products.

They [could] come into your world and watch [...] how you consume, how you act. (Interviewee 15).

One of the participants indicates that, when it comes to technical products, the company could call on expert employees who are also day-to-day consumers. Interestingly, this point can be related to the materiality exercise (see in section 4.1), in which a company engaged and integrated employees as consumers. Other proposed methods mirror those discussed by companies or observed in the literature, such as brainstorming, focus groups, participatory design, the use of experts, idea competitions, or even places that bring together outsiders to think creatively (such as living labs). Others raise the point that a company could facilitate consumer engagement in exchange for money, a point that also applies to methods such as competitions, idea competitions or crowdsourcing.

Another important element that emerged from the interviews is that three of the interviewees indicate that they feel B2B companies are too far away from the final consumers, it is impossible to communicate with them, and within the SC, the company that should focus on consumer integration is the company closest to the consumer (i.e. the last customer). Indeed, certain customers and even some suppliers do not want to be involved in consumer integration. One consumer interviewee, for example, makes it clear that, in the context of the B2B side of the sector in which she works (cosmetics), consumers are not necessarily aware that they are consumers.

When you talk about [my company] no one ... except B2B companies actually knows us. The consumer in the end doesn't know who we are. [...] And you know that [in my sector] it's a bit hidden; we don't want everyone to know who does what. (Interviewee 17).

Many of the concerns mentioned by companies corroborate with those raised by the consumers, such as the difficulty that a B2B company can have in engaging with the final actor, or that sometimes within the B2B framework the consumer is not conscious that they are a consumer. Concerning integration methods, many methods suggested by both groups of interviewees overlap; others proposed by consumers were more innovative but could still be used by companies. As for rare metals specifically, the consumers do not seem particularly informed on the subject and, for their part, companies do not necessarily contribute by educating others about it. In terms of sustainability, and for products as high tech as those used in the IoT sector, the economic and business components sometimes take precedence over sustainable development.

Several consumers interviewees advocate the importance of raising consumer awareness and limiting overconsumption of IoT, which they also consider having an impact on people's health.

I think we should put a stop this overconsumption [...] It creates health problems, all the problems that it causes in some countries, the children—all that for products that I don't think are essential. (Interviewee 10).

5. Discussion

The results presented in Section 4 provide a significant insight into the engagement and co-creation methods of downstream actors in the new technologies sector. In this discussion, we map the different integration methods seen in the literature and proposed by companies as well as those suggested by consumers. Though not exhaustive, this diagram serves to present graphically (1) a number of methods according to the upstream or downstream engagement of the downstream

actors and (2) their limitations in terms of risks, and the importance of sustainability. The methods are sorted according to whether they are customer- or consumer-oriented or both, and according to whether they are suggested by consumers or companies' employees interviewed. We discuss these methods in terms of sustainability and engagement through co-creation.

5.1 Sustainability

The methods studied in this article have different objectives. Some have a strong focus on sustainable development, such as the living lab method or the materiality exercise. Others have a more technical focus. Some companies have proposed co-creation methods that involve the customer in the design phase to provide products that meet the needs of consumers. In the field of IoT, new products often have technical objectives, but durability is also sometimes taken into account, such as replacing gold by copper, as one of the employee interviewees explains (interviewee 1). These more technical integration methods, which may have a link with sustainability, require input from consumers with technical and specific skills, such as the lead user method or hackathons, which involve volunteer developers in collaborative projects. As Zimmerling et al. (2017) point out, these methods can be combined with the aim of proposing more sustainable solutions that remain competitive. For example, in the IoT sector, it would be possible to involve standard consumers during brainstorming sessions or focus groups to generate themes and ideas related to the design of a new product. The company could then take these themes and incorporate them into a prototype that could be studied during a hackathon using expert consumers or in the form of participatory design, which allows expert consumers to be involved in the development of a product (Spinuzzi, 2005). Setting up living labs in parallel could also enable companies to improve engagement with the consumer as well as the customer, thereby allowing all the actors to be present and to exchange and collaborate on the product. Surveys or quizzes on social networks could be set up afterwards to gain feedback.

5.2 Engagement through co-creation

The concept of co-creation has become increasingly important over the last ten years (Cova et al., 2011; Hilton et al., 2012; Jaakkola and Hakanen, 2013), specifically its involvement in the B2B sector (Lacoste, 2016; Leroy et al., 2013), as well as for sustainability (Arnold, 2017; Lacoste, 2016). Closely linked to these co-creation processes, there is customer and consumer engagement, which can take place at different stages of the SC. Depending on the methods used, one question put to companies is: are these downstream actors fully integrated, partially integrated or superficially integrated? For example, in a co-creation process with a customer or in a hackathon with expert consumers, the consumer and customer engagement is total. In contrast, in the context of a trade show—such as the Consumer Electronics Show, mentioned by one of the interviewees—the consumer is not fundamentally integrated by the B2B company, that is, they do not play an active role. Nevertheless, during such trade shows, the B2B companies (in this case, equipment manufacturers) have important interactions with their customers, who are therefore partially integrated and demonstrate moderate engagement. The use of social networks or websites has a more communicative aim—communicating the company’s values, the way it approaches conflict metals, for example—as mentioned by one interviewee.

When analysing the results, we realized that methods requiring low engagement took place downstream, while those requiring high engagement took place upstream. Companies could thus implement different types of methods (Zimmerling et al., 2017) depending on their objectives. Figure 37 shows the different methods that can be used to better engage customers and consumers, depending on the upstream or downstream needs of the company and on the objectives, whether they are more oriented towards a sustainability approach or a risk limitation approach. For example, to create products that do not contain gold (part of the 3TGs) (Barume et al., 2016), companies can co-create with their customers or implement lead user methods. To check that their new product satisfies the customers, companies can implement methods such as VoC (Griffin and Hauser, 1993), surveys or audits carried out by their customers. Finally, companies can communicate with customers and consumers

about rare metals through their website or social media platforms. Subjects including the environment, the economy and social issues (including working conditions in mines and factories, child labour, land pollution, etc.) can all be addressed in this way (Maniglier, 2020; Massari and Ruberti, 2013; Pitron, 2018).

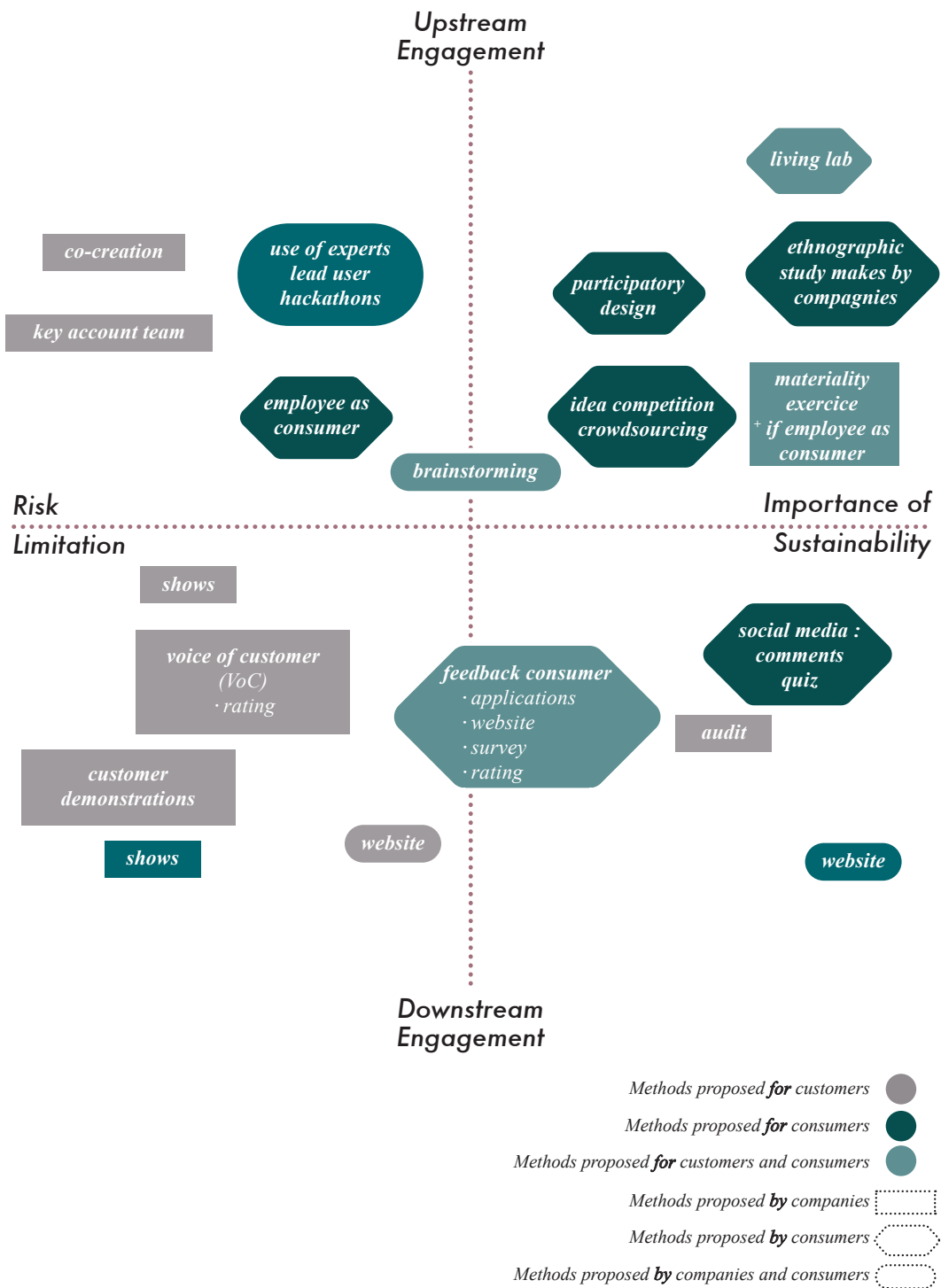


Figure 37: Appropriate methods for customer and consumer engagement

6. Conclusion

This article demonstrates the importance of sustainability in companies today, particularly in the field of IoT, as perceived by employees and consumers. Consumers still seem to know relatively little about the issues related to rare metals, despite the awareness of global problems linked to social, ethical and environmental concerns. As for companies, their priority is to limit both the criticality of these metals and the risks linked to supply. Despite the distance between B2B companies and their consumers, it is, however, essential to integrate them as much to know their needs as to benefit from their knowledge. Several methods are proposed in this article to enable B2B companies to meet these integration challenges. To deliver sustainable, ethical but also competitive products in the field of IoT (where the consumer is sometimes not even aware that they are a consumer), companies must raise consumers' awareness, communicate with them, integrate them into and enable them to engage throughout the SC. Customers, but also consumers, have a role to play in IoT's ecological transition in terms of rare metal use.

This article makes several contributions. The most important contribution relates to the mapping of the different methods that enable co-creation according to the sustainability objectives and the level of engagement desired, whether upstream or further downstream in the Supply Chain (Figure 37). By listing and classifying methods, the diagram enables companies to choose which methods are best for them depending on the specific challenges they face. If they need more downstream vision and feedback on their products, they can use the methods such as VoC. If they wish to focus on their upstream processes, they can use methods such as lead users. If a company's objectives are related to sustainability, they can use methods such as living labs, and if they are more related to risk limitations, technicality and quality, it can refer to methods such as Key Account Team. As such, this article provides a managerial contribution through the mapping of applicable methods. Furthermore, this article links the literature to the field by connecting the theoretical methods with their actual use in the B2B IoT sector. It also compares the companies' perspectives with the feelings of end consumers. For example, both consumers and companies' employees emphasize the difficulty of consumer engagement in a B2B framework.

Finally, we find that consumers have no real knowledge about rare metals, and that companies neither communicate nor integrate their consumers sufficiently.

One of the limitations of this article lies in its constructivist approach. As authors, we fully engaged in the discussion during the interviews and so our analysis of the results may be biased by our own values, knowledge and insights. For more objectivity, this study could be complemented by quantitative analyses using surveys based on Likert scales. Future research could also test these methods directly in companies to assess their impacts as well as the various constraints, difficulties, leverage effects and possible contributions.

Conclusion PART II

This thesis includes three articles that address the main problematic: Supply chain integration in B2B companies: leveraging downstream actors to address sustainability challenges in the context of the IoT. The first article contextualises the thesis within the field of SCM and more specifically in the field of SCI. This first bibliometric article provides an objective review of the literature on the subject of the integration of downstream actors into SCM, as it follows the bibliometric methodology which allows the literature to be studied in a quantitative manner. This analysis reveals the major authors in the field, keywords, evolution of the field and the different main clusters, one of which, sustainability, is addressed in Articles 2 and 3. The second article examines how this integration of downstream actors is carried out in practice, i.e., by which methods. The different methods are analysed through a systematic literature review. A content analysis then enables the elaboration of a conceptual framework of integration methods according to processes, objectives, customer roles and level of integration. This research is completed by Article 3 which proposes an analysis of downstream actor integration methods used in B2B companies operating in the IoT and nanotechnology sector and using rare metals. The third article provides a mapping of downstream actor integration methods, according to the type of downstream actor, the processes and the level of sustainability. Figure 38 provides a visual conclusion to the second part of this thesis. It shows the different articles, their respective research questions, as well as the methodology used for each of the articles, and the results arising from them.

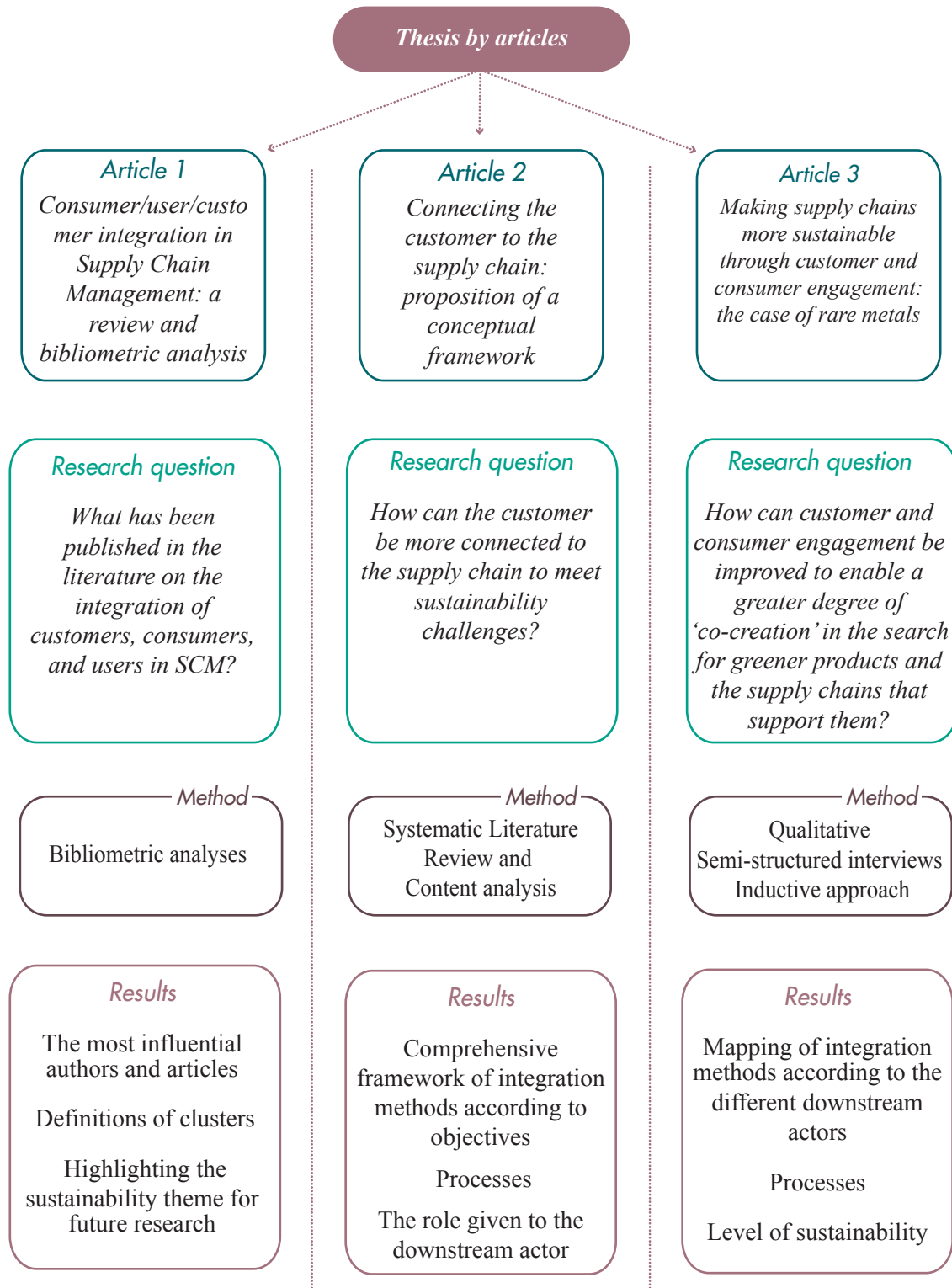


Figure 38: General conclusion of the second part of this thesis

PART III: GENERAL CONCLUSION

In a context where the demand for IoT continues to grow, the importance of integrating downstream actors, such as the customer, consumer and user, has to be considered. The problematic of this thesis is to understand supply chain integration in B2B companies and how to leverage downstream actors to address sustainability challenges in the context of the IoT. Using an interpretivist epistemological approach, we chose to observe how this integration and related methods are perceived by B2B companies in the IoT sector, as well as by consumers themselves. The existing literature on this subject is analysed, first by carrying out a bibliometric study on the integration of downstream actors in the SC. A systematic study of the literature is then carried out to identify the different existing integration methods and their objectives, including that of enhanced sustainability. The qualitative approach is used to observe how this topic is perceived by companies and consumers. It was chosen due to the dearth of literature to date and the exploratory nature of the study. The previous chapters of this thesis have provided the background, literature review, and methodologies used (Part I), and have also presented the different articles (Part II). The third part proposes first to synthesise the results in a more transversal way, then to discuss the theoretical, methodological and managerial contributions. Finally, the limits of this thesis and avenues for future research are discussed.

PART I: GENERAL INTRODUCTION		
Chapter 1 Contextualization of the research topic	Chapter 2 Literature review	Chapter 3 Methodology
PART II: ARTICLES		
Chapter 4 Consumer/user/customer integration in Supply Chain Management: a review and bibliometric analysis	Chapter 5 Connecting the customer to the supply chain: pro- position of a conceptual framework	Chapter 6 Making supply chains more sustainable through customer and consumer engagement: the case of rare metals
PART III: GENERAL CONCLUSION		
Chapter 7 Discussion of the results	Chapter 8 Contributions	Chapter 9 Limitations and future research

Chapter 7. *Summary of results*

This seventh chapter of Part III proposes to synthesise the different results from both the articles and the cross-sectional results. This chapter also reviews the research design contributions and aims to address proposals for the different research questions outlined in Part I of this thesis.

1. Summary of overall results

A summary of the results for each article is presented (Table 15) as well as a summary of the research design (Table 14). This summary highlights the main research question, the theoretical fields in which we have situated our research, as well as the methodologies employed the empirical material. Concerning the summary of the results of each article (Table 15), this table provides the objectives, main results and finally the contribution.

1.1 Summary of the research structure

This research takes place within the Need for IoT project, which questions product use in relation to the IoT. Within the framework of the project, the question

of the consumer is raised, as well as the consumer role in the supply chain. This thesis aims to address the following problematic: **Supply chain integration in B2B companies: leveraging downstream actors to address sustainability challenges in the context of the IoT**

To address this problematic, the theoretical fields studied are related to SCM, involving the concepts of integration (Flynn et al., 2010; Frohlich and Westbrook, 2001; Jacob, 2006; Vachon and Klassen, 2006; Yao, 2017; Y. Zhang et al., 2019), connection (Kim and Hall, 2015; Vachon and Klassen, 2006) and engagement (Bijmolt et al., 2010; Bowden, 2009; Harrigan et al., 2018; Kumar et al., 2019b; Moliner et al., 2018; Verhoef et al., 2010), but also the theoretical concepts of the sustainable supply chain (Carter and Rogers, 2008; Seuring and Müller, 2008a; Vachon and Klassen, 2006). The analysis of the literature anchors this research in the aforementioned theoretical fields. The concept of sustainability is analysed in relation to social, economic and environmental aspects (Elkington, 1997; Pagell and Wu, 2009; Seuring and Müller, 2008a). The dimensions underlying sustainability are the environmental and ethical aspects and the methods to integrate downstream actors.

This research adopts an article-based thesis format, each article being closely connected to the two others. Indeed, the first article deals with the integration of downstream actors in SCM, the second aims to identify the methods to achieve this integration through connection, and the last one observes how these methods are used in B2B companies in the IoT field, in relation to the issue of rare metals. The first article is therefore a literature review. In order to provide a representative overview of the current state of knowledge, a bibliometric analysis based on a pre-established methodology is proposed (Fahimnia et al., 2015, 2015; González-Benito et al., 2013; Kazemi et al., 2019; Mishra et al., 2018a; Xu et al., 2018). For the second article, which identifies methods, a systematic review of the literature is carried out (Bastas and Liyanage, 2018; Denyer and Tranfield, 2009; Hofmann and Bosshard, 2017; Koberg and Longoni, 2019; Lagorio et al., 2016; Melacini et al., 2018; Saenz et al., 2015; Seuring and Müller, 2008a; Wilding et al., 2012), by proposing first

a quantitative analysis, then a content analysis, thereby allowing a conceptual framework to emerge. Finally, the last article is a case study on the IoT and rare metals using a qualitative method to explore the field in depth (Kaufmann and Denk, 2011; Rauer and Kaufmann, 2015; Robert K Yin, 2003). Concerning the empirical material, the first article analyses 678 articles in a quantitative way in order to bring out the main authors, journals and particularly the main fields of research (clusters), thus allowing future research pathways to emerge. The second article analyses 41 articles, analysing the content in depth. Finally, the third article on the field study deals with 19 interviews with B2B companies in the rare metals, nanotechnology and IoT sector, as well as interviews with consumers.

Table 14: Summary of the research structure

Problematic	<i>Supply chain integration in B2B companies: leveraging downstream actors to address sustainability challenges in the context of the IoT</i>
Themes mobilised from the literature	<i>Sustainable supply chain management Supply chain integration</i>
Methodology	<i>Thesis by articles Article 1: Bibliometric analysis (study of articles in a quantitative way) Article 2: Systematic analysis (study of articles in a quantitative way, then analysis of article content) Article 3: Case study on rare metals and the IoT (qualitative approach through interviews)</i>
Empirical material	<i>Article 1: 678 articles studied Article 2: 41 articles studied Article 3: 19 semi-structured interviews</i>

1.2 Summary of the main results for each article

This article-based thesis proposes three research areas, each with its own objectives and results, which are presented to show their overall contribution to this thesis. The first article operates within the theoretical field of SCI (supply chain integration). This article, entitled “Consumer/user/customer integration in supply chain management: a review and bibliometric analysis”, and published in *Supply Chain Forum: An International Journal*, aims to study literature in the field of SCI with a focus on the integration of downstream actors. It also presents the major clusters and their evolution over time, thus allowing the emergence of future areas of activity to be studied. It highlights the major authors in this field of research, the two key ones being Frohlich and Westbrook (2001) and Flynn et al. (2010). As a bibliometric article, it also shows research clusters, as well as future research avenues. One important point that has emerged from this research is that sustainability represents a cluster on its own. Many renowned authors and articles underline the importance of sustainability in the field of SCI (Barbosa-Póvoa et al., 2018; Carter and Rogers, 2008; Seuring et al., 2008). This article highlights the link between integration in the B2C and B2B sectors. As stated by Reaidy et al. (2021), the integration of downstream actors such as the consumer is more difficult to achieve in B2B than in B2C. However, it remains important to integrate them in order to achieve sustainability (Lacoste, 2016). Our article confirms that even in the literature, the integration of customers is more important than that of consumers and users; the keywords ‘consumers’ and ‘users’ appear in 100th and 827th position respectively, while ‘customer’ is in 21st position. Thus, this article contributes fully to the key research problematic of this thesis; firstly, it anchors the research in a specific theoretical field of SCI, and secondly it serves to highlight our main concept, namely, sustainability. It also supports our questioning of the complicated integration of downstream actors in B2B companies, and especially consumers and users.

The second article, entitled “Connecting the customer to the supply chain: proposition of a comprehensive framework” aims to identify the different methods to connect downstream actors in the SC, depending on the processes, objectives

and role given to these actors. Furthermore, it aims to provide companies with the tools to decide which methods are the most relevant for them depending on the aforementioned priorities. The main result that emerges from this article is the realization of a comprehensive framework that responds to these challenges. All methods are identified and presented, and then a systematic analysis of the articles allows major categories to emerge, proposing possible methods according to the processes, roles of the downstream actors and objectives. This article also provides a statistical study of the different articles, including the evolution of articles by year, the most recognized articles and the most used keywords. This article contributes to the evolution of this thesis via its managerial character and the fact that it proposes a comprehensive framework. It also serves as a continuation of Article 1 by highlighting the different methods that exist before going to observe them in the field (Article 3). It also raises the singular characteristic of sustainability which is a key concept throughout our research.

Article 3, entitled “Making supply chains more sustainable through customer and consumer engagement: the case of rare metals” attempts to answer the following question: How can customer and consumer engagement be improved to enable a greater degree of ‘co-creation’ in the search for greener products and the supply chains that support them? This article proposes, through 19 interviews using a qualitative method, to identify the methods that exist in B2B companies in the rare metals and IoT sector to engage downstream actors. This is directly related to Article 2, as many of the methods studied in the literature are also mentioned by companies and consumers. In addition, this research has made it possible to draw up a map of the methods used according to the process, whether upstream or downstream, and according to the desired degree of sustainability. This article brings this research to a logical conclusion by analysing, within our context of interest, i.e., rare metals and the IoT, the elements seen in the two previous articles, i.e., the integration of downstream actors into the SCM and the different methods that can contribute to connecting them to the SC. It also opens up pertinent new research pathways.

Table 15: Summary of the main results according to the articles

	Objectives	Main results	Contribution to research
Article 1	<p>Study the literature on integration of downstream actors in SCM. Observe the evolution of this topic over the years, and highlight the major clusters of this research topic as well as future avenues.</p>	<ul style="list-style-type: none"> -The analysis of the evolution of the clusters over the years shows the disappearance of some clusters, such as the theoretical one, leaving room for more recent clusters such as the one dealing with sustainability. -The article shows that the customer is mainly much more integrated in the SC than consumers and users. -Sustainability is less studied than performance or optimization, even in the most recent articles 	<p>This article highlights the issue of sustainability. This theme is therefore widely addressed in the next two articles. Moreover, this article already shows that the integration of the consumer is less important than that of the customer, especially in the B2B field.</p> <p>This article has a theoretical contribution to the continuation of this thesis: it allows the subject to be anchored and to fit into a theoretical framework.</p>
Article 2	<p>Identify the different methods to integrate downstream actors in different SC processes according to the companies' objectives and the role given to these actors.</p>	<ul style="list-style-type: none"> -Identify the different existing methods to integrate downstream actors in SCM. -Study this field of research in a structured way to classify the articles according to various categories. -Propose a conceptual framework to identify the most suitable methods according to categories (level of connection, role given to the downstream actor, targeted process and objective pursued by this connection). 	<p>This article highlights the different methods. The conceptual framework provides a pathway to connect customers. This literature review is a first approach to see what has been completed in the field (Article 3) and to gain good knowledge of the methods and their objectives. It also provides a managerial contribution, allowing companies to observe which methods are the most relevant in relation to the different categories.</p>
Article 3	<p>Understand how to engage customers and consumers to enable a greater degree of 'co-creation' in the search for greener and sustainable products and the supply chains that support them.</p>	<ul style="list-style-type: none"> -Mapping of the different methods that enable co-creation according to the sustainability objectives and the level of engagement desired, and according to the upstream or downstream processes in the supply chain. -It emerges that it seems to be easier for companies to engage their customers than consumers and users. This point is emphasized both by companies and by consumers themselves. 	<p>The case study approach highlights the rare metals and IoT context of interest. It also links to the literature on the integration of downstream actors in SC as well as existing methods. This field analysis completes the research and results previously found in the first two papers, as it observes the methods used in companies' SCs. It also highlights the different possible future avenues of research.</p>

2. Answers to research questions

The research questions presented in the first part are reviewed in order to address the problematic: **Supply chain integration in B2B companies: leveraging downstream actors to address sustainability challenges in the context of the IoT.** All the questions and sub-questions are presented.

2.1 Addressing the first research question

The first research question is: **What has been published in the SCM literature regarding the integration, connection and engagement of downstream actors?** It is followed by four sub-questions:

- Sub-question 1a) What differences are there between downstream actors: customers, consumers and users?
- Sub-question 1b) What differences are there between integration, connection and engagement of downstream actors?
- Sub-question 1c) What are the main themes studied regarding the integration of downstream actors?
- Sub-question 1d) Which topics related to this issue will become more important in the future?

Figure 39 provide answers to each of these questions, with a summary diagram highlighting the key points.

To answer the first sub-question dealing with the different downstream actors, the literature is examined. The authors point out that the definitions are not clear and not sufficiently covered (Bennett, 1995; Yadin, 2002). Many articles use the terms ‘customer’, ‘consumer’ and ‘user’ as synonyms (Kaulio, 1998), or without distinguishing between them (Jo Bitner et al., 1997; Sampson and Spring, 2012). However, the French and English dictionaries show a clear difference between these terms. Definitions of these terms applied to the field of SCM are proposed in this thesis based on various definitions in the literature and dictionaries:

- The customer is a member of a company's downstream supply chain who may be the actor between manufacturing (or distribution) and the final consumer of the product or service. Customers buy goods or services not for their own consumption, but to benefit others (this often involves a resale stage).
- Consumers are the last members of a company's downstream supply chain; they buy and consume a product or service themselves.
- Users are also the last members of a company's downstream supply chain, but can also be considered members of the reverse supply chain—they are the last actors to consume the product or service, without necessarily having purchased it.

It seems essential to define these actors clearly because depending on who they are, they do not have the same roles in the SC and are not integrated in the same way.

Regarding the second research sub-question on the difference between integration, connection and engagement, the notion of integration is specific to SCM (Flynn et al., 2010; Frohlich and Westbrook, 2001), whereas the topic of connection and engagement is more present in the fields of marketing and innovation (Bowden, 2009; Kumar et al., 2019a; Moliner et al., 2018; Noble and Kumar, 2008; Schuurman et al., 2016). Moreover, integration has more of a performance objective (Fabbe-Costes and Jahre, 2008; Khan and Wisner, 2019; Narasimhan and Kim, 2002), whereas in the case of engagement and connection, the objective of sustainability is much more present (Leminen et al., 2015; Schuurman et al., 2016; Zimmerling et al., 2017). Secondly, the notion of integration can be defined as the act of inserting something into something, so in our case, inserting the downstream actors into the SC. This notion of integration means that the downstream actors were not previously part of the SC (Flynn et al., 2010; Frohlich and Westbrook, 2001). The term integration is seen, in this thesis, as the general concept, but in the field of SCM, the articles do not set out how this integration can be achieved. The research scope was consequently extended to other areas, like innovation and marketing. In these two fields, the notion of integration is not often present, whereas connection and engagement are common (Bowden, 2009; Kumar et al., 2019a; Moliner et al., 2018; Noble and Kumar, 2008; Schuurman et al., 2016), and it is in these two fields that integration methods are

presented (Shin, 2019; Von Hippel, 2001; Zimmerling et al., 2017). Connection allows two things to be linked, i.e., the downstream actors and the SC, while the notion of engagement suggests a more important role for the downstream actor as it implies choices and responsibilities. In this perspective, the aim is to couple the SCM domain with the basic concept of integration, and the notions of connection and engagement which allow the downstream actor to be integrated at different levels. The higher the level of integration, the more use the integration methods make of engagement, while conversely, if the expected integration is lower, integration methods tend to lean towards the notion of connections. Hence, the vision is more transversal and calls upon the fields of marketing and innovation, within a general SCM framework.

With regard to the third research sub-question relating to the main themes studied for the integration of downstream actors, it refers to the clusters seen in Article 1 (Part 2, Chapter 4). Initially, the research focuses mainly on the theoretical development of this field. Another category of articles deals with the development of the dimensions surrounding the theoretical field. Another section focuses on the modelling of this field. Finally, two distinct categories of articles broaden the subject by proposing the different drivers, including mainly the fields of information systems and sustainability.

To answer the last sub-question, still referring to Article 1, the themes of information systems and sustainability are those that will be most prominent in the future. Concerning information systems, research is increasingly focused on Industry 4.0 and the place of computerization in the SCI, including the IoT and blockchain (Kamble et al., 2019; Pfahl and Moxham, 2014; Saengchai and Jermisittiparsert, 2019). As far as sustainability is concerned, the question of integration as a means to propose more sustainable SCs while taking into account the notions of performance is also present (Wiengarten and Longoni, 2015; Wong et al., 2015; Woo et al., 2016; Xie et al., 2018). Several research papers even combine aspects of information systems and sustainability to enable SCI to be ever more efficient while taking into account sustainability dimensions (Cui et al., 2020; De Vass et al., 2018; Nahr et al., 2021; Zhang et al., 2020).

To conclude on question one concerning the existing SCM literature on the integration of downstream actors, it is important to redefine downstream actors to avoid confusion between the terms before moving on. The question of integration is paramount, but to understand how to implement it concretely, we look at the fields of innovation and marketing using the notions of connection and engagement. The issues of integration, connection and engagement highlight the centrality of sustainability in today's SCs. From this angle, it is possible to find out how to integrate downstream actors in order to meet the sustainability challenge. In the SCM domain, there are several authors who have written prestigious articles and who are still working on the SCI theme. Some are now focusing on the most important topics, such as sustainability and information systems, as is the case of Wong et al. (2020) who co-authored the article "Effects of green supply chain integration and green innovation on environmental and cost performance" (Wong et al., 2020). Likewise Yu et al. (2021), with their article "Impact of information technology on supply chain integration and company performance: evidence from cross-border e-commerce companies in China" (Yu et al., 2021). The weight of research on this topic is growing as SCs are become more complex and seek to be more sustainable while integrating different actors, particularly those downstream (Christopher, 2016).

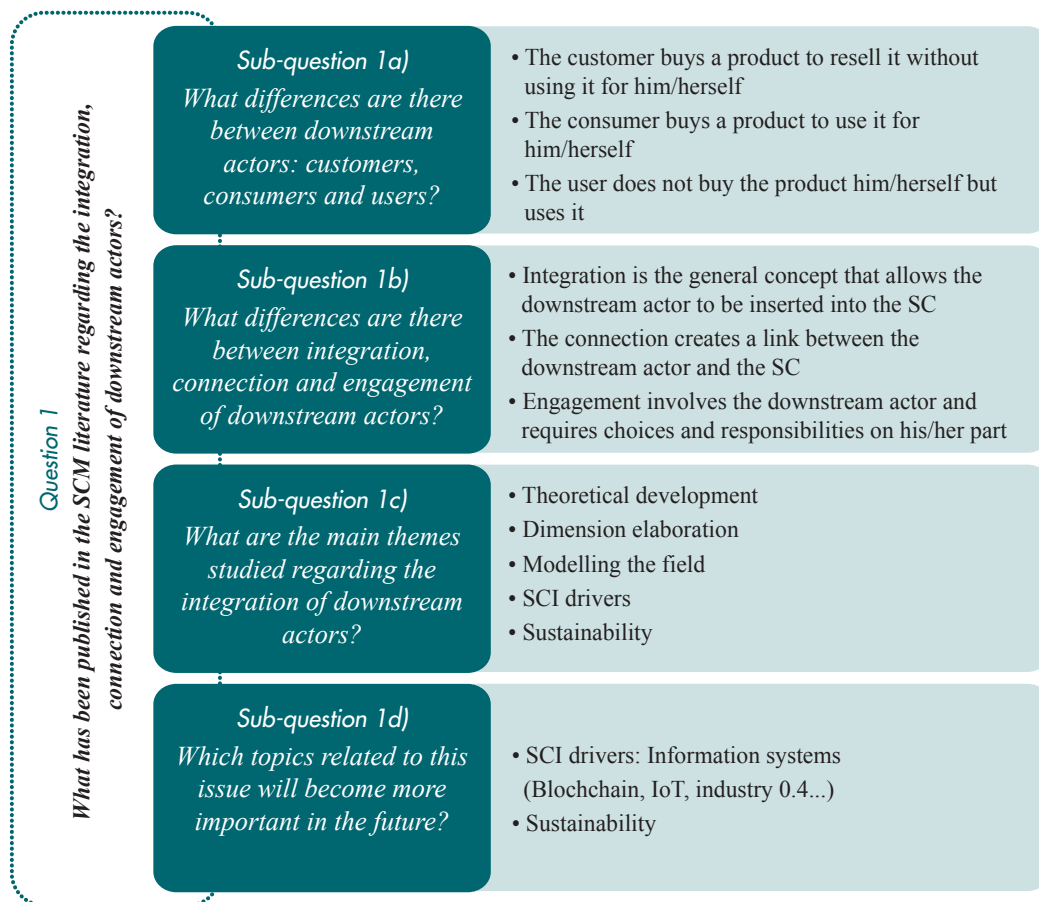


Figure 39: Key elements for answering the first research question

2.2 Addressing the second research question

The second research question is: **Which methods can be used in order to integrate downstream actors into the SC?** It is followed by four sub-questions:

- Sub-question 2a) What methods can be used for integration?
- Sub-question 2b) Which SC processes can be targeted for this integration?
- Sub-question 2c) What are the objectives of such methods?
- Sub-question 2d) What are the different roles of downstream actors in this integration?

To answer the first sub-question, integration methods of downstream actors were present in five articles and one book (Edvardsson et al., 2012, 2010; K. Füller et

al., 2014; Piller et al., 2010; Rese et al., 2015; Zogaj and Bretschneider, 2012). To find these articles, the following search term was entered into Google Scholar: “customer integration methods”. The same search was carried out using the terms “consumer” and “user”, but no articles came up. After a thorough reading of the articles and the book, here are the different methods that exist to integrate downstream actors into the SC: ‘VoC’ (Griffin and Hauser, 1993), ‘customer interviews’ (Cooper and Dreher, 2010), ‘laddering’ (Gutman, 1982; Reynolds and Gutman, 1988), ‘brainstorming’ (Camacho and Paulus, 1995), ‘lead user’ (Urban and Von Hippel, 1988; Von Hippel, 1986), ‘user toolkit’ (Von Hippel, 2001), ‘idea contest/idea competition’ (K. Füller et al., 2014; Piller and Walcher, 2006; Terwiesch and Xu, 2008), ‘crowdsourcing’ (Brabham, 2008; Howe, 2006; Leimeister et al., 2009), ‘living labs’ (BHMSA Bergvall-Kåreborn et al., 2009; Birgitta Bergvall-Kåreborn et al., 2009; Bergvall-Kåreborn and Stahlbrost, 2009), ‘empathic design’ (Leonard and Rayport, 1997), ‘participatory design’ (Spinuzzi, 2005), ‘innovation communities’ (Fichter, 2009), and TRIZ (Edvardsson et al., 2010; Yamashina et al., 2002). Regarding the second sub-question, the content analysis of the systematic study revealed three important processes: upstream, internal and downstream processes. For the third sub-question on the different objectives of this integration, we identified six, namely, quality, performance, sustainability, innovation, risk management and technical. With regard to the fourth sub-question, the role of the actors, they have either an active or a rather passive role. Figure 40 summarizes the results of the main question two and the four sub-questions.

The analysis of the content of the articles revealed two main categories, namely, ‘high’ and ‘low’ integration. Overall, we see that the literature focuses more on low integration of downstream actors where the role of the actor is generally more passive than active, and the main objective targeted is that of quality, often obtained through the VoC method. Nevertheless, several methods can be used to achieve different objectives, depending on the different processes. Thus, the VoC method, for example, can meet both quality and sustainability objectives.

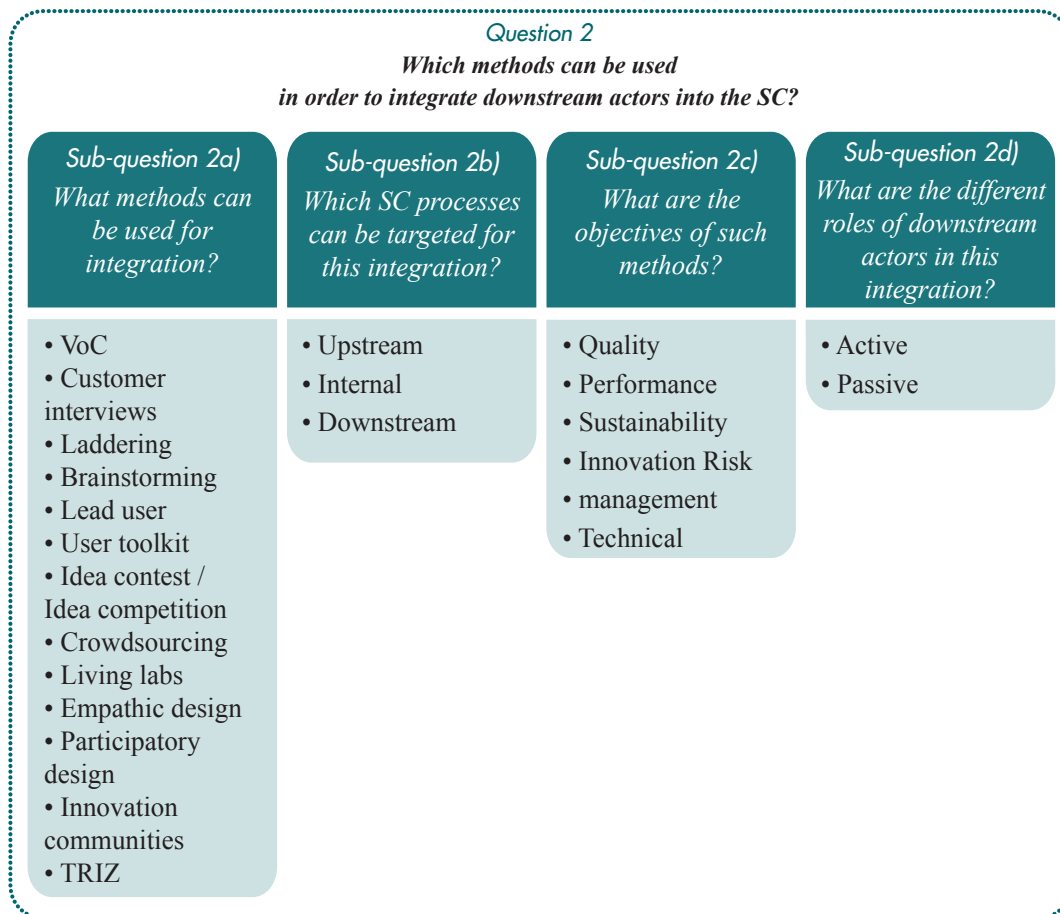


Figure 40: Key elements for answering the second research question

2.3 Addressing the third research question

The third research question is: **To what extent do downstream actors' perceptions lead to greater sustainability when these actors are integrated into the IoT supply chain?** It is followed by four sub-questions:

- Sub-question 3a) What are the sustainability challenges in the SC?
- Sub-question 3b) What are the sustainability challenges in the context of the IoT?
- Sub-question 3c) How is this issue perceived by the companies in this sector, and particularly the link to sustainability and the integration of downstream actors?
- Sub-question 3d) How is this issue perceived by consumers, and particularly the link to sustainability and the integration of downstream actors?

In order to answer the first sub-question, the six main issues were retrieved from the literature out of the 19 proposed by Seuring and Müller (2008) which highlight the issues related to SSCM. These issues allow the research to be anchored in a theoretical field, but also to highlight the knowledge gaps that we seek to fill:

- “Supply chain-wide cooperation and communication (cross-border information management; long-term contracts; providing confidence; generating common values)
- Awareness of social and environmental responsibility; corporate social responsibility
- View of extended SC; extending sustainability efforts beyond immediate interfaces; SC network; chain-wide process integration; product life-cycle
- Sustainable innovation
- (Public) pressure of stakeholders; need for transparency (especially related to focal companies)
- Labour conditions” (Seuring and Müller, 2008, p. 459)

These six issues show that the notions of the extended supply chain and collaboration are presented. The authors also stress the importance of integrating suppliers. However, the downstream actors are not identified, hence this research focuses on the concept of integration of downstream actors. The many articles in SCM that stress that integration has an impact on sustainability (Neutzling et al., 2018; Seuring and Müller, 2008a; Wolf, 2011), are mirrored in other fields such as marketing and innovation (Heiskanen et al., 2005; Sul and Lee, 2020; Zimmerling et al., 2017). Thus, this thesis seeks to add a brick to the SSCM wall by adding the notion of downstream actor integration to address the current knowledge gap. Articles 2 and 3 of this thesis (Part 2, Chapters 4 and 5) show that this integration of downstream actors in SC processes can address sustainability issues and lead to more sustainable products or processes.

To answer the second sub-question on the link between sustainability and the IoT, firstly we present the context of the IoT and related nanotechnology, with its widespread use of rare metals. These rare metals have an important impact on the environment and on societies (Bekara, 2014; Ethirajan Manavalan and Jayakrishna, 2019; Rus et al., 2019)

The main issues connected to these products lie in the supply chain vulnerability, i.e., there are geopolitical issues related to their supply and manufacture and this may imply price variations or disruptions. Moreover, the basic components are not renewable resources but finite, directly impacting the quantity of reserves (Massari and Ruberti, 2013; Mutumi and Simatele, 2017). It is essential to find technical solutions such as material substitution or reduction (Egbue and Long, 2012; Palomino et al., 2021; Quinteros-Condoretty et al., 2021). The notion of network is also important - reflections on sustainability must be embraced at all levels of the SC, for example, during the product design stage, by finding substitutes or by reducing the components. Manufacture should also be addressed, since this stage features too few regulations leading to precarious and unsanitary working conditions, as well as forced labour of adults or children (Maniglier, 2020; Massari and Ruberti, 2013; Mutumi and Simatele, 2017; Pitron, 2018). The end of life of the products must also be better managed, as to date the management of recycling and waste management has not been sufficient (Bakas et al., 2014; Barume et al., 2016; Sauer and Seuring, 2017; Zhang et al., 2017). Integrating the downstream actors by questioning their uses of the IoT can initially make it possible to respond to these sustainability issues, and some research has already been undertaken by Kasulaitis et al. (2021). Nevertheless, in their article, consumers only feature in a passive role and are not directly engaged in the SC. Hence, this thesis looks for ways to integrate these actors in a more or less active way in the SC in order to propose more sustainable products and processes.

Regarding the third sub-question concerning companies' perceptions of the IoT and links with sustainability and integration of downstream actors, the interviews show that firstly, even if the concept of sustainability in a company is seen as an essential element, it is presented through the corporate prism. In the case of the IoT and its raw materials (rare metals), it would seem that external factors are more important. Indeed, it is often legislation or supply problems, or an increase in the price of the raw material that will change the behaviour of companies with regard to these metals. For companies, the most important thing is the availability of these metals and their technical characteristics, although the ecological and, above all,

ethical aspects have been gaining traction, which is why some companies no longer source conflict metals from certain countries.

Concerning the integration of downstream actors, the methods proposed by the companies give more of a passive role than an active one, and the more active the role is, the greater the likelihood that this integration takes place upstream. A low level of integration means that the integrated actor has a passive role, whereas a high level of integration means that the integrated actor has an active role. Generally speaking, the further away the company is from its consumers, the more difficult it is to integrate them. Figure 41 summarizes these elements in core categories for companies.

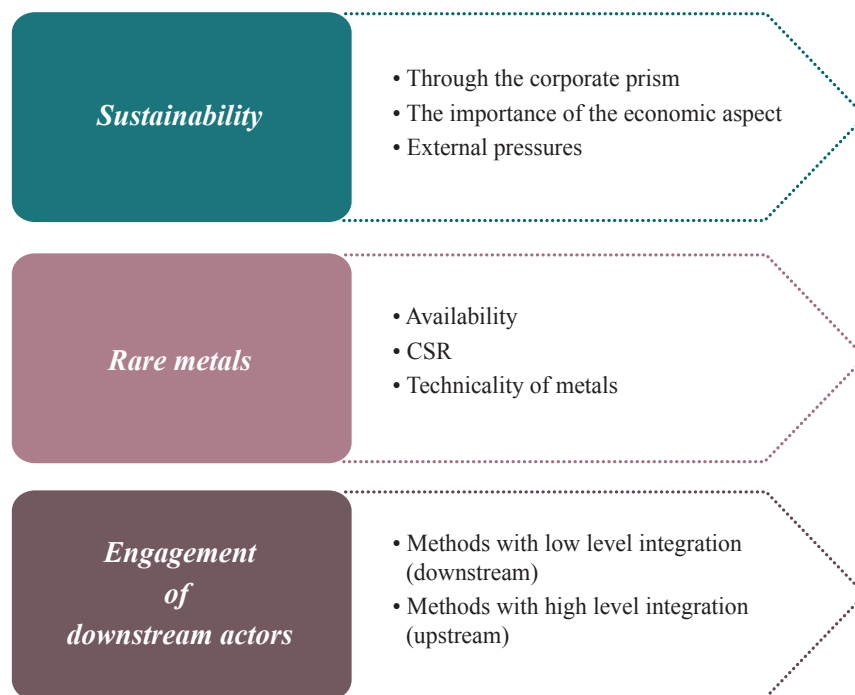


Figure 41: Core categories for companies' interpretation

The fourth sub-question attempts to understand the consumers' perceptions of the topic of the IoT and the link to sustainability and downstream actor integration. Firstly, it is important to note that one of the key findings is that consumers have limited knowledge of the IoT. They have heard of it, but they do not know what it is or how the different aspects function. Nevertheless, despite not being experts on the

subject, they understand the stakes and the importance of finding new opportunities. For them, companies must find answers both internally, such as rethinking the design of products, and externally, such as getting help from experts. They underline the importance of taking sustainability issues into consideration throughout the whole supply chain. Concerning the IoT and rare metals, the focus is on the disadvantages of their use by companies, such as pollution in the manufacturing process or the lack of recycling. Consumers raise many suggestions, such as redesigning the entire product, substituting what can be substituted and reducing what cannot be substituted. Regarding the integration of downstream actors, consumers are proactive and list many methods. When comparing the methods consumers proposed using their own vocabulary and the methods in the literature, the methods overlap. In addition, emphasis is also placed on the rather active or rather passive role of this actor integration. Figure 42 summarizes these elements through the core categories.

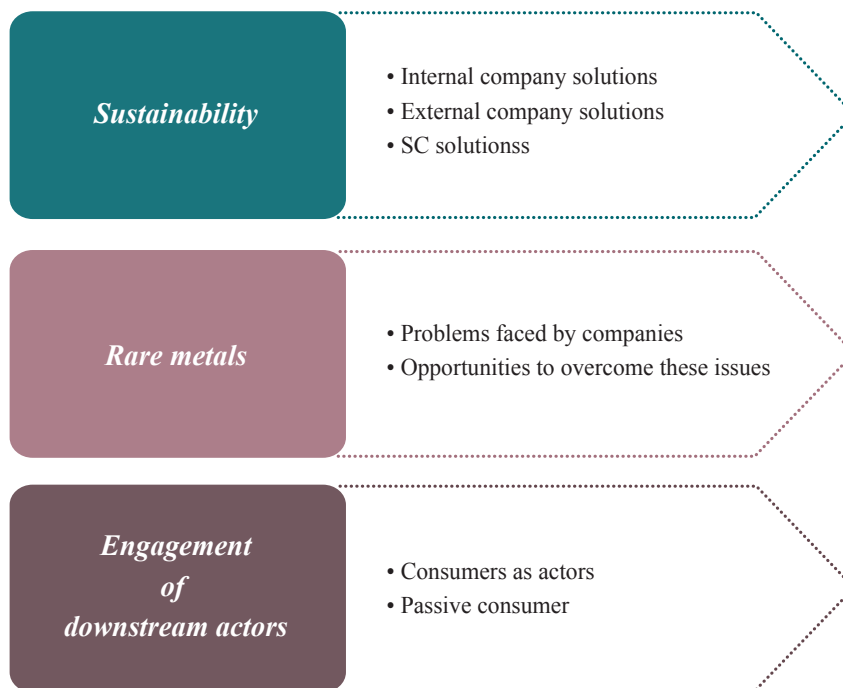


Figure 42: Core categories for consumers' interpretation

To conclude on the third research question, “How to integrate downstream actors to enable the creation of more sustainable products and SCs in the rare metals and IoT sector?”, the integration of downstream actors therefore emerges

as an option. The integration of downstream actors is not obvious, especially for companies that are far upstream, but there are many methods to achieve integration for sustainability purposes, which give a more or less passive or active role to the actors involved. These methods can help to meet the challenges of sustainability, which are important for companies as well as consumers. Figure 43 summarizes the answers to these questions.



Figure 43: Key elements for answering the third research question

Summary Chapter 7

Chapter 7 highlights the different results obtained in this thesis. Firstly, a summary of the design research is proposed, presenting the main research question, theoretical framework, overall methodology and empirical material. Secondly, the results inherent to the articles are presented, specifying the objectives, main results and the contribution of the PhD for each article. A second part seeks to answer the research questions proposed in Part 1 of this thesis. To this end, some answers are proposed for each of the three main questions, which are as follows: What has been published in the SCM literature regarding the integration, connection and engagement of downstream actors? Which methods can be used in order to integrate downstream actors into the SC? To what extent do downstream actors' perceptions lead to greater sustainability when these actors are integrated into the IoT supply chain? Likewise for the sub-questions that follow on from these three main questions. Overall, the first question, which deals with the integration of downstream actors in the SCM, proposes clear definitions of the customer, the consumer and the user. The importance of transversality is highlighted and the concepts of connection and engagement allow methods for integrating downstream actors to be identified. Finally, it is emphasised that the fields of information systems and sustainability are increasingly being addressed in relation to the integration of downstream actors. Regarding the second question, it is important to note that there are many methods that can be used depending on the different objectives, targeted processes and the role given to actors. In terms of the third question which deals with the context of the IoT and the link to sustainability and downstream actor integration, it is worth noting that within the context of the IoT, nanotechnology and rare metals, issues relating to raw materials, ecology and ethics are increasingly emerging. Moreover, the issue of sustainability is widely present in relation to these aspects and an opportunity to propose more sustainable products could lie in the integration of downstream actors. This includes consumers, even if they have limited technical knowledge on the subject of the IoT and it may sometimes seem complex for companies to integrate them when they are much further downstream.

Chapter 8. *Contributions*

In this eighth chapter of Part III, the contributions of this thesis are presented according to theoretical, methodological and managerial inputs. Concerning theoretical contributions, whilst this thesis does not propose a new theory, it does enhance the field of SCM. The same applies to methodological contributions—rather than proposing new methods, specific methods present in other domains have been applied to the SCM domain, mainly concerning the integration of downstream actors. Regarding managerial contributions, these are the most significant, as they propose to support companies in choosing the most relevant integration methods. All these contributions will be detailed below.

1. Theoretical contributions

From a theoretical point of view, the first two articles (the bibliometric article and the systematic literature review) greatly enrich the literature. The first article conducts a review of what has been carried out on the subject of the integration of downstream actors in the theoretical field of SCM, and more specifically SCI. This research provides evidence of the main authors, most used keywords, most

represented journals and the most prestigious articles, among others. Moreover, from a theoretical point of view, thanks to the keyword analysis it reveals that the further actors are downstream from the company, the more difficult it seems to be to integrate them. Indeed, Ready et al., (2021) indicate that it is sometimes complicated for a company to integrate the actors who are furthest downstream when their activities operate upstream. It is worth observing how these upstream companies, especially those in B2B, are able to integrate downstream actors. As the keyword analysis also shows, customer integration is better represented than consumer integration (consumers being further downstream than customers) in the SCM field. In the database of the first article it is possible to see that many authors focus on the integration of customers. Out of 687 articles, 45 of them contain the term customer in their titles. These articles deal with customer integration to improve operational performance (Chavez et al., 2015; Nagati and Rebolledo, 2013; Yildiz et al., 2010), financial performance (Vickery et al., 2003; Yu et al., 2013), global performance (Afshan and Motwani, 2018; Danese and Romano, 2011), sustainability (Jermisittiparsert et al., 2019; Zhang and Awasthi, 2014), and innovation (Boer and Boer, 2019; Sheikh and Awan, 2013). However, far fewer articles in the database deal with consumer integration, with only 10 of the 687 articles mentioning the term consumer in the title. These articles mainly deal with consumers' perceptions of the company's products, and their behaviour or feedback on the company's performance (Helo and Luomala, 2011; Marino et al., 2018; Mukhopadhyay and Barua, 2003; Reyes and Bhutta, 2005). Concerning users, only one article out of 687 uses this word in its title and it mainly deals with user behaviour (Kim and Garrison, 2010). This analysis illustrates that one of the knowledge gaps identified in this thesis concerning the limited literature on the integration of downstream actors, and especially consumers and users, is less dominant in the SCM domain. That is why this thesis offers an overview according to these different actors (customer, consumer, user) in the three articles. The third article proposes to consider the integration methods for both the customer and the consumer.

Still from a theoretical point of view, this article focuses on the major fields of research that have emerged since 2015 and will be central in the coming years,

namely, SCI through the lens of information systems, and SCI through the lens of sustainability. Regarding information systems, 77 articles of the 687-article database from Article 1 deal with this subject, either from a competition point of view (Addo-Tenkorang et al., 2017; Du, 2007) or from an information sharing perspective (Choy et al., 2004; Klein, 2007). Information systems can enable the integration of downstream actors through different methods based on the internet or software, such as crowdsourcing (Huang and Ardiansyah, 2019; Zhu et al., 2017) or idea competitions (Ebner et al., 2009; Piller and Walcher, 2006).

Regarding sustainability, a significant number of articles focus on this notion - out of 687 articles 40 include the word sustainability or sustainable in their title, whether from an operational point of view (Qian et al., 2019; Wiengarten and Longoni, 2015; Zhang and Awasthi, 2014), a risk management perspective (Torres-Ruiz and Ravindran, 2018) or innovation angle (Genc and De Giovanni, 2020; Neutzling et al., 2018). This concept of sustainability is central in this thesis and seems to be the key issue to address in the analysis of corporate SCs when seeking to move towards a more sustainable world. The three articles therefore propose to enrich the fields of SCM, SCI, and SSCM.

Concerning the second article, the systematic analysis of the methods used to integrate downstream actors, we also contribute to the literature. To our knowledge, there are no articles in the fields of SCM or SCI that group, explain and analyse a large number of methods. Indeed, articles in the SCM field on this subject often detail one or two methods, such as crowdsourcing (V. E. Castillo et al., 2018; Li et al., 2021), but do not list them exhaustively. Similarly, the proposal of a comprehensive framework concerning methods of integrating downstream actors is, to our knowledge, a new feature in this field. Indeed, integration methods as seen from a global point of view are analysed and compared more in other fields such as marketing (Vargo, 2008; Vargo and Lusch, 2004; Wilson et al., 2016) and innovation (Da Mota Pedrosa, 2012; Edvardsson et al., 2010; Petersen et al., 2003). Some articles also provide a framework (Edvardsson et al., 2012, 2010; K. Füller et al., 2014; Piller et al., 2010; Rese et al., 2015; Zogaj and Bretschneider, 2012) focusing on the different

degrees of collaboration, the types of information, or the implementation modalities (K. Füller et al., 2014; Piller et al., 2010; Zogaj and Bretschneider, 2012). However, Article 2 of this thesis looks at these methods from the point of view of objectives, processes, level of integration and the role of the downstream actor, thus enriching the literature on the subject of integration, but above all enriching the field of SCM, where there is little literature on the subject. It thereby addresses one of the research gaps identified in this thesis concerning the lack of literature on integration methods for downstream actors in SCM.

Lastly, from a theoretical perspective in relation to the third article dealing with the context of rare metals and the IoT, we also contribute to the literature on this subject. Indeed, whilst rare metals have been previously studied, that has been mainly through the technical prism (Bekara, 2014; Gokhale et al., 2018; Madakam et al., 2015; Palomino et al., 2021; Van Kranenburg and Bassi, 2012) in journals such as the “Journal of Computer and Communications” or “Sustainable Materials and Technologies”, and somewhat less in the humanities and social sciences. Moreover, even though several articles exist on the SCM of rare metals and the IoT (Rauer and Kaufmann, 2015; Sauer and Seuring, 2017; Son et al., 2018), it can be observed that this is a fairly recent topic and only a few of them address the downstream actors (Kasulaitis et al., 2021). Even the key article by Kasulaitis et al. (2021) does not propose to give an active role to consumers but rather looks at their buying behaviour. Indeed, the analysis in their article states that “a survey of 1,011 adults across the United States demonstrated theoretical potential for material efficiency gains, as respondents indicated willingness to accept a smaller number of multi-functional devices” (Kasulaitis et al., 2021, p. 1). Hence, their analysis observes purchasing behaviour but does not link companies directly to users. By contrast, the objective of this thesis is to propose a way for companies to take into account these technical and sustainable aspects directly from consumers and users. The third article also provides a theoretical contribution, in addition to its managerial contribution (detailed later), by enriching the literature in this field with a consumer point of view, as well as the point of view of companies in the IoT sector. Thus, the gap highlighted

in this thesis regarding the lack of integration of downstream actors in the IoT sector is addressed.

This research also attempts to provide some general answers regarding the use and definition of the terms customer, consumer and user. As shown in the first part of this thesis, there is ambiguity between these terms. Some authors use these terms either interchangeably (Kaulio, 1998; Kurniawan et al., 2004), imprecisely (Pergelova, 2010; Verhoef et al., 2010) or confusingly (Patel et al., 2013; Payne et al., 2008). Hence, this research aims to provide clear definitions based on the literature and dictionaries to specify terms in the SCM sector, thus addressing one of the research gaps that exists in the SCM literature regarding the ambiguity of these actors. It is important to define the terms clearly given that the integration of these actors depends on who they are. This research also proposes to consider integration through the prism of connection and engagement, two notions that have been widely discussed in the marketing field (Behnam et al., 2020; Bonsu and Darmody, 2008; Forza and Salvador, 2006; Kimmel, 2010; Mikkonen et al., 2008; Pergelova, 2010; Schmitt, 2010; Wilson et al., 2016) and the innovation field (Burton et al., 2020; Haas et al., 2016; Kurniawan et al., 2004; Margulis et al., 2020; Noble and Kumar, 2008; Pynnönen et al., 2019, 2012). These two notions coupled with the concept of integration allow this research to enrich the literature in the field of SCM.

2. Methodological contributions

From a methodological point of view, this thesis uses methods that do not seem to have been applied already to the research field of integration of downstream actors in SCM. As stated in Article 1, the integration of downstream actors has been studied but not following a bibliometric methodology. Many bibliometric articles exist in the field of SCM, adding knowledge on different subjects, such as green supply chains and SSCM (Fahimnia et al., 2015, 2015; Feng et al., 2017; Gong et al., 2019, 2019), risk management in the SC (Kilubi, 2016; Nobanee et al., 2021; Xu et al., 2020) information systems (Mishra et al., 2018a; Rejeb et al., 2020; Riahi et al., 2021; Zhang et al., 2020), and SC performance (Mishra et al., 2018b; Xu et al., 2018). However, when it comes to SCI, few bibliometric articles deal with this

subject, in fact, only two articles are proposed in Google Scholar (Asgari et al., 2017; Kotzab et al., 2021). However, these two articles do not focus on downstream actors. Moreover, the article by Asgari et al. (2017) mentions the customer several times, but does not address consumers or users, although these downstream actors are recognized as members of the SC (Christopher, 2016; Reaidy et al., 2021).

Other articles deal with the subject of integrating downstream actors into SCM (Martinelli and Tunisini, 2018; Morash and Clinton, 1998; Reaidy et al., 2021) but not through the prism of a bibliometric methodology. For example, the article by Reaidy et al. (2021) entitled “Consumer integration in supply chain management: a taxonomy”, which studies the integration of downstream actors but through a qualitative and empirical study. The first article of this thesis serves to complement the study by Reaidy et al. (2021) while using an existing methodology, that of bibliometrics. This methodology allows a review of the existing research in this field and an analysis of the evolution of the literature on this subject. Furthermore, Article 1 of this thesis uses an existing methodology, i.e., bibliometrics, and applies it to the SCM sector, thus addressing one of the knowledge gaps identified concerning the lack of literature on the subject of the integration of downstream actors.

Similarly, for the second article, there does not seem to be a systematic literature review in the SCM domain concerning the integration methods of downstream actors that has led to a conceptual framework. Other articles propose frameworks on integration methods but not in the SCM domain (Edvardsson et al., 2012, 2010; K. Füller et al., 2014; Piller et al., 2010; Rese et al., 2015; Zogaj and Bretschneider, 2012). Systematic literature reviews do exist in the field of SCI, but they do not focus on downstream actors and do not address integration methods. (Danese et al., 2020; Kamal and Irani, 2014; Tiwari, 2020). As explained above, some of these articles rarely mention consumers and users. In the article by Kamal and Irani (2014), the word consumer is mentioned twice and is introduced as an active member of the chain: “organisations instead should focus on collaborating with the entire SC (i.e. from raw material supplier, to goods manufacturer, to wholesalers and retailers, through to buyers/consumers) of their business.” (Kamal and Irani, 2014, p. 2). The

user is mentioned three times, once in the definition of the SCM itself: “Supply chain management is the integration of key business processes from end user through original suppliers that provides products, services and information that add value for customers and other stakeholders” (Kamal and Irani, 2014, p. 2), and twice it is stated that the company can take advantage of the user’s knowledge. By contrast, the term customer appears 71 times. In an article by Tiwari (2020), the term user appears only once in terminology such as user interfaces or user friendly, while the word customer appears 82 times. Thus, the second article of this thesis uses an existing methodology present in the SCI but applies it to downstream actors and integration methods in order to propose a conceptual framework. Although the title of this article refers to customers, consumers and users are widely addressed and some of the methods are also dedicated to these two downstream actors. This article thus addresses the gap concerning limited insight into existing methods for integrating downstream actors into SCM.

Article 3 proposes a mapping of these integration methods following a qualitative approach based on interviews. The qualitative interview method based on Grounded Theory has already been used in the SCM field (Flint et al., 2012b; Gimenez, 2004; Kaufmann and Denk, 2011; Sachan and Datta, 2005), however, here it is adopted in the context of the IoT. Several articles dealing with the subject of the IoT use a qualitative approach, but these articles do not focus on the environmental impacts of IoT-related products, nor the rare metals that compose them. Rather, these articles focus on the benefits of the IoT in a SC (Azizi et al., 2021; de Vass et al., 2021; Tu, 2018). Article 3 raises the challenges associated with the IoT while integrating the point of view of both companies in the sector and consumers. Moreover, this article proposes to actively integrate downstream actors to address these issues, which does not seem to have been tackled in the literature to date. Hence, the knowledge gap concerning a lack of integration of downstream actors in B2B companies operating in the IoT and rare metals sector is addressed. Furthermore, this article uses a qualitative approach to carry out a mapping, which has not been proposed by other articles in this field. Some articles in the field of marketing or innovation propose typologies of methods (Edvardsson et al., 2012, 2010; K. Füller et al., 2014; Piller

et al., 2010; Rese et al., 2015; Zogaj and Bretschneider, 2012), but they are not based on a qualitative approach for identifying different methods and neither do they take the point of view of companies or of customers themselves. This mapping is hence a methodological contribution to the field of SCI focusing on the integration of downstream actors.

3. Managerial contributions

The managerial contributions are considered to be the most important contributions and they are made in Article 2, which proposes the conceptual framework, and Article 3, which proposes the mapping of methods.

The second article concludes the results with a conceptual framework that can help companies to use the most appropriate methods according to their objectives, processes, level of integration, and the role given to the downstream actor. The conceptual framework highlights the different methods, which are sometimes specific to a single objective, as is the case of the innovative communities method (it meets the objective of innovation). It also highlights methods that can serve several objectives, as in the case of the living lab, which can serve both the objectives of innovation and sustainability. Thanks to this conceptual framework, companies can select the methods they want according to the objective they are aiming for (technological, innovation, sustainability, quality, performance, risk management), as well as according to the process by which they want to integrate this downstream actor (upstream, internal, downstream), or the role they want to give to this actor (passive or active). For example, some companies have internal constraints such as data sensitivity or complex manufacturing processes, in which case they may wish to integrate downstream actors in a rather passive way to limit their interactions and potential information leaks. Or conversely, a company that wishes to actively include its downstream actors in order to find new opportunities in terms of sustainable product design could choose the living lab method, which allows all the downstream actors as well as other actors such as employees, suppliers, researchers or students to be integrated. This conceptual framework can help companies to find the most appropriate method depending on the processes, objectives, level of integration and

role of the actor. Figure 44 shows how the conceptual framework can be used in relation to the different dimensions presented in Article 2. This figure allows these dimensions to be linked together in order to understand the overall meaning of the conceptual framework. The company is central and it depends on its different processes, objectives and customers. Integration can be high or low—overall, a low level of integration leads to a passive role for the downstream actor, while on the contrary, a high level of integration leads to an active role. Hence, depending on its objectives, processes and customers, the company can choose to integrate actors either through a high or low level of integration or by giving them an active or passive role; this company can base its decision on the methods proposed in the conceptual framework. The output of Figure 44, “Selection of the most appropriate method”, is based on the model from Article 2, Figure 35.

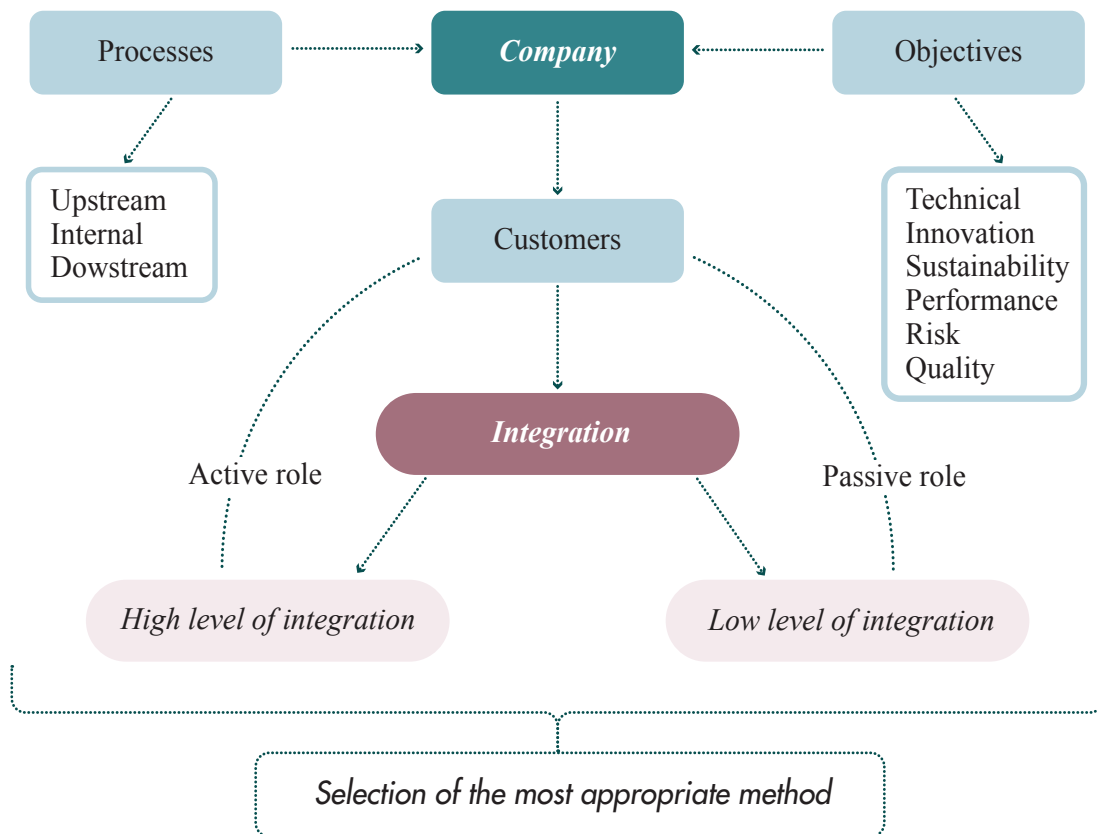


Figure 44: Customer integration

Similarly, Article 3, which is specific to the context of rare metals and the IoT, looks at the different methods used in B2B companies in this sector. In addition, consumers also propose methods that could be used by companies in this sector. The mapping suggests the different integration methods and whether they are methods that enable customer integration or consumer integration or both, through engagement. It also proposes the methods according to the degree of sustainability desired by the company and whether the integration of the actor takes place in the upstream or downstream processes. Thus, a company that wants to partially integrate its downstream actors and communicate on the importance of sustainability can use websites or social networks in order to connect with these actors. If, on the other hand, it wishes to integrate its actors at an early stage, it could use the living lab method in order to engage these actors. This mapping reinforces the contribution of Article 2 as the analysis is a field study of B2B companies in the IoT sector. Article 2 is based on articles from the literature and this research is deepened through Article 3 and its field analysis. Furthermore, this mapping not only focuses on the customer but also takes into account the consumer and proposes methods for both customer and consumer integration. This mapping mainly addresses the dimension of sustainability level or risk limitation, thus allowing the focus to remain on the sustainability issue of IoT-related products. Figure 45 shows the integration of downstream actors (customers, consumers or both) according to the importance of sustainability and risk limitation in order to allow the company to select the most appropriate method from the mapping presented in Article 3 (Figure 37).

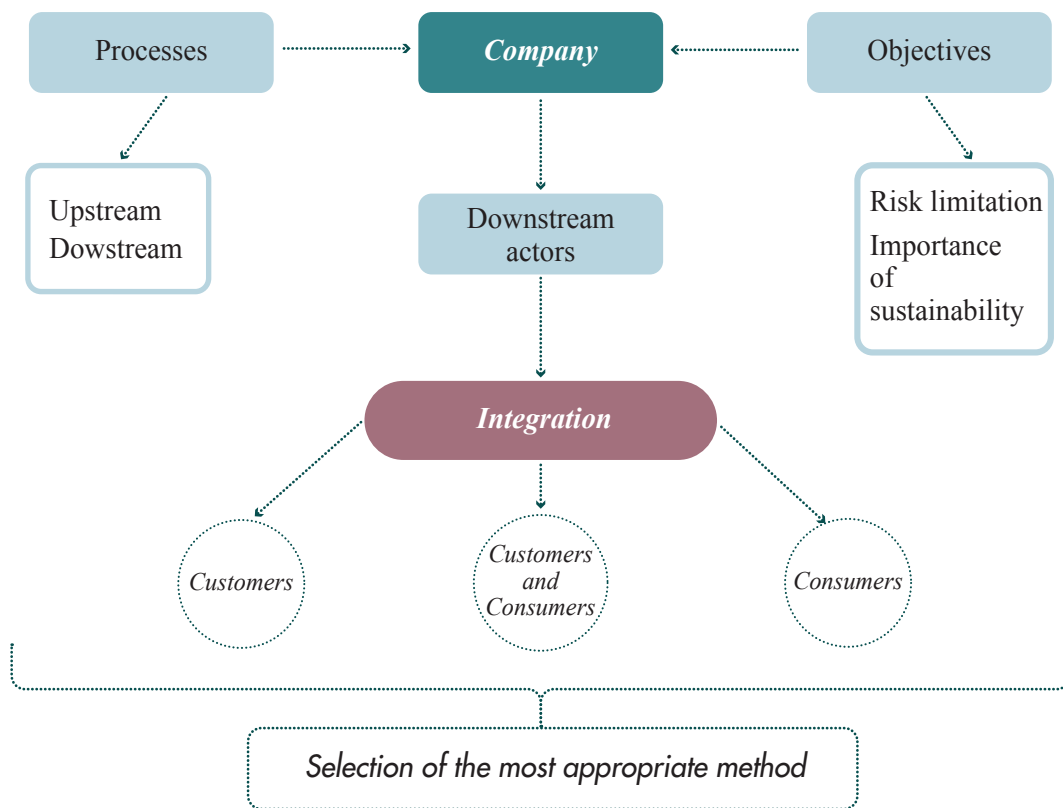


Figure 45: Downstream actor integration

These two elements - the comprehensive framework and the mapping - can be used simultaneously by companies to enable them to propose more sustainable products or processes thanks to the integration of downstream actors. Thus, the contribution of the literature-based conceptual framework is enhanced by the mapping based on the field analysis, which both focus on the notion of sustainability and including different downstream actors. The user is not present in the mapping or the conceptual framework, but it seems that some integration methods for consumers can also be applied to certain types of users. This is the case for the crowdsourcing method and the living lab, which allows new ideas to emerge regardless of whether actors bought the product for themselves or are only end users who didn't purchase the product. This topic of the user can be considered an avenue for future research. Figure 46 allows the elements from the mapping and the conceptual framework to be combined in order to best respond to the integration of downstream actors.

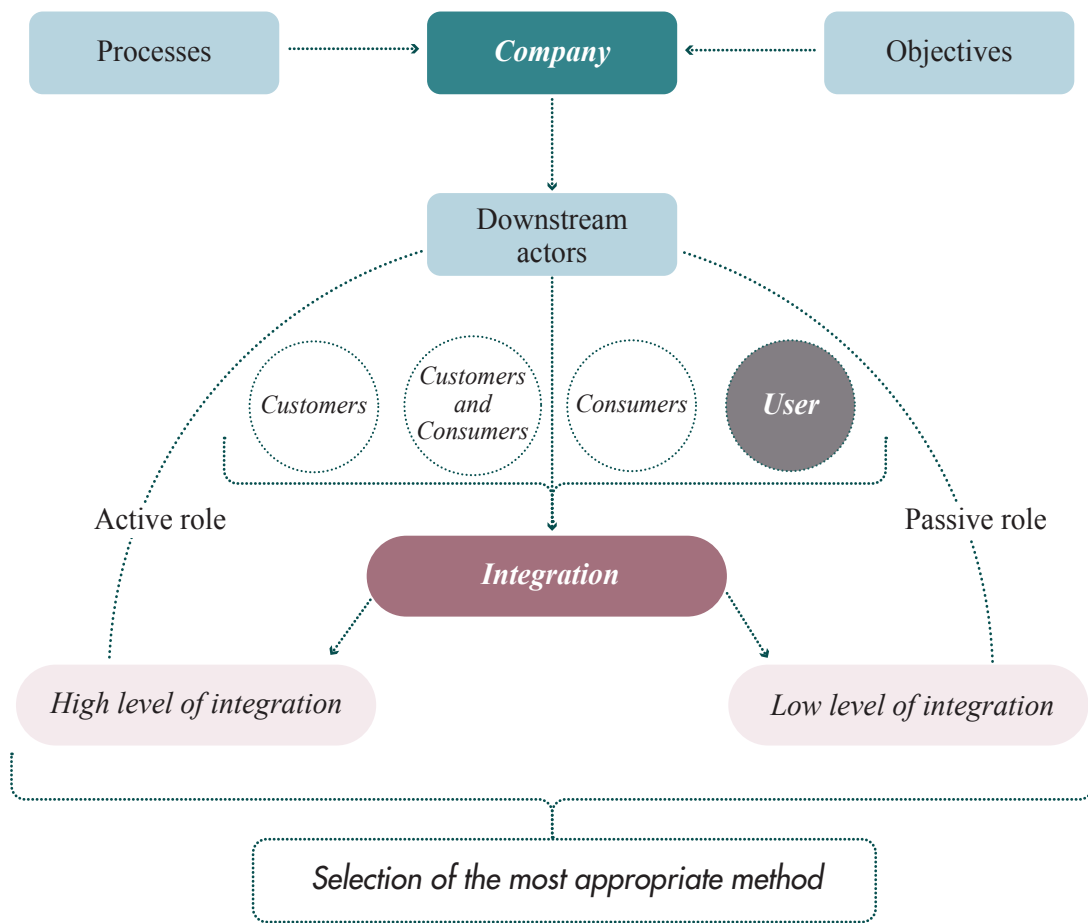


Figure 46: Global downstream actor integration

Figure 46 thus provides support for the company in its approach to integrating downstream actors. Based on this figure, the company can first identify the process targeted by the integration, which can be upstream, internal or downstream. The company can also define the objective it is trying to achieve through this integration, which may be related to technical aspects, innovation, sustainability and its importance, performance, risk management or limitation, or quality. Subsequently, the company specifies which actor it wants to integrate. This choice may depend on the processes and objectives that have been set. Once this decision has been made, the integration level of the selected actor(s) will be either high or low, giving either an active or a passive role to the downstream actor. This high or low level of integration also depends on the processes, objectives and actors to be integrated. However, it may also take into account constraints which are not mentioned in this

figure but which may relate to finance, confidentiality issues, language barriers, time limits, or organisational problems among others (the subject of constraints is discussed in Chapter 9, Section 2 on future research). Once the steps in this figure have been followed, the company can use the mapping and conceptual framework to select the most appropriate method(s) for this integration. For example, if the company chooses to integrate customers and consumers in the upstream process with the objective of sustainability as it has few constraints and it wants a high level of integration, the actors' role will be active. Referring to the mapping and the conceptual framework, the integration methods available to the company are, in the conceptual framework, the living lab or crowdsourcing, and according to the map, the living lab (Figure 47). Figure 47 shows the conceptual framework and mapping in use together, selecting the criteria to be applied. In this example, a high level of integration, active role, upstream process, and sustainability objective are chosen for the conceptual framework; as for the mapping, the criteria selected are engagement in upstream processes, importance of sustainability and integration methods for customers and consumers. These criteria selections result in the output of the living lab and crowdsourcing methods. Nevertheless, crowdsourcing is a method that is more applicable to the integration of an external crowd as it does not necessarily allow for the targeting of specific consumers and customers. Moreover, if the company wishes to integrate its customers alongside its consumers, it would be more appropriate to use the living lab method.

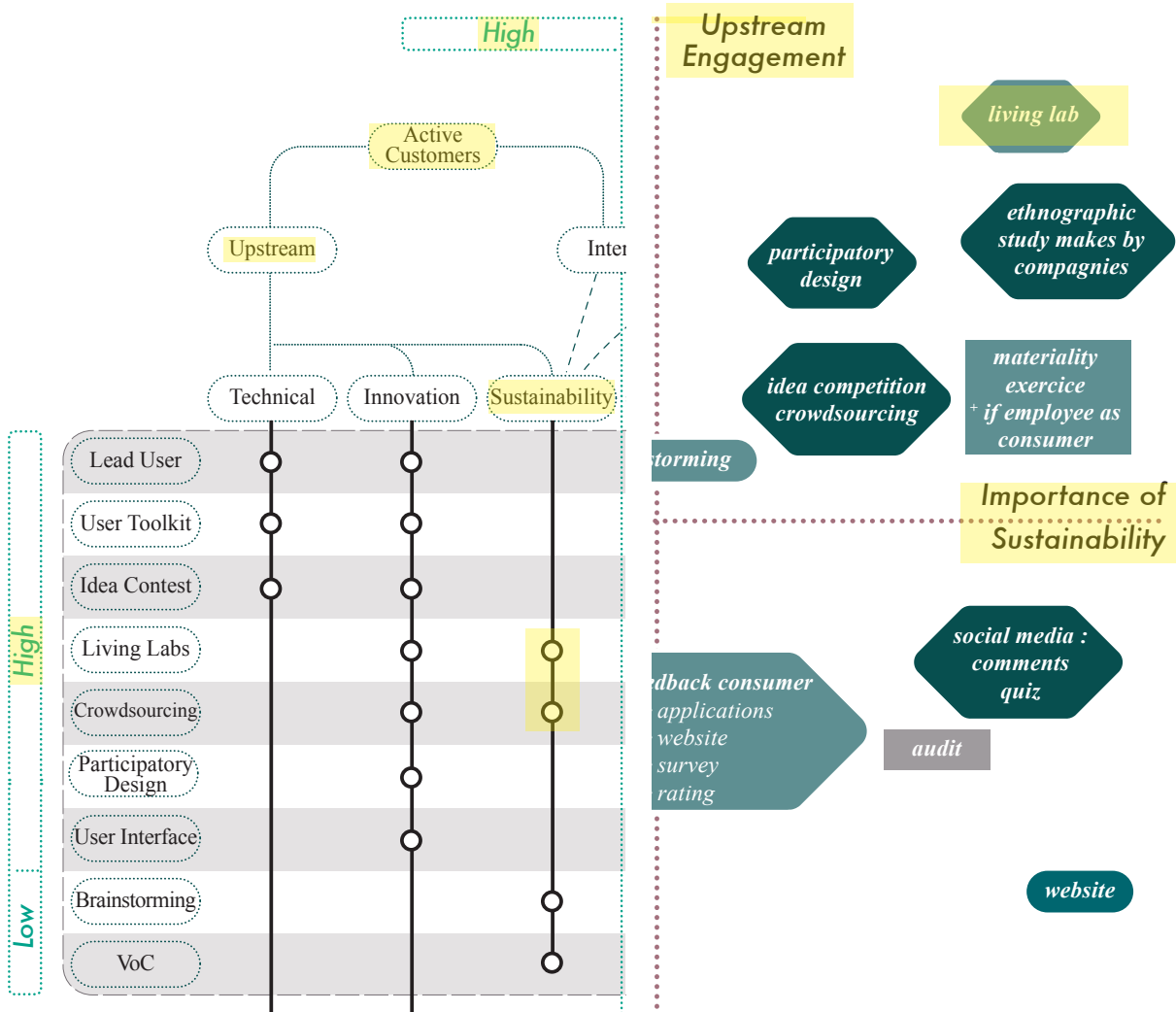


Figure 47: Use of the conceptual framework and mapping

Figure 48 summarizes the contributions of this thesis according to the different knowledge gaps identified in the first part. The contributions are observed through the prism of theoretical contributions, methodological contributions and managerial contributions. From a theoretical point of view, all the analyses concerning each of the gaps have resulted in an enrichment of the SCM literature, particularly in relation to SCI. Contributions have also been made specifically in relation to the integration of downstream actors and the IoT. These theoretical contributions highlight the evolution of the literature and the observation of different integration methods present in other domains such as marketing and innovation. The methodological contributions support the bridging of the four knowledge gaps through the use of methods not used previously in relation to the different topics. The managerial contributions mainly support the research on integration methods and the IoT sector.

		Contributions		
		Theoretical contributions	Methodological contributions	Managerial contributions
Gap identification	Confusion over terms related to downstream actors in the SCM	Enrichment of existing literature	The use of existing methods in a new field of research concerning the integration of downstream actors in the SCM, and the methods derived from it	
	Lack of integration of downstream actors in the B2B context			
	Limited insight into existing methods to integrate downstream actors into the SCM	Identification of different integration methods	Creation of a comprehensive framework following a systematic literature review	Creation of a comprehensive framework and a mapping allowing companies to select the most appropriate integration method according to their processes, objectives, level of integration, and the role of the downstream actor
	Lack of integration of downstream actors by B2B companies in the IoT sector			

Figure 48: Contribution of the thesis

Summary Chapter 8

This chapter highlights the various theoretical, methodological and managerial contributions. Theoretical contributions include the enrichment of the theoretical fields of SCM and particularly SCI, as well as the IoT field. The research carried out allows the evolution of the literature on the subject of integration of downstream actors in SCM to be analysed, highlighting the most prestigious articles, most published authors and the evolution of the fields of study, as well as stating and explaining the different possible integration methods. From a methodological point of view, the contributions mainly lie in the use of existing methods which seem not to have been used previously in the SCI field of research or in relation to integration of downstream actors. These methods include the systematic literature review leading to a conceptual framework, and in the SCI field in the context of the IoT, the use of qualitative methods to propose a mapping. The managerial contributions are the most significant and are based on the creation of the conceptual framework and the mapping, which can assist companies in understanding the most relevant methods depending to their process, objectives, the role given to the downstream actor and the desired level of sustainability. These two outputs, from both an analysis of the literature and the field, can be used in combination to provide companies with an overview of downstream actor integration methods.

Chapter 9. *Limitations and future research*

This ninth chapter outlines the limitations in theoretical, methodological and managerial terms. As for future research, it is presented in a comprehensive way including future research that is of most personal interest to the researcher.

1. Limitations

This research has several limitations of a theoretical, methodological and managerial nature. These concern the limitations of the individual articles as well as the overall thesis.

1.1 Theoretical limitations

From a theoretical perspective in relation to the first article, which proposes a bibliometric literature review on the integration of downstream actors, the main limitation lies in the lack of multidisciplinary. Indeed, despite the fact that the article focuses on the SCM field, integration is also present in the fields of marketing and innovation (Griffin and Hauser, 1993; Liedtke et al., 2015; von Hippel et al., 2011), especially concerning downstream actors. Extending the research to these

fields could have made it possible to compare the differences that exist in terms of the integration of downstream actors according to field. Indeed, a bibliometric analysis including the same basic keywords but extending to the fields of innovation and marketing would have impacted the results. For example, the most cited authors or the most used keywords might not have been the same. With regard to keywords, in adding these two other fields, the terms consumers and users would probably have had a more predominant place given that many articles in these two fields deal more with the integration of consumers and users. For example, the article by Piller and Walcher (2006) entitled “Toolkits for idea competitions: a novel method to integrate users in new product development”, or the article by Hoyer et al. (2010) entitled “Consumer cocreation in new product development”, deal with the integration of these two actors. Moreover, from the point of view of co-citations, different clusters could have emerged, such as perhaps the new product development cluster, as this is a main reason for integration in the innovation field (Hoyer et al., 2010; Schemmann et al., 2016; Van Kleef et al., 2005).

The same applies to the second article, which proposes a systematic literature review. Indeed, when collecting the articles, we restricted the research to the SC field, whereas the majority of integration methods for downstream actors relate to marketing or innovation research (Edvardsson et al., 2012, 2010; K. Füller et al., 2014; Piller et al., 2010; Rese et al., 2015; Zogaj and Bretschneider, 2012). Adding these fields could firstly have had an impact on the quantitative analysis of the results and thus on the evolution of the literature and on the most cited articles. Secondly, it could also have added other categories such as the limitations of the methods or the barriers to integration (Hienerth et al., 2011; Lilien et al., 2002; Piller et al., 2011; Sawhney et al., 2005). Or, new elements may have been added to these categories, such as new methods or other objectives, such as a financial or satisfaction objective (Giese and Cote, 2000; Martovoy and Dos Santos, 2012; Orsingher et al., 2011).

Overall, the theoretical limitations of this thesis are inherent to the subject as there is no theoretical framework for the integration of downstream actors in SCM, although there is a theoretical framework for SCI more generally. Indeed, the field of SCI is widely developed in the SCM literature, as Asgari et al. (2017) state: “SCI is

widely considered by both practitioners and researchers on investigating collaborative relationships between a manufacturing firm and its supply chain partners” (p. 1). Nevertheless, it seems that in the field of SCI, most downstream actors are not mentioned. Indeed, the authors state that “Effective SCI links a manufacturer firm with upstream suppliers and downstream customers” (Asgari et al., 2017, p. 1). The notion of consumer and user is not present in these authors’ bibliometric analysis, although they do give an overview of research in the field of SCI. Downstream actors are not well represented in this subject of integration, and it is mainly the customer who is the subject of integration and not consumers and users. Hence, opening up to other fields could be a good opportunity to determine whether it is possible to apply the results found in marketing and innovation to the SCM sector.

1.2 Methodological limitations.

From a methodological standpoint, the main overall limitation of the research, and also that of Article 3, is the epistemological, interpretivist positioning. Within this epistemological approach, the authors fully accept their role as researchers and are aware that the way they observe a phenomenon has an impact on the analysis. The same applies for interactions with others, especially during the interviews for Article 3. The chosen approach can influence interactions with the interviewees, just as the interpretation can be biased by the author’s own opinions, culture and knowledge. Indeed, as Kaufmann and Denk (2011) explain, “Researchers have found that supply chain management (SCM) studies that employ inductive approaches lack a common structure and often fail to adequately describe their research process and methodology.” (Kaufmann and Denk, 2011, p. 64). To overcome this issue, the use of GT can improve the rigour of the research and the interpretation of results. For this reason, Article 3 focuses on the steps proposed by GT to limit this bias of subjectivity and lack of structure. In general, the structure of the methodology is crucial, as Seuring points out: “the research process is only described as a minor issue, if it is mentioned at all” (Seuring, 2008, p. 128). The author also proposes to follow “The five-stage research process model” (Seuring, 2008, p. 131) of GT to propose more structure and relevant analyses. These are the same 5 steps that were used in Article 3.

Moreover, from a methodological perspective, another important limitation is the fact that the interviews were conducted by videoconference and not in person. Indeed, the data collection period took place in the middle of the Covid-19 pandemic, and since the lockdown was required at that time, the interviews could not be conducted face-to-face. This limitation may have had an impact on the results; if we had been able to carry out the interviews in person, it would have been possible that additional elements would have been proposed by the interviewees in their answers. Nevertheless, some authors who worked on group interviews during the pandemic indicate that “participants feel more comfortable in an online group interview.” (Dodds and Hess, 2020, p. 208) and that “in comparison to face-to-face, there was noticeably more sensitive information shared, for example, issues around drinking behaviour and personal experiences with alcohol, when interviewed online” (Dodds and Hess, 2020, p. 208). This was confirmed by two of the interviews that occurred in the context of Article 3. Two of the interviewees pointed out that despite all that had been done from a sustainability point of view within the company, in terms of the sourcing of rare metals, the sustainability aspects were not necessarily taken into account when a component ran out, for example. These elements were discussed at the end of the interview when the interviewees felt confident. Perhaps if the interviews had taken place face to face in their workplace, this point would not have been raised. Nevertheless, the authors point out that one of the limitations of online interviews lies in “the inability for researcher’s to take field notes and the loss of valuable information about the context” (Dodds and Hess, 2020, p. 211). Indeed, in the framework of Article 3, visits to companies could have allowed new elements to emerge that only take place at employees’ workplaces. For example, the researchers could have had access to concrete elements of sustainability implementation on IoT production lines or to sustainability aspects implemented from a corporate point of view.

Furthermore, one of the limitations of Article 3 is also due to the analysis of the data. The interviews were conducted by a single researcher and the analysis of the results was also carried out by this same researcher. This may have had an impact on the interpretation of the results. Nevertheless, the use of software can limit these

biases. Indeed, Nvivo allows the data to be transcribed and then categorised in a structured way in nodes, significantly limiting subjectivity. Maher et al. (2018, p.10) state that Nvivo “encouraged the researcher to stay close to the actual interview transcript as it is quick and easy to retrieve and it also helped maintain a clear data trail”.

Likewise from a methodological perspective, one limitation of Article 1, the bibliometric article, is the quantitative approach to the articles. Indeed, the contents themselves are not studied, and even if a purging of the article base has been carried out, it may happen that some articles are not relevant. Based on Bradford’s law, which many bibliometric articles in the field of SC use (Arantes et al., 2016; El Baz and Iddik, 2021; Montecchi et al., 2021), it can be observed that about one third of the articles are in the ‘non-related area’ category.

Finally, concerning Article 2, one of the methodological limitations could be the sample size. Indeed, the analysis is based on 41 articles, which may seem a rather small sample size. Nevertheless, the analysis of the content provides certainty that the 41 articles are completely relevant to the theme of the study. If Article 2 had been a bibliometric study, a higher number of articles would have been found. However, since the content of the articles is analysed in a systematic analysis, only those articles that are relevant to the subject are retrieved. Thus, following Bradford’s law, there could have been a third more articles, but they might not have been pertinent to the subject under study.

In addition, Articles 1 and 2 rely on the Scopus database to collect articles. Though this database is the most representative for our field (Fahimnia et al., 2015; Perera et al., 2019), other databases, such as Web of Science, were left out. The addition of these databases could have been a real asset and could have allowed the recovery of a large number of items, as indicated by Gong et al. (2019), who state that the Web of Science “is a premier worldwide database of papers” (Gong et al., 2019, p. 3). Hence, some authors combine the use of both databases in order to have access to the most articles possible (Kazemi et al., 2019). Nevertheless, preliminary research had been conducted concerning this first article in order to know which

database contained the most articles (Table 16). The Scopus database offered a higher number of articles with a total of 1,576 articles, against 614 in Web of Science. As the analysis using Scopus allowed the evaluation of a large number of articles, Web of Science was excluded. Nevertheless, future research could do the same study on Web of Science to see if the results are similar or whether they differ, in which case comparing the two analyses may be an interesting avenue of research. Moreover, this comparison between the two databases also relates to the knowledge gap concerning the limited amount of research on integration of users and consumers, given that most research has been carried out on the customer. Indeed, when the query concerns the integration of the actor and the supply chain, 415 articles appear on Web of Science compared with 1,058 on Scopus in relation to customers, against 109 and 258 respectively in relation to consumers, and 44 and 159 in relation to users.

Table 16: Comparison of Web of Science and Scopus

Queries	Web of Science	Scopus
<i>“customer” AND “integration” AND “supply chain”</i>	415 articles	1,058 articles
<i>“consumer” AND “integration” AND “supply chain”</i>	109 articles	258 articles
<i>“user” AND “integration” AND “supply chain”</i>	44 articles	159 articles
<i>“customer integration” AND “supply chain”</i>	43 articles	98 articles
<i>“consumer integration” AND “supply chain”</i>	2 articles	2 articles
<i>“user integration” AND “supply chain”</i>	1 article	1 article

1.3 Managerial limitations

Regarding managerial limitations, there are several. Concerning Article 2, the proposed comprehensive framework has not been tested in companies, so its effectiveness is not tested. Similarly, the mapping of methods according to the degree of sustainability, as proposed in Article 3, is based only on the elements recovered during the interviews, i.e., the methods used by five B2B companies in the rare metals and IoT sectors. The results might not have been the same if the research had been extended to other companies in this sector, and it is questionable whether these

results can be generalized to all types of companies. Indeed, more than 100 requests to companies were made, and only nine interviews were conducted. The refusal rate was high despite several reminders, and some companies did not want to participate in this research. Moreover, as these companies are world leaders in this field, so it would have been interesting to see the impact that the addition of these companies would have had on the results. Similarly, with regard to the mapping and conceptual framework, future research on their implementation in companies would be beneficial to determine whether the methods are in line with the company's objectives, targeted process, role of the downstream actor or the level of sustainability.

The major managerial contribution of Article 1 relates to the observation of clusters, which indicate that the research is evolving towards information systems and sustainability. This is in line with what seems to be occurring in companies. Nevertheless, this contribution is limited, as it does not provide any concrete guidance for companies. It would be worthwhile extending the analysis of Article 1 to a field study focusing on B2B companies in the context of the IoT in order to cross the results found and the field analysis. A focus on information systems and sustainability clusters could compare what has been published in the literature and how the latter relates to what has been achieved in companies.

From the thesis point of view, two limitations of Article 2 can be raised. First, the article sample for the study is small as this systematic analysis is focused on SCM. Future research could broaden the study scope by including areas such as marketing and innovation. Secondly, the comprehensive framework could also be tested in the field by implementing the different methods according to companies' objectives. Finally, future research could investigate the constraints and barriers that companies may face when implementing methods to integrate their customers into their SC processes.

From the project research perspective, one of the limitations of this thesis is that the context of the IoT, nanotechnologies, and the use of rare metals is recent and that the increase in demand for these products and the impact on sustainability has thus far been little studied. Indeed, the latest Intergovernmental Panel on Climate Change

(IPCC) report from April 2022 stresses the importance of switching to renewable energies and promoting the use of electric vehicles, highlighting the falling price of Lithium ion batteries. However, it is mentioned that mineral dependency is a problem that needs to be monitored. Furthermore, the report also stresses the importance of robotics, which also makes use of the IoT, although this is contrasted with the fact that over-consumption should not be allowed to occur (“AR6 Climate Change 2022”, 2022). Nevertheless, these elements of the report show that governments will be relying heavily on the IoT in the coming years. Hence, it is crucial to quickly find ways of improving the IoT in order to minimise the impact on sustainability through the SSCM field.

Concerning the research questions, several limitations can be underlined. Firstly, the research questions focus on the field of SCM, and as has been illustrated, the integration of downstream actors is more represented in the field of innovation and marketing (Edvardsson et al., 2012, 2010; K. Füller et al., 2014; Piller et al., 2010; Rese et al., 2015; Zogaj and Bretschneider, 2012), so extending research to these areas would be one of the potential future avenues of research. Secondly, the third research question concerns B2B companies in the IoT sector and how they integrate downstream actors. However, the difficulty of integrating downstream actors was highlighted when companies operate in B2B (Reaidy et al., 2021). Conducting an analysis of what has been achieved in B2C could help to see if these practices can be applied to the B2B context.

With regard to observations, one of the main limitations is that the research focuses on downstream actors. Nevertheless, there is already a lot of research in SCM on the integration of upstream actors (Ji et al., 2020; Li et al., 2016; Petersen et al., 2005; Zhang et al., 2016). A comparative study of what has been carried out upstream and downstream could help to understand why the subject of the integration of downstream actors is less addressed in SCM.

Moreover, the observations were made during the COVID-19 period. The effects of this pandemic had not yet been felt by companies in the IoT sector, although it seemed clear that there would be an impact on the supply of raw materials

or semi-finished products. An analysis of the consequences of COVID-19 on IoT sector companies could allow us to observe whether these consequences have had an impact on the integration of downstream actors, and whether this integration is higher or lower and why that might be. Currently, the research on COVID-19, the IoT and nanotechnology is more about what the IoT can do to limit the impact of the pandemic (Singh et al., 2021; Tharayil et al., 2021; Vazquez-Munoz and Lopez-Ribot, 2020). It would be interesting to explore the issue the other way round, i.e., to study the impact of COVID-19 on the IoT sector.

Figure 49 shows the different theoretical, methodological and managerial limitations of the articles and of the thesis.

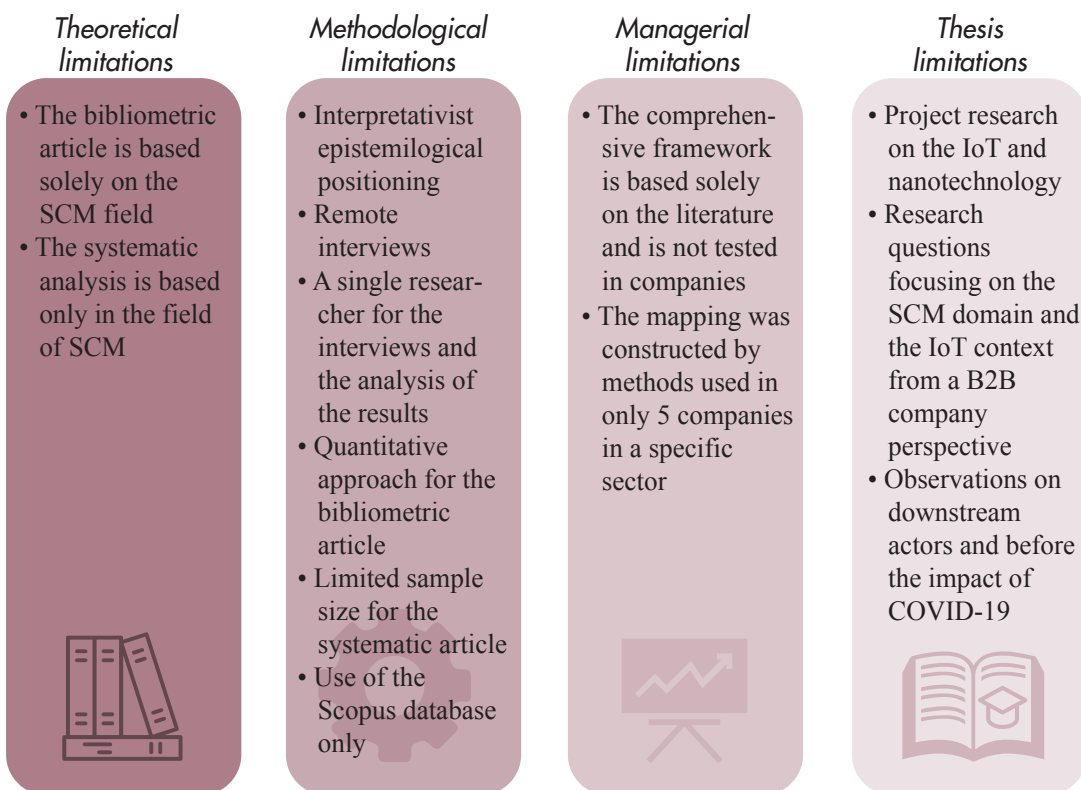


Figure 49: Limitations of the articles and the thesis

2. Future research

Future research could focus on continuing the research proposed by this thesis and the articles. Concerning the integration of downstream actors in the SC, the main limitation of the first article is its lack of multidisciplinary. One of the future research directions could be to produce a bibliometric article integrating other fields, such as marketing or innovation, to discover which areas deal most with the integration of downstream actors and what the specificities of each of these areas in relation to this topic are. It would also be appropriate to look at these areas not only through the prism of bibliometrics, but by studying the content of the literature, allowing the barriers and obstacles to integration to emerge. Moreover, the methodological limitations of bibliometric articles, which study articles in a quantitative way, could be counter-balanced with a content analysis. Indeed, content analysis could firstly allow researchers to identify which articles deal with the customer, consumer and user. It could also reveal the main trends in the direction of the articles, such as “consumer or customer orientation”, “consumer or customer role”, “consumer or customer focus” or “consumer or customer satisfaction”. Analysis of these elements would highlight the level of integration. A content analysis could also highlight the areas of SC activity in which this integration takes place, such as transport, operations management, manufacturing, reverse SC, logistics, quality, or SCM service. It would then be interesting to compare the different areas according to the downstream actors identified and the orientations of the articles. Furthermore, the role of these downstream actors could be studied in more depth; as some authors point out, the roles can be varied, for example: “Customers as Labor, Customers as Design Engineers, Customers as Production Managers, Customers as Products, Customers as Quality Assurance, Customers as Inventory, Customers as Competitors” (Sampson and Spring, 2012, pp. 32–35). Or as Maull et al. (2012, p. 75) state, the customer can have a role as “input, as coproducer, as user, as buyer, as product”. An in-depth role analysis would allow the bibliometric article to be enriched from a content point of view and it could also lead to a comparison of the different clusters according to the roles of the downstream actors.

Article 1 has also brought the fields of sustainability and information systems into focus. It would be interesting to see if the integration of downstream actors could be achieved through information systems with a view to sustainability. When searching the database of 678 articles for Article 1, several articles emerged that propose to use information systems to enable the integration of downstream actors with a view to sustainability, for example, using big data or the IoT (Farooq et al., 2016; Foerstl et al., 2015; Raut et al., 2019; Saengchai and Jermsittiparsert, 2019). It would be interesting to combine these elements on the use of information systems for sustainability with a quantitative analysis of the bibliometric article, such as the most cited authors, most prestigious articles, most present keywords, most co-cited articles, and clusters.

From a managerial point of view, this thesis proposes a comprehensive framework as well as a mapping, and it would be interesting to use these two tools in companies to establish whether the methods fit with the companies' objectives and processes. This field analysis could also help to highlight the different barriers and constraints to the implementation of downstream integration methods. Indeed, as per the aforementioned limitations of this research, the challenges of implementing integration methods have not been addressed in the conceptual framework or the mapping, yet several barriers to this integration may exist, either due to internal constraints within the company (sensitive sector of activity), or external constraints (proximity to downstream actors), as discussed by several respondents in Article 3. Thus, the analysis of articles dealing with integration methods and barriers to implementation that is proposed here could be used as a basis for any such future fieldwork.

The different barriers to the integration of downstream actors as identified in the literature are briefly discussed below. Table 17 lists the different barriers according to the methods and provides a citation for each barrier. The barriers are as follows: time limits and access to the participant (Sawhney et al., 2005), technical issues (Von Hippel, 1986), systems and basic condition and lack of innovativeness (Carrillo-Hermosilla et al., 2010), organizational and internal regulations (Zimmerling et al., 2017), language barriers (Piller et al., 2011), internal problems (employees) (Hienerth et al., 2011), and feasibility (Lilien et al., 2002). In future research, it would be pertinent to investigate the different barriers and study whether they are specific to the methods or rather to integration in general, and to examine how to overcome them.

Table 17: Barriers to integration according to methods

Barriers	Methods	Citations
Language barrier	User toolkit	<i>"Sometimes we have issues with the language barrier. Not everyone from our community speaks English as a first, second or third language. So we have to try and facilitate that as well. We have a lot of Turkish guys on the forums, Americans, French, Germans, Spanish guys, some of them are from Afghanistan, someone from Iraq and a couple of Chinese guys. So it really is multicultural"</i> (Piller et al., 2011, p. 165)
Internal problems (employees)	User interface	<i>"Such fears may exacerbate the 'not invented here' syndrome: Employees may resist innovative ideas from outside the company, and inputs from company-external sources may be unconsciously considered inferior to ideas generated in-house"</i> (Hienerth et al., 2011, p. 9)
Feasibility	Lead User	<i>"First, some interviewees expressed concern that ideas developed via the LU process might have low 'organizational fit' with the 3M technical, production, and market environment, and hence, be less likely to be judged worthy of funding by 3M management"</i> (Lilien et al., 2002, p. 1047).
Time limits and access to the participant	User interface	<i>"Traditional market research techniques like focus groups and surveys are limited in terms of the frequency with which firms can engage with customers, and the time taken to solicit customer input"</i> (Sawhney et al., 2005)
Technical issues	Lead User	<i>"Users selected to provide input data to consumer and industrial market analyses have an important limitation: Their insights into new product (and process and service) needs and potential solutions are constrained by their own real-world experience. Users steeped in the present are thus unlikely to generate novel product concepts which conflict with the familiar."</i> (Von Hippel, 1986, p. 791)
Organizational and internal regulations	Lead User Idea contest Co-creation group	<i>"Deeply established practices, procedures and operational norms might limit the cognitive capabilities of managers and potential funders to appreciate the potential of novel products and related business models"</i> (Zimmerling et al., 2017, p. 6)
Systems and basic conditions	Lead User	<i>"We consider that, particularly at the system level, the governance of eco-innovation has a crucial role to play, despite the fact that transitions towards radically different systems are complex societal co-evolutionary processes"</i> (Carrillo-Hermosilla et al., 2010, p. 1078)
Lack of innovativeness	Lead User	<i>"When considering the radical nature of user-driven innovations, the new products have a rather low to medium degree of innovativeness. This might be explained by the specific barriers to users in the context of radical innovations. Cognitive limitations may prevent them from delivering valuable inputs."</i> (Carrillo-Hermosilla et al., 2010, p. 1077)

These different barriers are summarized in Figure 50. It would be interesting to investigate this topic further by looking at the literature to determine whether these barriers are dependent on the sector of activity, the size of the company or the type of product sold. It would also be useful to observe whether these barriers apply to the context studied in this thesis, namely, that of the IoT. Companies in the IoT sector often operate in a B2B context, hence, actors (such as consumers and users) are often far downstream and therefore more difficult to integrate. Companies often know little of the end consumers or users of the products being manufactured.

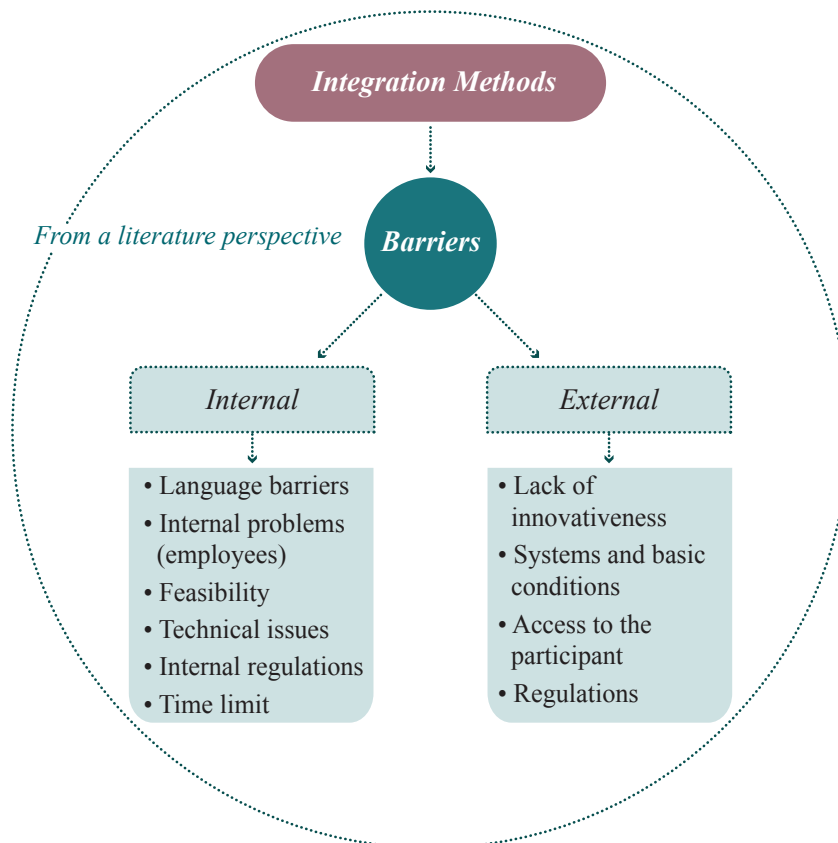


Figure 50: Barriers to integration methods retrieved from the literature

Regarding our interpretivist epistemological position, which, as discussed, can affect the interactions with interviewees as well as analysis of the results, one of the future avenues of research would be to complete this research with a more quantitative approach. For example, a survey could be designed to allow the elements retrieved to be quantified. This would make it possible to know the percentage of

integration methods used according to each actor, or to quantify which integration methods are more or less used and why. In addition, connections with the different barriers observed in the literature could be made by quantifying them. In addition, the different roles given to downstream actors as proposed in the literature could be quantitatively examined. The survey could be introduced to a larger number of companies within the sector and it would be possible to confirm or deny the suitability of the use of certain methods according to the degree of sustainability. This extension to a larger number of companies would provide an overview and validate the results observed in a qualitative way.

This thesis could also be connected to research on related and important issues, such as consumer behaviour in the IoT sector and consumer perceptions of the environmental impacts of the IoT. Similar qualitative research could also be proposed but with a focus on the B2C sector, as it is easier to integrate downstream actors there. Still on the subject of the IoT context, it would be interesting to look at the actions taken by companies in order to respond to environmental and social issues without focusing solely on the integration of downstream actors. Figure 51 summarizes the future research proposed by this thesis.

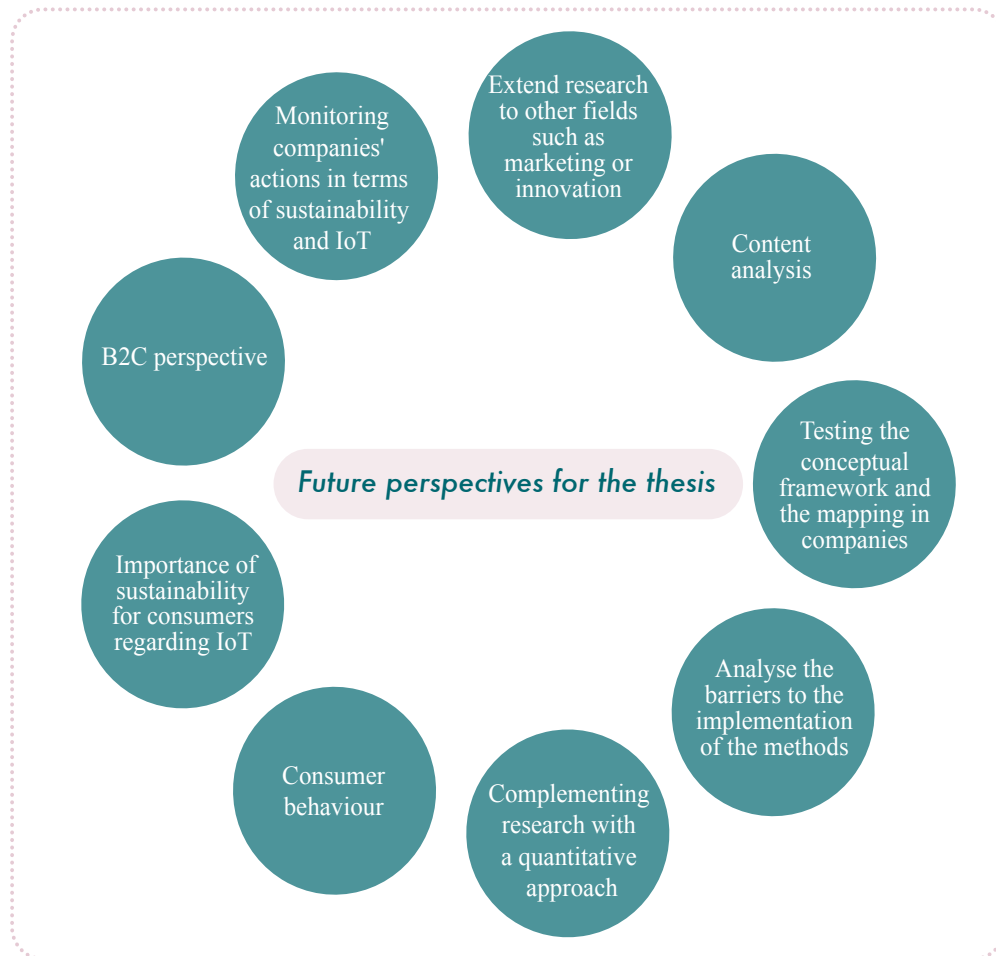


Figure 51: Future research stemming from this thesis

Summary Chapter 9

Chapter 9 discusses the limitations and future research pathways relating to this thesis. Theoretical limitations include the lack of integration of downstream actors and, more specifically, the consumer and user in the field of SCM. From a methodological point of view, the limitations are more extensive, firstly the quantitative approach for the bibliometric article limits the quality of the content of the articles. Moreover, the sample size for the second article is rather limited, with only 41 articles studied, even though this due to selecting articles according to their content which is directly related to the subject studied. Secondly, the interpretivist approach in this thesis may have an impact on the interpretation of the results. Furthermore, only one researcher collected the data and analysed it. The managerial limitations are that the comprehensive framework and the mapping have not been tested in companies. Finally, future research could include other theoretical fields, such as marketing or innovation. An analysis of barriers and difficulties with integration could be carried out either theoretically or empirically by testing the comprehensive framework and the mapping within companies. A more quantitative approach could be considered for the field study, firstly to avoid biases related to epistemological positioning and secondly to quantitatively measure integration. Conversely, a qualitative approach through participant observation could allow the subject to be further explored. Lastly, the research could focus more on the issue of sustainability and ethics, and how these elements are taken into account in B2C companies and by consumers.

Conclusion PART III

Figure 52 provides a visual conclusion to the third part of this thesis. It shows the problematic, which is: Supply chain integration in B2B companies: leveraging downstream actors to address sustainability challenges in the context of the IoT. It presents the theoretical framework from SCM and SCI, as well as the methodologies employed for each article, namely, a bibliometric analysis for Article 1, a systematic analysis for Article 2, and a qualitative analysis for Article 3. It also provides the empirical material: For Article 1, 678 articles were studied, for Article 2, 41 articles were studied, and for Article 3, 19 semi-structured interviews were conducted. Figure 52 also highlights the answers to the research questions proposed in Part 1. The first question is: What has been published in the SCM literature regarding the integration, connection and engagement of downstream actors? The second question is: Which methods can be used in order to integrate downstream actors into the SC? The third question is: What are the perceptions of downstream actor integration for more sustainability in the IoT sector? The contributions of this thesis are also introduced from the theoretical, methodological and managerial points of view. The same applies to the limitations. As for future research, an overview is given in relation to the thesis, as each of the Chapters 4, 5 and 6 already present possible future research in a more specific way.

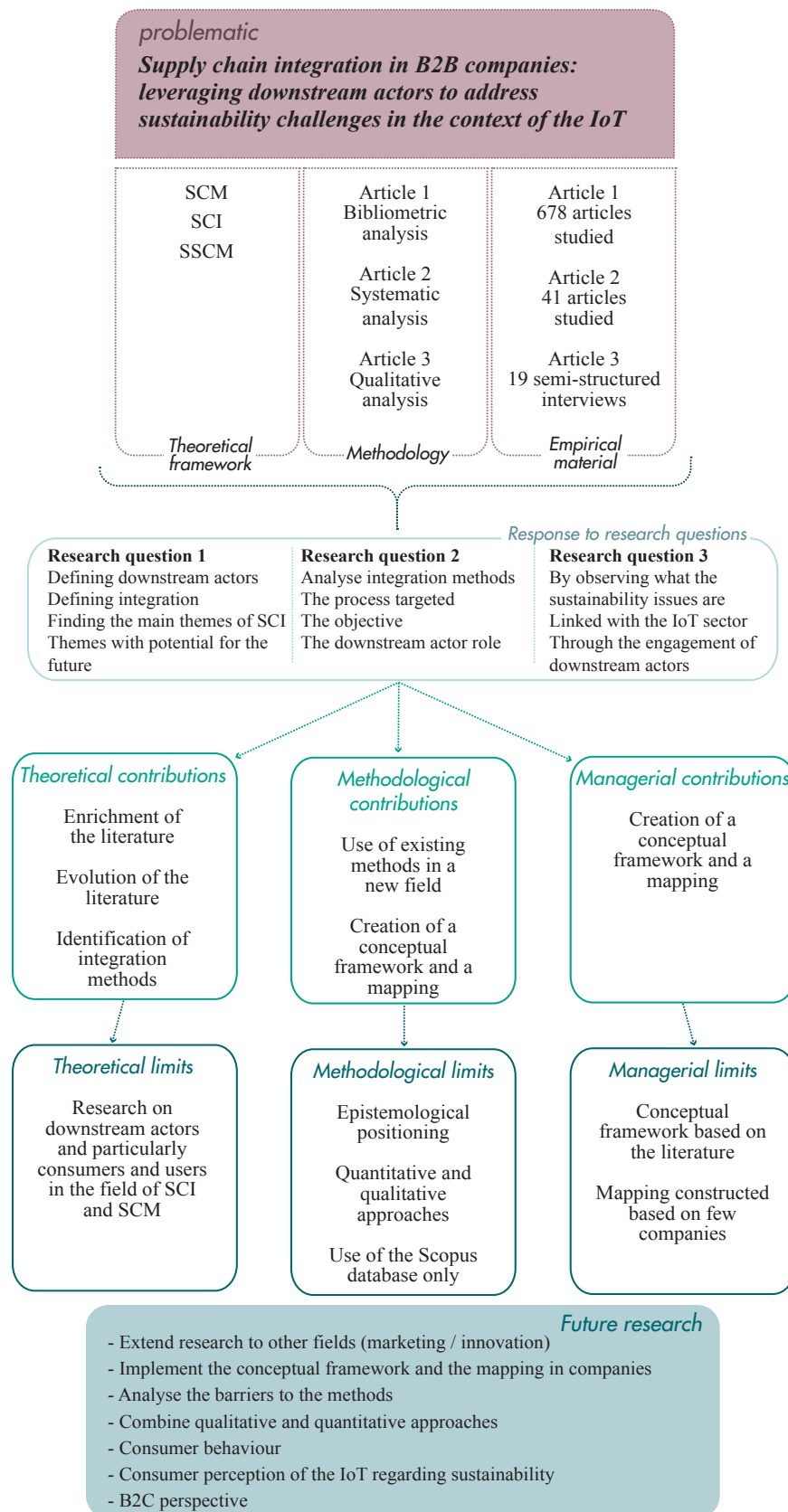


Figure 52: General conclusion of the third part of this thesis

RÉSUMÉ EN FRANÇAIS

RÉSUMÉ

Les problématiques liées au changement climatique sont désormais omniprésentes dans la vie quotidienne des personnes, des pays, des gouvernements et des entreprises. Un secteur assez récent, et largement visé pour ses impacts environnementaux et éthiques, est celui de l'Internet des objets (IoT). Ces appareils sont présents dans de nombreux foyers et échangent des informations entre eux. Il peut s'agir de téléphones, de voitures, de montres connectées, d'écouteurs connectés et bien d'autres. Les nanotechnologies, comprises dans les IoTs, jouent également un rôle dans le cadre de la transition écologique. Elles se retrouvent, à titre d'exemple, dans les voitures électriques, les panneaux solaires et les éoliennes. Pour fabriquer tous ces appareils, il est nécessaire d'utiliser de nombreuses matières premières, notamment des métaux rares, des métaux critiques, des terres rares et des minéraux de conflit. Tous ces métaux ont des impacts environnementaux et éthiques importants lors de leur extraction et tout au long de la fabrication de l'IoT. Aujourd'hui, les consommateurs comme les entreprises sont de plus en plus conscients de l'impact de ces activités et des efforts à fournir pour résoudre la problématique de durabilité de ces produits. Les clients, consommateurs et utilisateurs prennent de plus en plus part dans la chaîne d'approvisionnement des entreprises et deviennent des acteurs du changement en proposant des solutions plus durables tant pour les produits que pour les processus liés à leur cycle de vie. Cependant, il semble qu'il soit plus aisé d'intégrer ces consommateurs dans les entreprises B2C qui sont proches des consommateurs. Dans cette thèse, la problématique générale suivante «Intégration de la chaîne d'approvisionnement dans les entreprises B2B : Tirer parti des acteurs aval pour relever les défis de la durabilité dans le contexte de l'IoT» est soulevée. Pour répondre à cette problématique, une thèse basée sur des articles est proposée. Le premier article est une analyse bibliométrique qui tente d'observer l'évolution de la littérature concernant l'intégration des acteurs aval dans la chaîne d'approvisionnement, et permet de mettre en évidence la dimension de durabilité. Le deuxième article, présenté sous la forme d'une revue systématique de la littérature

et présentant un cadre global, cherche à savoir comment et par quelles méthodes il est possible d'intégrer ces acteurs aval par rapport aux objectifs et aux processus des entreprises. Enfin, le troisième article est une étude de cas sur les métaux rares qui vise à comprendre comment les entreprises du secteur de l'IoT, évoluant en B2B, peuvent intégrer leurs acteurs aval et par quelles méthodes.

Mots clés : Gestion de la chaîne d'approvisionnement durable, intégration de la chaîne d'approvisionnement, acteurs en aval, IoT.

1. Introduction

La crise du Covid-19 a mis en évidence les difficultés d'approvisionnement auxquelles sont confrontés certains pays. En effet, les différents approvisionnements en provenance de Chine ou de certains autres pays ont été perturbés. La France, en particulier, a eu des difficultés à s'approvisionner en produits essentiels au secteur de la santé (masques, gants, gel hydroalcoolique et blouses) (Geitzholz, 2021). Cette période a mis en évidence la dépendance des pays développés vis-à-vis d'autres pays ; la France étant par exemple dépendante de la Chine pour les substances actives et de l'Inde pour les médicaments finis. En effet, il y a trente ans, seulement 30 % des principes actifs dans le secteur de la santé étaient produits en dehors de l'Europe, contre 80 % aujourd'hui, ce qui souligne la forte dépendance de la France et de l'Union européenne vis-à-vis de la Chine et de l'Inde (Geitzholz, 2021). Les ruptures d'approvisionnement n'ont pas seulement affecté le marché des produits sanitaires, mais aussi les secteurs du bois, du textile, de l'automobile, des équipements de transport, de l'informatique et de l'électricité (Geitzholz, 2021). Le secteur automobile connaît une crise, notamment pour les semi-conducteurs, et certains constructeurs soulignent l'importance de relocaliser des usines en Europe. Renault, à titre d'exemple, entend désormais entretenir une relation très étroite avec le fournisseur français de puces STMicroelectronics, afin de sécuriser l'approvisionnement en semi-conducteurs, essentiels à la production de ses véhicules. Ces pénuries d'approvisionnement ne sont pas seulement un obstacle industriel, mais aussi un défi stratégique pour les gouvernements. C'est pourquoi la France a choisi d'injecter un prêt de 700 millions d'euros pour l'industrie en général afin de regagner de la souveraineté dans de multiples domaines comme la technologie (Normand, 2021). La France porte ainsi l'ambition de retrouver sa souveraineté technologique et, pour ce faire, elle lance le projet «Nano 2022» afin de préserver la maîtrise des technologies, nécessaire au secteur industriel, mais aussi à la Défense. La France dispose déjà de deux acteurs clés, STMicroelectronics et Soitec. Néanmoins, la France entend investir massivement dans ce secteur, main dans la main avec l'Europe (Lefigaro, 2021).

Dans cette thèse, le contexte de l'IoT est central. Mais, pour comprendre l'IoT il est essentiel de définir les nanotechnologies, dont la définition suivante est utilisée : « la compréhension, le contrôle et la restructuration de la matière de l'ordre du nanomètre (c'est-à-dire moins de 100 nm) pour créer des matériaux aux propriétés et fonctions fondamentalement nouvelles » (Sanchez and Sobolev, 2010, p. 2061). L'IoT et les nanotechnologies sont de plus en plus présentes dans la société. La taille de ces objets, d'ordre nanométrique, est inversement proportionnelle à leur puissance. Ils possèdent des propriétés particulières qui peuvent être notamment bénéfiques dans plusieurs secteurs comme la santé ou l'industrie automobile. Ils sont également présents dans le secteur des énergies renouvelables telles que l'énergie solaire, l'énergie hydrogène et l'énergie éolienne (Hussein, 2015). Les nanotechnologies sont également présentes dans les voitures thermiques et électriques, et principalement dans les batteries des voitures électriques ainsi que dans les batteries des objets du quotidien tels que les ordinateurs, les smartphones et autres objets électroniques. En effet, les nanotechnologies sont essentielles dans les composants électroniques que l'on peut trouver dans les smartphones (pour les écrans, les caméras, les batteries, les mémoires...), les ordinateurs, et autres objets connectés. Ces objets connectés sont également appelés IoT (Internet of Things). La croissance exponentielle de l'Internet des objets (IoT), faisant référence aux objets capables de communiquer entre eux, nécessite une augmentation de l'utilisation de métaux. Ces objets connectés sont de plus en plus présents dans les foyers. Il peut s'agir entre autres des réfrigérateurs connectés, des téléviseurs intelligents ou encore des montres connectées. Par exemple, une étude menée par Avast (Elder, 2019) indique qu'en Europe occidentale, 57 % des ménages possèdent au moins un appareil IoT. Dans l'ensemble, « le nombre d'appareils IoT aujourd'hui a officiellement dépassé la population mondiale, et ce nombre ne fera que croître », a déclaré Deepali Garg, Senior Data Scientist chez Avast.

Les nanotechnologies et l'IoT sont en partie composés de métaux rares, ce qui soulève des questions en termes de durabilité. Plus largement, les problématiques liées au changement climatique sont désormais au centre de la vie quotidienne des personnes, des pays, des gouvernements et des entreprises. L'objectif de réduction

des émissions de CO₂ est au cœur des discussions depuis de nombreuses années. De manière générale, la promotion des énergies renouvelables est essentielle. Dans le domaine des transports, la voiture électrique semble être une des opportunités pour limiter «le réchauffement climatique en réduisant les émissions de gaz à effet de serre (GES)» (Quinteros-Condoretty et al., 2021, p. 73 ; Zackrisson et al., 2010).

Le 22 septembre 2020 a eu lieu le Battery Day, au cours duquel Elon Musk a fait une grande annonce concernant son entreprise de voitures électriques, Tesla. Le milliardaire, souvent qualifié de visionnaire, qui a rendu la voiture électrique populaire, ne cesse de proposer des voitures plus performantes. À l'occasion du Battery Day, il a présenté les nouvelles innovations technologiques qu'il compte apporter à ses voitures électriques d'ici 2022. L'innovation majeure porte sur l'augmentation de l'autonomie du véhicule et sa puissance. Cependant, un point important qui a également été soulevé est celui de l'environnement. En effet, depuis cinq ans, les voitures électriques – et principalement les batteries – font objet de nombreuses controverses liées à l'environnement et à l'éthique. Certains organes de ces véhicules font appel aux nanotechnologies composées de métaux rares, de terres rares et de métaux critiques, comme le cobalt ou le lithium.

Le lithium, par exemple, est utilisé dans les batteries des voitures électriques, appelées batteries lithium-ion. Ces batteries au lithium sont utilisées dans les voitures électriques «en raison de leur densité énergétique élevée pour leur poids, de leur effet mémoire réduit, et du nombre important de cycles de charge/décharge supportés» (Mossali et al., 2020, p. 1). Mais l'utilisation de ce métal s'avère problématique considérant notamment que son extraction a un impact environnemental très défavorable et qu'une quantité très importante d'eau est nécessaire pendant le processus d'extraction (Mossali et al., 2020). Une autre question prédominante concernant le recyclage et la gestion de la fin de vie des piles au lithium. En effet, «moins de 3 % des piles au lithium sont recyclées dans le monde» (Han et al., 2019 ; Mossali et al., 2020, p. 4 ; Quinteros-Condoretty et al., 2021 ; Zackrisson et al., 2010). De plus, ce métal est exploité dans des zones géographiques très restreintes : «le lithium est principalement extrait de deux types de sources : 32 % à partir de

roches dures (par exemple, en Australie et en Chine) et 46 % à partir de saumures (par exemple, en Argentine, en Bolivie et au Chili)» (Mayyas et al., 2019; Olivetti et al., 2017; Quinteros-Condoretty et al., 2021, p. 74).

La demande croissante de ce métal, due à la croissance exponentielle des véhicules électriques, est également un réel problème : «la demande mondiale de batteries devrait doubler entre 2024 et 2025, tandis que la croissance de la production de lithium est de 3 à 5 % par an» (Quinteros-Condoretty et al., 2021, p. 74) et «la demande de batteries lithium-ion, notamment pour les véhicules électriques, devrait augmenter de plus de 300 % au cours de la prochaine décennie» (Fu et al., 2020, p. 2). Par conséquent, des problèmes majeurs d'approvisionnement pourront survenir, tels qu'une pénurie ou «des perturbations dans l'approvisionnement en matériaux qui pourront entraîner des écarts d'approvisionnement à court terme, et qui ont le potentiel de créer une volatilité significative des prix et une incertitude des prix des produits de base» (Olivetti et al., 2017, p. 233). Ainsi, le lithium est en train de devenir une «ressource énergétique stratégique, car il s'agit d'une matière première critique en raison de son risque d'approvisionnement élevé et de son importance économique en Europe» (Quinteros-Condoretty et al., 2021, p. 73). Ainsi, du point de vue de la chaîne d'approvisionnement, le lithium pose plusieurs problèmes : une demande croissante, des questions environnementales liées à son extraction et à l'exploitation minière, la distribution géographique, l'impact de l'évolution possible du prix du lithium et la gestion du recyclage et de la fin de vie du métal (Egbue and Long, 2012).

Il en va de même pour le cobalt, qui est utilisé pour améliorer la stabilité de la borne positive des batteries lithium-ion. Le cobalt peut être inclus dans les minéraux de conflit, qui sont généralement l'étain, le tantale, le tungstène et l'or, appelés les 3TG (Fraser et al., 2020). Ces minéraux de conflit sont appelés ainsi, car ils proviennent majoritairement de territoires en tension ou militairement instables. Le cobalt est l'un des minéraux sur lesquels il est important de se pencher en termes de durabilité, de conditions de travail, de traçabilité et de risque d'approvisionnement (Fraser et al., 2020). Comme le lithium, le cobalt est présent dans les batteries lithium-ion, et la

demande connaît une croissance exponentielle : « On estime que la demande de Co se situe entre 235 000 tonnes et 430 000 tonnes en 2030. Cette borne supérieure de la demande de Co en 2030 correspond à 280 % de la capacité mondiale de raffinage en 2016. » (Fu et al., 2020, p. 2).

Le sujet de la répartition géographique est également très présent pour le cobalt, qui est fortement concentré en République démocratique du Congo (RDC), représentant environ 60 % de la production mondiale, tant pour l'extraction que pour le raffinage (Fu et al., 2020 ; Jaffe, 2017). Outre le fait que cette forte concentration peut créer des tensions géopolitiques, un problème lié à l'éthique et aux conditions de travail émerge en ce qui concerne le cobalt en RDC (Fraser et al., 2020) « L'exploitation minière au Congo peut être problématique d'un point de vue social [...] en raison des violations des droits de l'homme et de la négligence environnementale dans la région du Katanga, en République démocratique du Congo » (Van den Brink et al., 2020, p. 2). Des milliers d'enfants travaillent dans une minorité de mines illégales en RDC et plusieurs dizaines de mineurs meurent chaque année dans les mines suite à des incidents (Van den Brink et al., 2020). L'absence de réglementation plus stricte a donc un impact à la fois sur l'environnement et sur l'aspect social. « Cette pratique non réglementée, souvent non enregistrée, a entraîné des préoccupations environnementales, sociales et sanitaires, notamment autour de la contamination des terres, de la pollution de l'eau, du travail des enfants et des troubles sociaux. » (Fu et al., 2020, p. 4).

En général, le lithium et le cobalt sont deux métaux dont la concentration dans la croûte terrestre est limitée et donc finie. Comme l'indique Mossali et al. (2020) « ces sources ne sont pas inépuisables, et il a été prévu qu'en 2023-2025, la demande de Li sera supérieure à l'offre minière, à moins que les LIB [Lithium-ion battery] ne soient recyclées avec une efficacité de 90 % » (Mossali et al., 2020, p. 3). Ces deux métaux ont en commun une demande en croissance exponentielle, due principalement à la démocratisation des véhicules électriques, et donc à l'utilisation de batteries au lithium également présente dans de nombreux IoT, une disponibilité restreinte, une réglementation limitée, des problèmes environnementaux et éthiques

en termes d'extraction et d'exploitation minière, une forte concentration dans des zones géographiques précises, un risque d'approvisionnement élevé, ainsi qu'une volatilité des prix, et, bien sûr, un problème majeur en termes de recyclage et de gestion de la fin de vie (Egbue and Long, 2012; Fraser et al., 2020; Fu et al., 2020; Han et al., 2019; Jaffe, 2017; Mayyas et al., 2019; Mossali et al., 2020; Olivetti et al., 2017; Quinteros-Condoretty et al., 2021; Van den Brink et al., 2020; Zackrisson et al., 2010).

Conscient des difficultés induites par ces métaux, le 22 septembre 2020, lors du Battery Day, Elon Musk a pris le temps de souligner qu'il souhaitait remplacer progressivement le cobalt par du nickel, dont l'extraction est moins controversée et le recyclage beaucoup plus simple. L'entrepreneur a également indiqué que le lithium sera remplacé par du silicium, permettant à l'entreprise de se passer de ce métal rare dans un premier temps, mais surtout de réduire ses coûts.

La décision d'Elon Musk de réduire les besoins de Tesla en métaux rares permettra non seulement de sécuriser la chaîne d'approvisionnement de la marque, mais aussi de répondre aux attentes des consommateurs pour une voiture plus écologique et moins chère. De manière générale, et pas seulement pour Tesla, la résilience et la durabilité des chaînes d'approvisionnement sont devenues des défis majeurs à gérer pour les entreprises. C'est dans ce contexte de l'IoT, des nanotechnologies et des métaux rares que prend place cette thèse qui fait partie du CDP Need for IoT.

Cette thèse s'inscrit dans le cadre du projet Need, qui englobe également d'autres questions, non présentées dans cette thèse. Mais il est essentiel de détailler la vision et les objectifs du projet, car ils font partie du raisonnement et du fil conducteur de cette thèse et les résultats présentés à la fin de ce travail, peuvent s'inscrire dans plusieurs démarches initiées par le projet Need.

Le projet Need se concentre sur le thème de l'IoT durable. Son objectif principal porte sur le développement de méthodologies appliquées à la recherche, en tenant compte des enjeux géopolitiques, de l'analyse économique, de la durabilité des

nouvelles technologies proposées et de leur acceptation. En abordant les composants, les processus techniques et technologiques, les méthodologies et l'innovation, le projet Need vise également à proposer une conception globale des produits IoT, afin d'éviter les risques liés à l'approvisionnement de certains matériaux clés (tels que les métaux rares), les variations excessives de prix et les changements de réglementation.

Le projet Need vise également à relever les défis de conception, en se concentrant sur la possibilité de substituer ou de remplacer certains matériaux essentiels aux applications IoT. Concernant les fonctions de ces applications, il est prévu d'utiliser des approches physiques alternatives pour réaliser les mêmes fonctions, mais de manière durable.

Du point de vue de la chaîne d'approvisionnement, les défis sont importants en termes de choix d'approvisionnement, car ces décisions sont prises à la lumière de nombreux facteurs qui sont parfois changeants ou évolutifs. Les risques sont nombreux, comme la disponibilité des matériaux qui peut impliquer des ruptures de stock ou d'approvisionnement, ou encore l'évolution du prix des matières premières, les risques géopolitiques, voire l'acceptabilité éthique. La croissance exponentielle de la demande de ces matériaux pour la production d'IoT ne fait que renforcer ces risques, notamment celui de la rareté de certaines matières premières. Les usages de l'IoT, et principalement les besoins et les modes d'utilisation des consommateurs, sont des questions tout aussi importantes à prendre en compte que les décisions d'approvisionnement (telles que le choix des fournisseurs, la localisation des fournisseurs, ou le choix des substituts possibles), afin de proposer des chaînes d'approvisionnement plus durables. À cette fin, le projet Need développe une vision globale de l'écosystème des IoT, pour permettre d'aligner les pratiques et les processus de R&D sur la réalité du marché. Le projet a pour objectif d'aborder une vision durable de la chaîne d'approvisionnement de l'IoT et des nanotechnologies à travers le prisme des pratiques durables d'intégration des consommateurs dans les entreprises. Il s'agira ensuite de développer des méthodes et des outils pour répondre aux besoins de visibilité accrue de la chaîne d'approvisionnement.

Dans ce contexte, où la digitalisation et l'informatique sont de plus en plus présentes, impliquant une demande croissante et exponentielle en IoT, mais aussi en métaux rares, les usages que les consommateurs ont de l'IoT sont à questionner. En effet, dans un environnement où les fabricants de ces IoT sont extrêmement éloignés des consommateurs finaux (du fait de leur positionnement sur le marché B2B), leur objectif premier est toujours d'améliorer la technologie des IoT, en les rendant toujours plus performants. Cette thèse évolue dans ce contexte et dans cette perspective d'intégrer les acteurs aval, à savoir les clients, les consommateurs et les utilisateurs, dans les chaînes d'approvisionnement afin de proposer des produits et des processus plus durables.

2. Question de recherche

Au regard du contexte et du sujet, il apparaît que la littérature est bien développée s'agissant du thème de l'intégration des acteurs aval, mais peu en B2B, constituant ainsi l'un des manquements identifiés, ainsi qu'une confusion sur les différents acteurs aval définis dans la littérature. Par ailleurs, plusieurs méthodes d'intégration sont discutées et détaillées dans la littérature, mais peu d'articles les répertorient et détaillent leur utilisation en fonction des objectifs et processus des entreprises, ce qui constitue une autre carence. En outre, concernant le sujet des métaux rares, de l'IoT et des nanotechnologies, la littérature semble se limiter aux considérations techniques, excluant ainsi les questions de durabilité et de management des chaînes d'approvisionnement ; ce qui constitue une insuffisance supplémentaire. Et enfin, il convient de souligner que le consommateur est l'un des premiers acteurs concernés par les produits finis IoT, et que son intégration par les entreprises manufacturières en amont n'est que très peu abordée dans la littérature, constituant le dernier manquement. La problématique principale est donc : **l'intégration de la chaîne d'approvisionnement dans l'entreprise B2B : Tirer parti des acteurs aval pour relever les défis de la durabilité dans le contexte de l'IoT.**

Ces différentes lacunes et la problématique générale ont conduit à l'émergence d'un énoncé de question globale qui est : **Comment les entreprises B2B du secteur de l'IoT peuvent-elles intégrer, leurs acteurs aval (clients/consommateurs/**

utilisateurs) dans leur chaîne d'approvisionnement pour relever les défis de la durabilité ?

Pour soutenir cette problématique et cette question de recherche globale, plusieurs sous-questions de recherche sont présentées.

Question 1 : Quels sont les sujets abordés dans la littérature concernant la gestion de la chaîne d'approvisionnement, relatifs à l'intégration, la connexion et l'engagement des acteurs aval ?

- Question 1a) Quelles différences y a-t-il entre les acteurs aval : clients, consommateurs et utilisateurs ?
- Question 1b) Quelles sont les différences entre l'intégration, la connexion et l'engagement des acteurs aval ?
- Question 1c) Quels sont les principaux thèmes étudiés concernant l'intégration des acteurs aval ?
- Question 1d) Quels sont les sujets liés à ce thème qui deviendront plus importants à l'avenir ?

Le thème de l'intégration des acteurs aval est étudié en premier lieu : il s'agit d'un sujet abordé dans la littérature de la gestion de la chaîne d'approvisionnement, principalement en ce qui concerne le client. L'intégration des acteurs aval est un sujet largement discuté qui a pris beaucoup d'importance dans la littérature, et les auteurs soulignent l'importance d'intégrer ces acteurs dans les chaînes d'approvisionnement des entreprises (Christopher, 2016; Djelassi and Decoopman, 2013; Frohlich and Westbrook, 2001; Jeanpert and Paché, 2016; Maull et al., 2012; Ramaswamy and Gouillart, 2010; Reaidy et al., 2021; Reyes and Bhutta, 2005; Wright et al., 2006; Yee et al., 2010). Cependant, il semblerait que les différents acteurs aval ne sont pas clairement définis dans la littérature (Marty, 2021 ; Yadin, 2002), et peuvent donc prêter à confusion en termes d'intégration et de rôle. Pour répondre à cette difficulté, la présente thèse propose des définitions pour clarifier les termes faisant référence aux acteurs aval, à savoir les clients, les consommateurs et les utilisateurs. De plus, la littérature relative à l'intégration de ces acteurs, dans le domaine de la chaîne d'approvisionnement, ne détaille pas nécessairement comment y parvenir, et traite principalement des questions de performance de la chaîne d'approvisionnement

(Droge et al., 2004; Flynn et al., 2010; Frohlich and Westbrook, 2001; Narasimhan and Kim, 2002). Ainsi, en observant la littérature dans les domaines du marketing et de l'innovation, des moyens de mettre en œuvre cette intégration ont été trouvés. (Hoyer et al., 2010; Leminen et al., 2015; Lusch and Vargo, 2011; Zimmerling et al., 2017). Néanmoins, ces articles utilisent peu le terme d'intégration et évoquent surtout les notions de connexion ou d'engagement. Ces concepts sont donc expliqués et comparés en se basant sur la littérature. Enfin, pour répondre aux deux dernières questions de recherche, concernant les principaux thèmes étudiés dans le domaine de la gestion de la chaîne d'approvisionnement sur l'intégration des acteurs aval, et sur les thèmes qui vont logiquement prédominer dans les années à venir, cette thèse propose un article bibliométrique. Il vise, grâce à l'analyse des co-citations et des clusters, à faire émerger des thèmes principaux, à savoir les thèmes des systèmes d'information et principalement de la durabilité (Fahimnia et al., 2015, 2015; González-Benito et al., 2013; Kazemi et al., 2019; Xu et al., 2018)

Question 2 : Quelles méthodes peuvent être utilisées afin d'intégrer les acteurs aval dans la chaîne d'approvisionnement ?

- Question 2 a) Quelles méthodes peuvent être utilisées pour l'intégration ?
- Question 2 b) Quels processus de la chaîne d'approvisionnement peuvent être ciblés par cette intégration ?
- Question 2 c) Pour quels objectifs ces méthodes sont-elles utilisées ?
- Question 2 d) Quels sont les différents rôles des acteurs aval dans cette intégration ?

Après avoir répondu aux premières questions sur le thème de l'intégration des acteurs aval, il a semblé opportun d'analyser les moyens mobilisables pour parvenir à cette intégration. Ainsi, les méthodes sont répertoriées et étudiées dans le domaine de la chaîne d'approvisionnement.

« Traditionnellement, les consommateurs ont été considérés comme des destinataires passifs dans la chaîne d'approvisionnement » (Ta et al., 2015, p. 133), mais, de nombreux auteurs encouragent l'intégration des acteurs aval dans les chaînes d'approvisionnement des entreprises (Christopher, 2016; Djelassi and

Decoopman, 2013; Frohlich and Westbrook, 2001; Jeanpert and Paché, 2016; Maull et al., 2012; Ramaswamy and Gouillart, 2010; Reaidy et al., 2021; Reyes and Bhutta, 2005; Wright et al., 2006; Yee et al., 2010). Certains auteurs soulignent l'importance de cette intégration en termes d'objectifs, par exemple pour améliorer la durabilité, réduire les risques, améliorer les performances, etc (Flynn et al., 2010; Frohlich and Westbrook, 2001; Vachon and Klassen, 2006; Zimmerling et al., 2017). Plusieurs méthodes existent pour intégrer les acteurs aval, et beaucoup ont été proposées dans la littérature, comme la méthode de la voix du client (Voice of Customer) ou encore les méthodes basées sur l'utilisation d'Internet et des nouvelles technologies telles que le crowdsourcing, le concours d'idées, les méthodes du living lab, la conception participative et la méthode de l'utilisateur principal (lead user) (Birgitta Bergvall-Kåreborn et al., 2009; Carbone et al., 2017; Franke et al., 2006; Gonzalez et al., 2008; Howe, 2006; Lee and Lin, 2006; Reynolds and Gutman, 1988; Soroor et al., 2012; Von Hippel, 2001, 1986). Comme indiqué précédemment, certains acteurs aval ont longtemps été perçus comme passifs dans la chaîne, mais grâce aux méthodes d'intégration, ces acteurs peuvent avoir un rôle et une action à jouer dans la chaîne d'approvisionnement, de façon plus ou moins active (Ta et al., 2015).

Pour répondre à ces questions, une revue systématique de la littérature est menée et un cadre complet est développé pour mettre en évidence les méthodes les plus pertinentes pour intégrer les clients dans la chaîne d'approvisionnement des entreprises en fonction des objectifs, des processus ciblés et du rôle à donner au client.

Question 3 : Dans quelle mesure les perceptions des acteurs aval conduisent-elles à une plus grande durabilité lorsque ces acteurs sont intégrés dans la chaîne d'approvisionnement de l'IoT?

- Question 3 a) Quels sont les enjeux de la durabilité dans le secteur de l'IoT?
- Question 3 b) Quels sont les enjeux de la durabilité dans le contexte de l'IoT?
- Question 3 c) Comment ce sujet est-il perçu par les entreprises de ce secteur, et principalement son lien avec la durabilité et l'intégration des acteurs aval?
- Question 3 d) Comment ce sujet est-il perçu par les consommateurs, et principalement son lien avec la durabilité et l'intégration des acteurs aval?

Enfin, après avoir étudié l'intégration des acteurs aval, et les différentes méthodes pour les intégrer à la chaîne d'approvisionnement, ces analyses sont transposées au contexte de l'IoT et leurs composants, les métaux rares. L'objectif est d'appliquer les recherches précédentes à ce contexte récent, en pleine évolution, et d'observer les enjeux de durabilité.

Les métaux rares sont largement utilisés dans les produits IoT et nanotechnologiques. Les dispositifs IoT ont un fort impact sur l'environnement, mais aussi sur les conditions de travail qui sont actuellement observées, aussi bien dans l'exploitation des composants primaires (métaux rares), que dans les processus de fabrication de l'IoT (Maniglier, 2020; Massari and Ruberti, 2013; Mutumi and Simatele, 2017; Pitron, 2018).

Pour répondre à la question de la durabilité dans la chaîne d'approvisionnement, il convient d'abord d'étudier l'évolution de la gestion durable de la chaîne d'approvisionnement, ainsi que les problèmes qui en découlent. Les liens entre les enjeux de la gestion durable de la chaîne d'approvisionnement et les contraintes de l'IoT sur la durabilité sont explicités. Le troisième article de cette thèse interroge ainsi la perception des entreprises de ce secteur et des consommateurs. Les discussions avec ces acteurs se font à travers une étude qualitative pour mettre en évidence les axes les plus prégnants et proposer une cartographie d'intégration des consommateurs dans la chaîne d'approvisionnement, selon le niveau de durabilité souhaité par l'entreprise.

ÉTUDE 1

L'intégration des acteurs dans la gestion de la chaîne d'approvisionnement est un sujet qui tend à gagner en importance. Tous les acteurs, y compris les fournisseurs, les fabricants, les clients, les consommateurs et les utilisateurs ont un rôle à jouer dans la performance de l'entreprise. Les clients, les consommateurs et les utilisateurs sont devenus des acteurs majeurs de la chaîne d'approvisionnement. Leur intégration active dans la chaîne d'approvisionnement devient un nouveau défi pour les entreprises. Cet article, intitulé « Intégration du consommateur/utilisateur/client dans la gestion de la chaîne d'approvisionnement : revue et analyse bibliométrique » vise d'une part à dresser un état des lieux de la littérature s'agissant de l'intégration des clients, consommateurs et utilisateurs dans la chaîne d'approvisionnement, et d'autre part à proposer des pistes pour des recherches futures. Une analyse bibliométrique est menée pour étudier l'intégration des acteurs aval. L'analyse fournit des détails sur les articles les plus cités, les auteurs publiés et les revues influentes en utilisant Bibexcel, puis le logiciel Gephi pour la réalisation d'un réseau. Cet article propose en premier lieu une analyse quantitative de la littérature en mettant en évidence les auteurs, articles et revues, les plus prestigieux, sur l'intégration des acteurs aval dans la chaîne d'approvisionnement. Par la suite, une analyse de réseau révèle cinq clusters et identifie les enjeux. Enfin, l'article suggère comment intégrer ces acteurs en fonction de différentes finalités. Cette analyse bibliométrique propose ainsi d'explorer ce sujet en profondeur, en identifiant les thèmes de recherche clé tels que la durabilité et les systèmes d'information, les interrelations et l'évolution des publications dans le temps.

Cet article, publié dans le journal *Supply Chain Forum : An International Journal*, présente une revue de la littérature et une analyse bibliométrique de l'intégration des acteurs aval dans le domaine de la chaîne d'approvisionnement. Plusieurs centaines d'articles ont été publiés sur ce sujet, avec une croissance des publications depuis les années 1990 (678 articles sur le sujet entre 1996 et 2020 ont été collectés). L'objectif de cette recherche préliminaire est donc de présenter les articles les plus influents et les plus significatifs et d'enrichir la littérature sur la chaîne d'approvisionnement tout en montrant son évolution dans le temps. Cette recherche

a montré qu'une forte concentration des articles les plus influents sont écrits par une minorité d'auteurs. De plus, les auteurs les plus productifs sont aussi les auteurs les plus cités, et proviennent également des universités les plus représentées.

En ce qui concerne l'analyse des co-citations d'auteurs, il apparaît que les articles de ce domaine sont fortement liés (les grappes sont proches et partagent de nombreuses citations et co-citations) et que les articles les plus influents sont souvent cités et co-cités entre eux. Cette étude met en évidence l'existence de cinq clusters de référence fondamentaux. Ces clusters structurent les domaines de recherche sur les études théoriques, conceptuelles et empiriques pour montrer l'importance de l'intégration de la chaîne d'approvisionnement pour améliorer la performance. Ils contribuent également à mettre en évidence l'évolution du domaine de recherche, en soulignant l'émergence de nouveaux sujets d'étude dans l'intégration de la chaîne d'approvisionnement. À cet égard, le un cluster ouvre la voie à la durabilité, qui est récemment devenue un sujet clé, notamment dans le domaine de la chaîne d'approvisionnement.

Cet article enrichit la littérature existante sur le sujet de l'intégration des acteurs aval dans la gestion de la chaîne d'approvisionnement, en réalisant une analyse bibliométrique avec une approche quantitative, tandis que d'autres auteurs ont analysé le sujet à travers une recherche qualitative et empirique (Reaidy et al., 2021). De plus, cette analyse bibliométrique montre que plus les acteurs de la chaîne d'approvisionnement sont en aval, moins il existe de recherches et plus il est complexe de les intégrer. En effet, le terme «client» apparaît en 21^{ème} position des mots les plus utilisés dans les titres. À l'inverse, les termes «consommateur» et «utilisateur», qui sont beaucoup plus en aval de la chaîne, apparaissent seulement en 100^{ème} et 827^{ème} position. Ce point a également été mentionné par Reaidy et al. (2021) et il est confirmé par cette recherche.

En ce qui concerne le thème de la durabilité dans l'intégration de la chaîne d'approvisionnement, l'analyse bibliométrique confirme que le sujet a gagné en importance. D'autres enjeux tels que la «performance», la «compétition» et l'«optimisation» apparaissent dans le top 20 des mots les plus fréquemment

utilisés dans les titres des publications. Le terme «durabilité» n'apparaît qu'en 61ème position. Toutefois, ce constat s'explique probablement du fait que la durabilité est un sujet émergent qui n'était jusqu'alors pas directement lié à la gestion de la chaîne d'approvisionnement, mais qui tend à se déplacer vers le centre des recherches. Cet article fournit donc une contribution sur l'émergence et l'importance de l'enjeu de la durabilité dans la gestion de la chaîne d'approvisionnement.

Les limites de cet article concernent principalement le manque de multidisciplinarité. En effet, cette recherche ne concerne que le domaine de la gestion de la chaîne d'approvisionnement, alors que l'intégration des acteurs aval tels que les clients, les consommateurs et les utilisateurs concerne également les domaines du marketing, de l'innovation et des services, entre autres (Griffin and Hauser, 1993; Liedtke et al., 2015; von Hippel et al., 2011). La recherche pourrait ainsi être étendue à ces domaines. En élargissant les termes de la recherche, de nombreuses autres contributions seraient identifiées, contribuant à modifier les résultats et mettre en évidence différents domaines de recherche fondamentaux. Il serait également opportun de mener une étude complémentaire concernant les outils et méthodes existants pour intégrer ces acteurs. En outre, une étude sur le contenu des articles pourrait être utile pour identifier les lacunes dans les connaissances sur ce sujet et proposer des pistes d'améliorations possibles. Enfin, cette recherche pourrait être étendue en incluant d'autres bases de données ou en se concentrant sur un journal spécifique.

ÉTUDE 2

Les clients cherchent de plus en plus à s'impliquer activement dans la manière dont les produits sont conçus, fabriqués et distribués. En outre, ils se préoccupent des questions éthiques et environnementales dans une mesure beaucoup plus grande qu'auparavant. Par conséquent, il est impératif que les entreprises déploient des moyens d'intégrer efficacement leurs clients dans les processus de gestion de la chaîne d'approvisionnement. L'objectif de cet article est d'explorer les options qui existent pour les organisations afin de connecter de manière proactive leurs clients à leurs chaînes d'approvisionnement. Dans cet article intitulé «Connecter le client à la chaîne d'approvisionnement : proposition d'un cadre global», les chercheurs proposent une revue systématique de la littérature sur les méthodes utilisées pour intégrer le client dans les processus de gestion de la chaîne d'approvisionnement en fonction des objectifs de l'entreprise. Une analyse descriptive est réalisée, puis des catégories et des dimensions sont identifiées dans les articles sélectionnés afin de proposer un cadre global. Ce cadre global met en évidence les méthodes les plus appropriées pour les entreprises, afin de leur permettre d'intégrer au mieux leurs clients au sein de leurs chaînes d'approvisionnement.

Cette revue systématique de la littérature présente un moyen pour les entreprises de connecter davantage leurs clients à leur chaîne d'approvisionnement. Il semblerait qu'il n'y a pas eu jusqu'à présent de revue systématique de la littérature sur ce sujet. Pour autant, l'intégration des clients et des acteurs aval revêt une importance croissante pour les entreprises. L'étude s'est basée sur un panel de 41 articles, publiés entre 1998 et 2020.

L'analyse descriptive des 41 articles permet d'avoir une vue d'ensemble des recherches menées à ce jour sur le thème des méthodes d'intégration des clients dans la gestion de la chaîne d'approvisionnement, de manière quantitative et en minimisant les biais. Il s'agit d'un sujet émergent, peu traité dans le domaine de la gestion de la chaîne d'approvisionnement, mais qui a déjà été abordé dans les domaines de l'innovation, du marketing et du marketing industriel (Lacoste, 2016 ;

Wagner, 2009). Cette analyse, et notamment l'analyse des mots clés, met en évidence le thème de la durabilité, qui est ensuite repris dans la dimension des objectifs.

L'analyse de plusieurs articles dans le domaine de l'intégration de la chaîne d'approvisionnement permet d'identifier deux grandes catégories de manière déductive, qui sont ensuite confirmées de manière inductive par l'étude des 41 articles. Ces deux catégories sont « haut niveau d'intégration » et « faible niveau d'intégration », et elles permettent de catégoriser les dimensions trouvées dans le cadre global proposé.

Les différentes dimensions ont émergé suite à l'étude détaillée des 41 articles. Quatre sont répertoriés, à savoir les processus de chaîne d'approvisionnement (amont, interne, aval), les objectifs (qualité, innovation, durabilité, performance, risque, technicité), le rôle du client (actif ou passif) et les méthodes d'intégration.

Concernant les processus, le processus aval est plus représenté, suivi de l'interne puis de l'amont, confirmant ainsi l'hypothèse initiale selon laquelle le client est plus difficile à intégrer en amont (Lacoste, 2016). Concernant les objectifs, le principal est la qualité. Cette dernière est souvent observée dans les processus aval. L'intégration des clients, lorsqu'ils poursuivent un objectif de qualité, peut être simplifiée au moyen de méthodes telles que la Voix du Client (VoC), ou encore des enquêtes. Il semble s'agir de l'objectif le plus facilement réalisable pour intégrer les clients. L'objectif technique est quant à lui le moins représenté. Il se situe souvent en amont du processus et nécessite une grande implication ainsi qu'un engagement important de la part du client, lorsqu'il est intégré par l'entreprise. Les méthodes peuvent être plus difficiles à mettre en place et la phase d'intégration peut être plus longue.

Quant aux méthodes, elles sont au nombre de 10 dans l'analyse, et sont classées en fonction du rôle actif ou passif du client. La méthode la plus courante est la VoC, qui est souvent mise en œuvre dans les processus aval dans une optique de qualité, et le client a souvent un rôle passif. Cela confirme qu'il semble plus simple d'intégrer

les clients lorsque ces derniers se situent proches du processus ciblé, c'est-à-dire en aval, et lorsque leur rôle n'est pas pleinement actif.

Au vu de ces différents éléments, catégories et dimensions, un cadre complet est proposé pour permettre aux entreprises de connecter davantage leurs clients à leur processus d'approvisionnement. Toutes les dimensions sont incluses ainsi que les méthodes. Celles-ci sont complétées par les trois autres méthodes étudiées dans la revue de littérature, mais qui ne sont pas présentes dans l'échantillon de 41 articles, car elles sont utilisées plus fréquemment dans le domaine du marketing et de l'innovation (boîte à outils pour utilisateurs, concours d'idées, conception empathique). Elles sont ajoutées, car elles présentent un intérêt pour aborder les objectifs techniques et d'innovation. Chacune des dimensions et des méthodes sont classées selon les deux principales catégories, à savoir « haut niveau d'intégration » et « faible niveau d'intégration ». Enfin, la notion de durabilité est abordée, il semblerait qu'elle soit au cœur des préoccupations de demain et qu'elle constitue un élément central des chaînes d'approvisionnement à une époque où les enjeux environnementaux et éthiques sont devenus incontournables.

Les organisations, et en particulier les managers, peuvent utiliser le cadre global pour rapprocher davantage leurs clients de leurs chaînes d'approvisionnement. Cette recherche propose aux organisations de suivre plusieurs étapes pour mieux intégrer leurs clients. Tout d'abord, elles doivent définir l'objectif qu'elles souhaitent atteindre, afin de pouvoir se concentrer sur certaines méthodes. Deuxièmement, elles doivent définir un niveau d'intégration cible : faible ou élevé. Ces choix dépendent bien sûr de l'objectif final, mais aussi des contraintes d'organisation, que ce soit en termes de temps disponible, de confidentialité des données ou de contraintes financières. Ces éléments vont permettre de définir quel processus d'intégration cibler : intégrer le client en amont, en interne ou en aval. Plus l'intégration se fait en amont, plus le niveau d'intégration est élevé. Enfin, les organisations peuvent utiliser plusieurs méthodes en combinaison, sachant qu'un produit mis sur le marché doit répondre aux enjeux environnementaux, mais aussi être innovant, parfois techniquement avancé, et de bonne qualité, tout en assurant une performance globale pour l'entreprise.

Cet article enrichit la littérature sur le sujet des méthodes d'intégration du client, qui est un sujet encore peu abordé et où le client a souvent un rôle plutôt passif. Ensuite, il propose des contributions managériales, en proposant un cadre global permettant aux entreprises de connecter davantage leurs clients à leurs processus de chaîne d'approvisionnement par le biais de différentes méthodes en fonction des objectifs. Cet article montre également le rôle important et croissant de la notion de durabilité, qui est la clé de la majorité des défis, que ce soit en termes de réduction des risques, d'augmentation de la qualité ou d'amélioration de l'innovation.

Néanmoins, deux limites de cet article peuvent être soulevées. Tout d'abord, l'échantillon d'articles de l'étude est restreint, car cette analyse systématique se concentre sur la gestion de la chaîne d'approvisionnement. Les recherches futures pourraient élargir la portée de l'étude en incluant des domaines tels que le marketing et l'innovation. Deuxièmement, ce cadre global pourrait également être confronté à la réalité du terrain, en mettant en œuvre les différentes méthodes en fonction des objectifs des entreprises. Enfin, les recherches futures pourraient étudier les contraintes et les obstacles auxquels les entreprises peuvent être confrontées lors de la mise en œuvre de méthodes visant à connecter leurs clients à leurs processus de gestion de chaîne d'approvisionnement.

ÉTUDE 3

La croissance exponentielle de la connectivité des consommateurs et de l'Internet des objets a augmenté la demande de métaux rares, mais l'extraction, le raffinage et la production de ces matériaux peuvent être dommageables pour l'environnement. Les clients et les consommateurs, quant à eux, sont de plus en plus préoccupés par la durabilité et souhaitent que leur voix puisse être entendue. Dès lors, comment améliorer l'engagement des consommateurs et des clients pour permettre un plus grand degré de «co-création» dans la recherche de produits plus écologiques et des chaînes d'approvisionnement qui les soutiennent? Pour répondre à cette question, les termes liés aux métaux rares et leurs défis sont définis ; les différentes méthodes d'engagement des clients et des consommateurs proposées dans la littérature sont passées en revue. Ensuite, au moyen d'entretiens avec des consommateurs et des entreprises du secteur de l'Internet des objets, l'engagement des acteurs aval est analysé, dans le contexte des métaux rares à travers les méthodes d'intégration. Les résultats proposent une cartographie des différentes méthodes qui permettent de concourir à la cocréation, et aux objectifs de durabilité.

Cet article intitulé «Rendre les chaînes d'approvisionnement plus durables grâce à l'engagement des clients et des consommateurs : le cas des métaux rares» démontre l'importance de la durabilité dans les entreprises aujourd'hui, notamment dans le domaine de l'Internet des Objets (IoT), tel qu'elle est perçue par les organisations et les consommateurs. Les consommateurs semblent encore relativement peu connaître les enjeux liés aux métaux rares, malgré la prise de conscience des problèmes mondiaux liés aux préoccupations sociales, éthiques et environnementales. Quant aux entreprises, leur priorité est de limiter à la fois la criticité de ces métaux et les risques liés à l'approvisionnement. Malgré la distance entre les entreprises Business To Business (B2B) et leurs consommateurs, il est cependant essentiel de les intégrer tant pour connaître leurs besoins que pour bénéficier de leurs connaissances. Plusieurs méthodes sont proposées dans cet article pour permettre aux entreprises B2B de relever ces défis d'intégration. Pour proposer des produits durables, éthiques, mais aussi compétitifs dans le domaine de l'IoT, les entreprises doivent sensibiliser les consommateurs, communiquer avec eux, les intégrer et leur permettre de s'engager tout au long de la

chaîne d'approvisionnement. Les clients, mais aussi les consommateurs, ont un rôle à jouer dans la transition écologique de l'IoT, notamment en termes d'utilisation des métaux rares.

Cet article apporte plusieurs contributions. La contribution la plus importante concerne la cartographie des différentes méthodes permettant la cocréation en fonction des objectifs de durabilité et du niveau d'engagement souhaité, que ce soit en amont ou plus en aval de la chaîne d'approvisionnement. En répertoriant et en classant les méthodes, la cartographie permet aux entreprises de choisir celles qui leur conviennent le mieux en fonction des défis et objectifs spécifiques auxquels elles sont confrontées. Si elles ont besoin d'une vision et d'un retour d'information plus en aval sur leurs produits, elles peuvent utiliser des méthodes telles que la VoC. Si elles souhaitent se concentrer sur leurs processus en amont, elles peuvent utiliser des méthodes telles que les utilisateurs principaux (lead users). Si les objectifs d'une entreprise sont liés à la durabilité, elle peut utiliser des méthodes telles que les laboratoires vivants, et s'ils sont davantage liés à la limitation des risques, à la technicité et à la qualité, elle peut se référer à des méthodes telles que «l'équipe grands comptes» (Key Account Team). En tant que tel, cet article fournit une contribution managériale à travers la cartographie des méthodes applicables. En outre, cet article relie la littérature au terrain en connectant les méthodes théoriques à leur utilisation réelle dans le secteur de l'IoT B2B. Il compare également les perspectives des entreprises avec les sentiments des consommateurs finaux. Par exemple, tant les consommateurs que les entreprises soulignent la difficulté de l'engagement des consommateurs dans un cadre B2B. Enfin, il est constaté que les consommateurs n'ont pas de réelles connaissances sur les métaux rares, et que les entreprises communiquent peu et n'intègrent pas suffisamment leurs consommateurs.

L'une des limites de cet article réside dans son approche constructiviste. En effet, l'analyse des résultats peut être biaisée par la perception des auteurs, leurs propres valeurs, connaissances et idées. Pour plus d'objectivité, cette étude pourrait être complétée par des analyses quantitatives utilisant des enquêtes basées sur des échelles de Likert. Des recherches futures pourraient également tester ces méthodes directement dans les entreprises afin d'évaluer leurs impacts ainsi que les différentes contraintes, difficultés, effets de levier et contributions possibles.

3. Conclusion

La conclusion propose de revenir sur les questions de recherche afin de répondre à la problématique : l'intégration de la chaîne d'approvisionnement dans l'entreprise B2B : Tirer parti des acteurs aval pour relever les défis de la durabilité dans le contexte de l'IoT. Les contributions, les limites, et les recherches futures sont ensuite présentées.

- ▶ La première question de recherche est : Quels sont les sujets abordés dans la littérature concernant la gestion de la chaîne d'approvisionnement, relatifs à l'intégration, la connexion et l'engagement des acteurs aval ?

Tout d'abord, pour répondre à la question portant sur les différents acteurs aval, la littérature est analysée. Les auteurs soulignent que les définitions ne sont pas suffisamment précises et souvent absentes dans les articles (Bennett, 1995; Yadin, 2002). Au fil des lectures, il semblerait que de nombreux articles utilisent les termes client, consommateur et utilisateur comme synonymes (Kaulio, 1998), ou sans réelle distinction (Jo Bitner et al., 1997; Sampson and Spring, 2012). Cependant, les dictionnaires français et anglais montrent une nette différence entre ces termes. Les différentes définitions au sein de la littérature et des dictionnaires sont reprises afin de préciser ces termes, s'agissant du domaine de la gestion de la chaîne d'approvisionnement.

- Le client est un membre de la chaîne d'approvisionnement aval d'une entreprise, qui peut être l'acteur entre la fabrication (ou la distribution) et le consommateur final du produit ou du service. Il achète des biens ou des services, non pas pour sa propre consommation, mais pour en faire bénéficier d'autres personnes (cela implique souvent une étape de revente).
- Le consommateur est le dernier membre de la chaîne d'approvisionnement aval d'une entreprise, il achète et consomme un produit ou un service pour sa propre consommation.
- L'utilisateur est également le dernier membre de la chaîne d'approvisionnement aval d'une entreprise, mais peut aussi être considéré comme un membre

de la chaîne d'approvisionnement inverse, il est le dernier acteur à consommer le produit ou le service, sans nécessairement l'avoir acheté.

Il semble essentiel de définir correctement ces acteurs, car selon leur positionnement, ils n'ont pas les mêmes rôles au sein de la chaîne d'approvisionnement et ne sont pas intégrés de la même manière.

La deuxième sous-question de recherche porte sur la différence entre l'intégration, la connexion et l'engagement. Tout d'abord, la notion d'intégration est spécifique à la gestion de la chaîne d'approvisionnement (Flynn et al., 2010; Frohlich and Westbrook, 2001), alors la connexion et l'engagement sont des approches davantage présentes dans les domaines du marketing et de l'innovation (Bowden, 2009; Kumar et al., 2019a; Moliner et al., 2018; Noble and Kumar, 2008; Schuurman et al., 2016). De plus, l'intégration renvoie essentiellement à un objectif de performance (Fabbe-Costes and Jahre, 2008; Khan and Wisner, 2019; Narasimhan and Kim, 2002), alors que l'objectif de durabilité est plus marqué dans le cas de l'engagement et de la connexion (Leminen et al., 2015; Schuurman et al., 2016; Zimmerling et al., 2017).

Ensuite, la notion d'intégration peut être définie comme le fait d'insérer 'quelque chose' dans 'quelque chose' et, dans le cadre de cette recherche, cette notion s'entend par l'insertion des acteurs aval dans la chaîne d'approvisionnement. Il apparaît que les articles ne proposent pas comment cette intégration peut être réalisée, s'agissant du domaine de la gestion de la chaîne d'approvisionnement. Les moyens d'intégration sont donc recherchés dans différents domaines tels que l'innovation et le marketing. Dans ces deux domaines, le terme intégration est peu présent alors que connexion et engagement sont prédominants (Bowden, 2009; Kumar et al., 2019a; Moliner et al., 2018; Noble and Kumar, 2008; Schuurman et al., 2016). Pour autant, ces deux domaines proposent de nombreuses méthodes permettant l'engagement et la connexion des acteurs aval, relevant des méthodes d'intégration (Shin, 2019; Von Hippel, 2001; Zimmerling et al., 2017).

Si la connexion permet de relier deux ‘choses’, à savoir les acteurs aval et la chaîne d’approvisionnement, la notion d’engagement renvoie quant à elle à un rôle plus important de l’acteur aval, car elle implique des choix et des responsabilités. Dans le cadre de cette thèse, le domaine de la gestion de la chaîne d’approvisionnement est couplé avec le concept de l’intégration, ainsi qu’avec les notions de connexion et d’engagement qui permettent d’intégrer l’acteur aval à différents niveaux. Plus l’intégration est forte, plus les méthodes d’intégration utilisent l’engagement alors, qu’à l’inverse, si l’intégration attendue est moindre, les méthodes d’intégration utilisent la notion de connexion. Cette thèse tente de proposer une vision transversale qui fait appel aux domaines du marketing et de l’innovation, dans un cadre général de la gestion de la chaîne d’approvisionnement. Elle propose notamment une méthodologie d’intégration des acteurs aval en fonction des différents besoins et objectifs de l’entreprise.

En ce qui concerne la troisième sous-question de recherche, relative aux principaux thèmes étudiés pour l’intégration des acteurs aval, les clusters exposés dans l’article n°1 servent de référence (partie 2 chapitre 4). Tout d’abord, le premier cluster correspond au développement théorique de ce domaine. Ensuite, le deuxième cluster d’articles traite du développement des dimensions entourant ce champ théorique. Le troisième cluster se concentre sur la modélisation de ce champ. Enfin, les deux derniers clusters élargissent le sujet en abordant les domaines des systèmes d’information et de la durabilité.

Pour répondre à la dernière sous-question, toujours en se référant à l’article 1, il semble que les thèmes des systèmes d’information et de la durabilité seront prédominants dans le futur. Concernant les systèmes d’information, la recherche s’intéresse de plus en plus à l’industrie 4.0 et à la place de l’informatisation dans l’intégration de la chaîne d’approvisionnement, notamment l’IoT et la blockchain (Kamble et al., 2019; Pfahl and Moxham, 2014; Saengchai and Jermstittiparsert, 2019). Et en ce qui concerne la durabilité, l’enjeu de l’intégration conduit à proposer des chaînes d’approvisionnement plus durables, mais également plus performantes (Wiengarten and Longoni, 2015; Wong et al., 2015; Woo et al., 2016; Xie et al.,

2018). Plusieurs recherches combinent les aspects des systèmes d'information et de la durabilité, pour permettre une intégration de la chaîne d'approvisionnement toujours plus performante, tout en prenant en compte les dimensions de durabilité (Cui et al., 2020; De Vass et al., 2018; Nahr et al., 2021; Zhang et al., 2020).

- La deuxième question de recherche est la suivante : Quelles méthodes peuvent être utilisées afin d'intégrer les acteurs aval dans la chaîne d'approvisionnement ?

Pour permettre de répondre à cette première question, il convient au préalable d'identifier les méthodes d'intégration. Pour ce faire, cinq articles et un livre ont été analysés (Edvardsson et al., 2012, 2010; K. Füller et al., 2014; Piller et al., 2010; Rese et al., 2015; Zogaj and Bretschneider, 2012). Après une lecture approfondie des articles et du livre, 14 méthodes d'intégration des acteurs aval dans la chaîne d'approvisionnement ont été identifiées : «VoC» (Griffin and Hauser, 1993), «Customer interviews» (Cooper and Dreher, 2010), «Laddering» (Gutman, 1982; Reynolds and Gutman, 1988), «Brainstorming» (Camacho and Paulus, 1995), «Lead user» (Urban and Von Hippel, 1988; Von Hippel, 1986), «User toolkit» (Von Hippel, 2001), «Idea contest»/«Idea competition» (K. Füller et al., 2014; Piller and Walcher, 2006; Terwiesch and Xu, 2008), «Crowdsourcing» (Brabham, 2008; Howe, 2006; Leimeister et al., 2009), «Living labs» (BHMSA Bergvall-Kåreborn et al., 2009; Birgitta Bergvall-Kåreborn et al., 2009; Bergvall-Kåreborn and Stahlbrost, 2009), «Empathic design» (Leonard and Rayport, 1997), «Participatory design» (Spinuzzi, 2005), «Innovation communities» (Fichter, 2009), «TRIZ» (Edvardsson et al., 2010; Yamashina et al., 2002).

Ces méthodes peuvent être classées ou regroupées en fonction de différentes grilles de lecture : processus de la chaîne d'approvisionnement, objectifs d'intégration, rôle des acteurs, ou encore en fonction du degré d'intégration.

‘En effet, l’analyse de contenu de l’étude systématique a permis de regrouper ces méthodes d’intégration au sein de trois processus importants pour cette recherche : les processus en amont, internes et en aval. De même, l’analyse a identifié six objectifs d’intégration auxquelles peuvent répondre ces méthodes à savoir la qualité,

la performance, la durabilité, l'innovation, la gestion des risques et la technique. En ce qui concerne le rôle des acteurs, les méthodes peuvent impliquer soit un rôle actif, soit un rôle plutôt passif. Enfin, l'analyse du contenu des articles a révélé deux catégories principales, à savoir une intégration « élevée » et « faible ». Globalement, la littérature se concentre davantage sur une faible intégration des acteurs aval, où le rôle de cet acteur est généralement plus passif que réellement actif, et le principal objectif visé est celui de la qualité – souvent obtenue par la méthode VoC. Néanmoins, plusieurs méthodes peuvent être utilisées pour atteindre plusieurs objectifs, en fonction des différents processus. Ainsi, par exemple, la méthode VoC peut répondre à la fois aux objectifs de qualité et de durabilité.

- ▶ La troisième question de recherche est la suivante : Dans quelle mesure les perceptions des acteurs aval conduisent-elles à une plus grande durabilité lorsque ces acteurs sont intégrés dans la chaîne d'approvisionnement de l'IoT?

Afin de répondre à la première sous-question qui traite des enjeux de la durabilité, six principales problématiques sont prélevées de la littérature, parmi les 19 proposées par Seuring and Müller (2008). Ces dernières mettent en évidence les enjeux liés à la gestion de la chaîne d'approvisionnement durable. Ces problématiques permettent d'ancrer la recherche dans le champ théorique, mais aussi de souligner les lacunes à combler.

- «Coopération et communication à l'échelle de la chaîne d'approvisionnement (gestion des informations [...]); contrats à long terme; instauration de la confiance; génération de valeurs communes);
- Sensibilisation à la responsabilité sociale et environnementale; responsabilité sociale des entreprises;
- Vue sur la chaîne d'approvisionnement étendue; extension des efforts de durabilité au-delà des interfaces immédiates; réseau de la chaîne d'approvisionnement; intégration des processus à l'échelle de la chaîne; cycle de vie des produits;
- Innovation durable;
- Pression (publique) des parties prenantes; besoin de transparence [...];
- Conditions de travail» (Seuring and Müller, 2008, p. 459).

Dans ces six citations, la notion de chaîne d'approvisionnement étendue et de collaboration est présentée. Les auteurs soulignent également l'importance de l'intégration des fournisseurs. Pour autant, les acteurs aval ne sont pas identifiés, et ce constat renforce l'opportunité de conduire une étude sur l'intégration de ces derniers. En outre, de nombreux articles dans le domaine de la gestion de la chaîne d'approvisionnement soulignent que l'intégration peut être utilisée pour la durabilité (Neutzling et al., 2018; Seuring and Müller, 2008a; Wolf, 2011). D'autres domaines tels que le marketing et l'innovation démontrent également que l'intégration des acteurs aval a un impact sur la durabilité (Heiskanen et al., 2005; Sul and Lee, 2020; Zimmerling et al., 2017). Les articles 2 et 3 de cette thèse (partie 2, chapitres 4 et 5) confirment ainsi que cette intégration des acteurs aval dans les processus de la chaîne d'approvisionnement peut répondre à l'enjeu de la durabilité et conduire à des produits ou des processus plus durables.

Pour répondre à la sous-question sur le lien entre durabilité et IoT, il est important de souligner que l'IoT est basé sur les nanotechnologies, elles-mêmes composées de métaux rares. Ces métaux rares, mais aussi tous les procédés de fabrication, ainsi que la gestion de la fin de vie de l'IoT ont un impact important sur l'environnement et soulèvent des enjeux d'éthique (Bekara, 2014; Ethirajan Manavalan and Jayakrishna, 2019; Rus et al., 2019).

Les principales faiblesses de ces produits résident dans la vulnérabilité de leur chaîne d'approvisionnement. Leur approvisionnement et leur fabrication sont dépendants du climat géopolitique. Dès lors, ces produits peuvent connaître des variations de prix. De plus, les composants utilisés dans la fabrication des IoT ne sont pas des ressources renouvelables, mais finies (Massari and Ruberti, 2013; Mutumi and Simatele, 2017). Il est donc essentiel de travailler à l'émergence de solutions techniques innovantes telles que la substitution ou la réduction des matériaux (Egbue and Long, 2012; Palomino et al., 2021; Quinteros-Condoretty et al., 2021). Une analyse doit également porter sur la phase de fabrication, considérant ses conséquences négatives sur l'environnement, ainsi que sur la réglementation qui l'encadre, pour permettre d'influer positivement sur les conditions de travail précaires qui impliquent

parfois le travail forcé d'adultes ou d'enfants dans des conditions sanitaires dégradées (Maniglier, 2020; Massari and Ruberti, 2013; Mutumi and Simatele, 2017; Pitron, 2018). Enfin, la gestion du cycle de vie du produit doit également être questionnée et mieux préparée. À ce jour, le recyclage de ces produits est complexe, coûteux et peu abordé. (Bakas et al., 2014; Barume et al., 2016; Sauer and Seuring, 2017; Zhang et al., 2017). Intégrer les acteurs aval en interrogeant leurs usages de l'IoT peut permettre dans un premier temps de répondre à ces enjeux de durabilité, et certaines recherches ont déjà été entreprises par Kasulaitis et al. (2021). Néanmoins, dans leur article, les consommateurs n'apparaissent que dans un rôle passif et ne sont pas directement engagés dans la chaîne d'approvisionnement. Cette thèse cherche donc des moyens d'intégrer ces acteurs de manière plus ou moins active dans la chaîne d'approvisionnement afin de proposer des produits et des processus plus durables.

Concernant la sous-question relative à la perception par les entreprises de l'IoT, de la durabilité et de l'intégration des acteurs aval, des entretiens ont mis en évidence que l'enjeu de durabilité est désormais pris en compte par les entreprises à des degrés divers. D'une part, si cet enjeu est un élément essentiel pour l'entreprise, il est traité avant tout sous l'angle de la Responsabilité Sociétale des Entreprises qui se traduit souvent par des actions internes à l'entreprise. D'autre part, dans le cas de l'IoT et de ses matières premières (métaux rares), il semble que l'entreprise se concentre également sur les facteurs externes : la législation, les problèmes d'approvisionnement, ou encore une augmentation du prix de la matière première modifient le comportement des entreprises vis-à-vis de ces métaux. Pour les entreprises, le plus important est la disponibilité de ces métaux et leurs caractéristiques techniques, mais aussi les composantes écologiques et éthiques. La prise de conscience de ces enjeux, et les préoccupations ou attentes des consommateurs, peuvent conduire les entreprises à ne plus s'approvisionner en métaux de conflit issus de certains pays. De plus, l'analyse des entretiens menée auprès des entreprises met en exergue que l'intégration des acteurs aval peut également répondre aux enjeux de la durabilité. Néanmoins, les méthodes proposées par les entreprises donnent un rôle plus passif qu'actif à cet acteur aval (la méthode VoC est par exemple plus utilisée que celle du lead user). En outre plus l'acteur est actif plus l'intégration se fait en amont (la méthode du

lead user peut être utilisée dans les phases de conception de produit). De manière générale, plus l'entreprise est éloignée de ses consommateurs, plus il est difficile de les intégrer. Les entretiens ont montré que l'entreprise de B2B a plus de difficulté à percevoir et intégrer ses consommateurs que ses clients directs.

La quatrième sous-question vise à comprendre la perception qu'ont les consommateurs du thème de l'IoT et de son lien avec la durabilité et l'intégration des acteurs aval. Tout d'abord, l'une des principales conclusions met en lumière que les consommateurs ont une connaissance limitée de l'IoT. Néanmoins, ils comprennent les enjeux et l'importance d'apporter des réponses aux diverses problématiques soulevées par l'IoT. Du point de vue du consommateur, les entreprises doivent trouver des réponses à la fois en interne, par exemple pour repenser la conception des produits, mais également en externe, en faisant appel aux experts et aux innovations. Ils ont souligné l'importance de prendre en compte les questions de durabilité tout au long de la chaîne d'approvisionnement. En ce qui concerne l'IoT et les métaux rares, l'accent est mis sur les problèmes liés à leur utilisation par les entreprises, comme la pollution dans le processus de fabrication ou l'absence de recyclage. Les consommateurs soulèvent de nombreuses opportunités, comme la reconception de l'ensemble du produit, la substitution et/ou la réduction de certains métaux. En ce qui concerne l'intégration des acteurs aval, les consommateurs sont proactifs et énumèrent de nombreuses méthodes. Celles-ci, décrites avec le vocabulaire des consommateurs, sont en définitive très proches des méthodes de la littérature.

En conclusion, cette thèse met en évidence les différents apports théoriques, méthodologiques et managériaux. Les contributions théoriques sont l'enrichissement des champs conceptuels de la gestion de la chaîne d'approvisionnement et principalement de l'intégration de la chaîne d'approvisionnement, notamment dans le cadre de l'IoT. La recherche effectuée permet d'analyser l'évolution de la littérature sur le sujet de l'intégration des acteurs aval dans la gestion de la chaîne d'approvisionnement, en exposant les articles les plus influents, les auteurs les plus publiés et l'évolution des champs d'études dans le temps, ainsi qu'en énonçant et explicitant les différentes méthodes d'intégration possibles. La présente étude met en

lumière l'existence de méthodes d'intégration des acteurs aval, encore peu utilisées dans le domaine de recherche. Les contributions managériales sont les plus importantes. En effet, la proposition d'un cadre global et d'une cartographie peut permettre d'aider les entreprises à identifier les méthodes les plus pertinentes à utiliser, en fonction de leur processus, de leurs objectifs, du rôle donné à l'acteur aval et du niveau de durabilité souhaité.

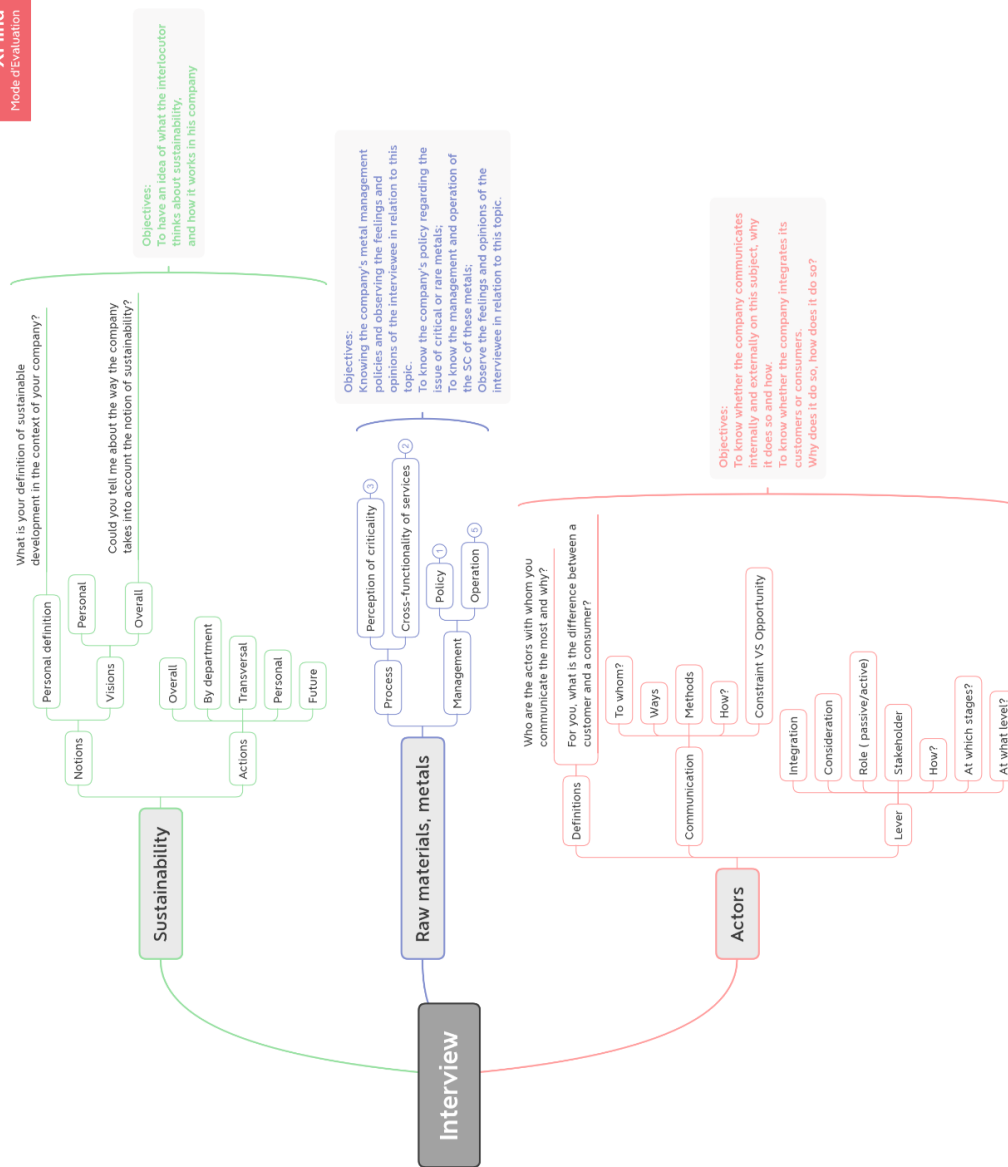
Cette conclusion vise également à proposer les limites et les recherches futures. Les limites théoriques sont dépendantes du peu de littérature portant sur l'intégration des acteurs aval et principalement le consommateur et l'utilisateur, dans le domaine de la chaîne d'approvisionnement. D'un point de vue méthodologique, les limites sont plus étendues, tout d'abord en raison de l'approche quantitative utilisée dans l'article bibliométrique, qui limite la qualité du contenu des articles. De même, la taille de l'échantillon pris en compte dans le second article est plutôt limitée, avec seulement 41 articles étudiés. Deuxièmement, l'approche interprétative de cette thèse peut avoir un impact sur l'interprétation des résultats du troisième article. Enfin, concernant le troisième article, un seul chercheur a collecté les données et les a analysées, pouvant générer un potentiel biais dans la phase d'analyse des résultats, et peut être même dès la conduite des entretiens. Les limites managériales résident quant à elle dans le fait que, ni le cadre global, ni la cartographie n'ont été testés en entreprise.

Enfin, s'agissant des perspectives, la recherche future pourrait être ouverte à d'autres domaines théoriques tels que le marketing ou l'innovation. L'analyse des obstacles et des difficultés pourrait être faite de manière théorique ou empirique en testant en entreprise le cadre global (article 2) et la cartographie (article 3). Une approche quantitative élargie pourrait être envisagée pour approfondir l'étude de terrain qualitative réalisée dans le cadre de cette recherche, d'une part pour éviter les biais liés au positionnement épistémologique et d'autre part pour mesurer quantitativement l'intégration des acteurs aval. À l'inverse, une approche qualitative par l'observation participante pourrait permettre d'approfondir le sujet. Enfin, le chercheur souhaiterait travailler davantage sur la question de la durabilité et de l'éthique, et sur la manière dont ces éléments sont pris en compte par les entreprises B2C et par les consommateurs.

APPENDICES

Appendix 1: Interview mind map

XMind
Mode of Evaluation



It is estimated that there are currently 22 billion connected objects in the world. The democratisation of electronic objects, present in vehicles, smartphones, smart meters and other everyday objects, is challenging and questioning the availability of the natural resources needed to manufacture these objects. However, it seems that consumers have very little awareness of the considerable need for raw materials, which are indispensable for the production of these connected devices. It is now crucial to improve the management of the nanotechnology supply chain, and the issue of sustainability is at the centre of this subject. The general objective: it is an exploratory work but a strong reflection emanates from this subject (companies, governments, European projects...). Today our objective will be to discover your practices and perspectives on this topic. The idea is to use these interviews as a method to help companies to better understand the theme of sustainability within the framework of nanotechnologies SC, by perceiving the consumer and the customer as potential levers.

Figure 53: Interview mind map

Appendix 2: Interview guide for company interviewees

Theme 1	Sustainability		Objectives
Q1		What is your definition of sustainable development in the context of your company?	Have an idea of what the interlocutor thinks about sustainability, and how it works in his company.
Q2		Could you tell me about the way the company takes into account the notion of sustainability?	
Q3		What are the actions implemented in a global way?	
Q4		What actions have been implemented in your department?	
Q5		What actions are planned for the future?	
Theme 2.1	Raw Materials		Objectives
Q1		Which metals are used in your products?	Knowing the company's metal management policies and observing the feelings and opinions of the interviewee in relation to this
Q2		How do you manage your raw materials?	
Q3		How do your management policies change according to the different types of raw materials?	
Q4		What do you think about the management of raw materials in your company?	
Theme 2.2	Rare Metals		Objectives
Q1		What is your definition of rare and critical metals?	To know the company's policy regarding the issue of critical or rare metals;
Q2		What are the rare or critical metals that are used in your products?	
Q3		What actions have been implemented to manage these resources?	To know the management and operation of the SC of these metals;
Q4		How does your Supply Chain for rare or critical metals work?	
Q5		What are the associated processes in your Supply Chain for your rare or critical metals?	
Q6		What is your policy for managing these products?	
Q7		How do you manage the criticality of these metals in your processes?	
Q8		What do you think about the management of rare or critical raw materials in your company?	
Theme 3.1	The actors		Objectives
Q1		For you, what is the difference between a customer and a consumer?	To know whether the company communicates internally and externally on this subject, why it does so and how.
Q2		How do you communicate about the criticality and rarity of metals with your customers and consumers?	
Q3		By what means or channels? (Internet, website, social networks)	
Q4		What information do you communicate?	
Q5		What are your motivations for communicating with them?	
Q6		What are the limits or constraints to this communication?	
Theme 3.2	Actors' integration		Objectives
Q1		What does the integration of the consumer or customer into Supply Chain Management mean to you?	To know whether the company integrates its customers or consumers. Why does it do so, how does it do so?
Q2		For you, what are the advantages and disadvantages of integrating the consumer or customer into the Supply Chain?	
Q3		How do you integrate the consumer or customer into your Supply Chain?	
Q4		a. At which stages of the Supply Chain?	
Q5		b. At what level (fully integrated, partially integrated, superficially integrated)?	
Q6		c. What integration methods are used?	
Q7		i. Why do you use these methods in particular?	
Q8		ii. What are the contributions of these methods?	
Q9		iii. What are their impacts?	
Q10		d. What are your motivations for integrating the consumer or customer?	
Q11		e. What are the barriers or obstacles to this integration?	
Q12		f. What are the reasons why you do not integrate your consumer or customer?	

Figure 54: Example of the interview guide for company interviewees

Appendix 3: Interview guide for consumer interviewees

Theme 1	Sustainability	Objectives
Q1	What is your definition of sustainability?	To have an idea of what the interlocutor thinks about sustainability and the link with the company and the product.
Q2	What importance do you attach to this notion?	
Q3	What do you think a company should do to be sustainable?	
Q4	What can a company do to offer sustainable products?	
Q5	By which means can a company offer sustainable products?	
Theme 2	Rare Metals	Objectives
Q1	What is your definition of rare metals?	Observe the respondent's feelings and opinions on this topic. To know if it is a subject he or she is familiar with. And how this topic is dealt with in the company, according to the respondent.
Q2	For you, what is the difference between rare metals, critical metals, conflict minerals?	
Q3	Is this a subject you have already heard about?	
Q3 a)	If so, through what channels?	
Q5	Is it a subject that is important to you?	
Q5 a)	If so, why?	
Q6	Do you see a link between rare metals and companies?	
Q6 a)	If so, which one(s)?	
Q7	How do you think a company can respond to the issue of rare metals?	
Q8	Do you know what sort of products contain these materials?	
Q9	Are there any products that you own or use that contain rare metals?	
Q10	If you do own or use these products what will happen to them when you no longer use them or replace them?	
Theme 3	Actors' integration	Objectives
Q1	For you, what is the difference between a customer, a consumer, a user?	To know if the user has notions related to integration and how he or she perceives this subject.
Q2	Is a company's proximity to these downstream actors important to you?	
Q3 a)	If so, why?	
Q4	Are you familiar with the terms BtoB BtoC?	
Q4 a)	If so, how would you define them?	
Q5	What can a company do to integrate these downstream actors?	
Q6	By what method(s) or means can a company integrate these downstream actors?	

Figure 55: Example of the interview guide for consumer interviewees

Appendix 4: Article distribution according to processes

Table 18: Article distribution according to processes

Process	Title	Author	Year
Downstream	<i>A constrained Nash bargaining approach to the stock rationing problem in multi-echelon supply chains</i>	Roy, D.; Srinivasa Raghavan, N.R.	2014
	<i>A world-class continuous quality improvement program: The fastener supply corporation case</i>	Min, H.	1998
	<i>AQUA: Analytical model for evaluation and selection of Third-Party Logistics service provider in supply chain</i>	Rajesh, R.; Pugazhendhi, S.; Ganesh, K.; Muralidharan, C.	2011
	<i>Crowdsourcing Last Mile Delivery: Strategic Implications and Future Research Directions</i>	Castillo, V.E.; Bell, J.E.; Rose, W.J.; Rodrigues, A.M.	2018
	<i>Design improvement of supply chain information system of public transportation services (Case study: Trans Jogja)</i>	Mansur, A.; Janari, D.; Setiawan, N.; Suryoputro, M.R.; Albar, F.B.	2017
	<i>Designing a supply chain management academic curriculum using QFD and benchmarking</i>	Gonzalez, M.E.; Quesada, G.; Gourdin, K.; Hartley, M.	2008
	<i>Environmental sustainability of logistics service provider: An ANP-QFD approach</i>	Lam, J.S.L.; Dai, J.	2015
	<i>Hybrid Zigbee RFID sensor network for humanitarian logistics centre management</i>	Yang, H.; Yang, L.; Yang, S.-H.	2011
	<i>Interpretive structural modelling and fuzzy MICMAC approaches for customer centric beef supply chain: application of a big data technique</i>	Mishra, N.; Singh, A.; Rana, N.P.; Dwivedi, Y.K.	2017
	<i>Laddered power</i>	Audin, L.	2007
	<i>Logistics service triad for household waste: consumers as co-producers of sustainability</i>	Halldórsson, Á.; Altuntas Vural, C.; Wehner, J.	2019
	<i>Measurement and Management of Supply Chain Performance: Practices in Today's Large Companies</i>	Lakri, S.; Dallery, Y.; Jemai, Z.	2015
	<i>On assessing the sensitivity to uncertainty in distribution network design</i>	Lalwani, C.S.; Disney, S.M.; Naim, M.M.	2006
	<i>Strategising customer voice-based quality improvement for logistics service providers</i>	Lee, T.-R.; Lin, J.-H.; Lenny Koh, S.C.	2006
	<i>The Rise of Crowd Logistics: A New Way to Co-Create Logistics Value</i>	Carbone, V.; Rouquet, A.; Roussat, C.	2017
	<i>Utilising quality function deployment to select customer voice-based quality improvement technique for 3PL companies</i>	Lee, T.-R.; Lin, J.-H.	2006
	<i>Weak links in the supply chain: Measuring fragility and sustainability</i>	Stonebraker, P.W.; Goldhar, J.; Nassos, G.	2009
	<i>Web-enabled integration of the voice-of customer for continuous improvement and product development</i>	Gunasekaran, N.; Arunachalam, V.P.; Selva Kumar, A.V.	2006
	Internal	<i>A hybrid framework based on SIPOC and Six Sigma DMAIC for improving process dimensions in supply chain network</i>	Mishra, P.; Sharma, R.K.
<i>Analyzing the supply chain risk issues for an Indian manufacturing company</i>		Kumar Pradhan, S.; Routroy, S.	2014
<i>Automated bid ranking for decentralized coordination of construction logistics</i>		Soroor, J.; Tarokh, M.J.; Abedzadeh, M.	2012
<i>B2C Mass Customization in the Classroom</i>		Visich, J.K.; Gu, Q.; Khumawala, B.M.	2012
<i>Crowdsourcing as a platform for digital labor unions</i>		Arora, P.; Thompson, L.H.	2019
<i>Developing supply chain evaluation framework through performance assessment approach</i>		Tewari, S.K.; Misra, M.	2013
<i>Evolving Information Systems and Technology Research Issues for COVID-19 and Other Pandemics</i>		O'Leary, D.E.	2020
<i>Industry 4.0: a supply chain innovation perspective</i>		Hahn, G.J.	2020
<i>Intelligent evaluation of supplier bids using a hybrid technique in distributed supply chains</i>		Soroor, J.; Tarokh, M.J.; Khoshalhan, F.; Sajjadi, S.	2012
<i>Make, buy, borrow or crowdsource? The evolution and future of outsourcing</i>		Malhotra, N.K.; Uslay, C.	2018
<i>Modelling Supply Chain Flexibility in the Indian Personal Hygiene Industry: An ISM-Fuzzy MICMAC Approach</i>		Singh, R.K.; Joshi, S.; Sharma, M.	2020
<i>Risk adjusted total cost of ownership model for strategic sourcing decisions</i>		Sharma, S.K.	2016
Upstream		<i>A knowledge-based algorithm for supply chain conflict detection based on OTSM-TRIZ problem flow network approach</i>	Razmi, J.; Haghighi, D.; Babazadeh, R.
	<i>Barriers in green lean six sigma product development process: An ISM approach</i>	Kumar, S.; Luthra, S.; Govindan, K.; Kumar, N.; Haleem, A.	2016
	<i>Breaking the Chains of open innovation: Post-blockchain and the case of sensorica</i>	Pazaitis, A.	2020
	<i>Cloud-based design and manufacturing: A new paradigm in digital manufacturing and design innovation</i>	Wu, D.; Rosen, D.W.; Wang, L.; Schaefer, D.	2015
	<i>Creating a living lab model for tourism and hospitality businesses to stimulate CSR and sustainability innovations</i>	Cigir, K.	2018
	<i>Develop Potential Solution to the Engineering Conflicts of Additive Manufacturing by Using the Theory of Solution of Inventive Problems (TRIZ)-The Case of Material Jetting Process</i>	Wang, Y.-H.; Trappey, A.J.; Hwang, S.-J.; Chen, K.-L.	2016
	<i>Industrial applications of virtual reality in architecture and construction</i>	Whyte, J.	2003
	<i>Managing the trade-off implications of global supply</i>	Stratton, R.; Warburton, R.D.H.	2006
	<i>Performing charlotte: A technique to bridge cultures in participatory design</i>	Light, A.; Kleine, D.; Holloway, R.; Vivent, M.	2010
	<i>Product design crowdsourcing in a dual-channel supply chain: joint reviews from manufacturer and consumers</i>	Li, J.; Yu, Y.; Liu, C.	2019
<i>Systems thinking benefits in supply change management: an illustration of the viable systems model in a Supply Chain</i>	Chronér, D.; Mirjamdotter, A.	2009	

Appendix 5: Article distribution according to objectives

Table 19: Article distribution according to objectives

Objective	Title	Author	Year
Quality	<i>A hybrid framework based on SIPOC and Six Sigma DMAIC for improving process dimensions in supply chain network</i>	Mishra, P.; Sharma, R.K.	2014
	<i>A world-class continuous quality improvement program: The fastener supply corporation case</i>	Min, H.	1998
	<i>AQUA: Analytical model for evaluation and selection of Third-Party Logistics service provider in supply chain</i>	Rajesh, R.; Pugazhendhi, S.; Ganesh, K.; Muralidharan, C.	2011
	<i>Automated bid ranking for decentralized coordination of construction logistics</i>	Soroor, J.; Tarokh, M.J.; Abedzadeh, M.	2012
	<i>Design improvement of supply chain information system or public transportation services (Case study: Trans Jogja)</i>	Mansur, A.; Janari, D.; Setiawan, N.; Suryoputro, M.R.; Albar, F.B.	2017
	<i>Designing a supply chain management academic curriculum using QFD and benchmarking</i>	Gonzalez, M.E.; Quesada, G.; Gourdin, K.; Hartley, M.	2008
	<i>Hybrid Zigbee RFID sensor network for humanitarian logistics centre management</i>	Yang, H.; Yang, L.; Yang, S.-H.	2011
	<i>Intelligent evaluation of supplier bids using a hybrid technique in distributed supply chains</i>	Soroor, J.; Tarokh, M.J.; Khoshalhan, F.; Sajjadi, S.	2012
	<i>Interpretive structural modelling and fuzzy MICMAC approaches for customer centric beef supply chain: application of a big data technique</i>	Mishra, N.; Singh, A.; Rana, N.P.; Dwivedi, Y.K.	2017
	<i>Laddered power</i>	Audin, L.	2007
	<i>Strategising customer voice-based quality improvement for logistics service providers</i>	Lee, T.-R.; Lin, J.-H.; Lenny Koh, S.C.	2006
	<i>Utilising quality function deployment to select customer voice-based quality improvement technique for 3PL companies</i>	Lee, T.-R.; Lin, J.-H.	2006
	<i>Web-enabled integration of the voice-of customer for continuous improvement and product development</i>	Gunasekaran, N.; Arunachalam, V.P.; Selva Kumar, A.V.	2006
	Innovation	<i>Breaking the Chains of open innovation: Post-blockchain and the case of sensorica</i>	Pazaitis, A.
<i>Cloud-based design and manufacturing: A new paradigm in digital manufacturing and design innovation</i>		Wu, D.; Rosen, D.W.; Wang, L.; Schaefer, D.	2015
<i>Crowdsourcing as a platform for digital labor unions</i>		Arora, P.; Thompson, L.H.	2019
<i>Industry 4.0: a supply chain innovation perspective</i>		Hahn, G.J.	2020
<i>Product design crowdsourcing in a dual-channel supply chain: joint reviews from manufacturer and consumers</i>		Li, J.; Yu, Y.; Liu, C.	2019
<i>Systems thinking benefits in supply change management: an illustration of the viable systems model in a Supply Chain</i>		Chron�er, D.; Mirijamdotter, A.	2009
<i>The Rise of Crowd Logistics: A New Way to Co-Crete Logistics Value</i>		Carbone, V.; Rouquet, A.; Roussat, C.	2017
Sustainability	<i>A knowledge-based algorithm for supply chain conict detection based on OTSM-TRIZ problem flow network approach</i>	Razmi, J.; Haghighi, D.; Babazadeh, R.	2018
	<i>Barriers in green lean six sigma product development process: An ISM approach</i>	Kumar, S.; Luthra, S.; Govindan, K.; Kumar, N.; Haleem, A.	2016
	<i>Creating a living lab model for tourism and hospitality businesses to stimulate CSR and sustainability innovations</i>	Cigir, K.	2018
	<i>Crowdsourcing Last Mile Delivery: Strategic Implications and Future Research Directions</i>	Castillo, V.E.; Bell, J.E.; Rose, W.J.; Rodrigues, A.M.	2018
	<i>Environmental sustainability of logistics service provider: An ANP-QFD approach</i>	Lam, J.S.L.; Dai, J.	2015
	<i>Logistics service triad for household waste: consumers as co-producers of sustainability</i>	Halld�rsson, �.; Altuntas Vural, C.; Wehner, J.	2019
Performance	<i>Make, buy, borrow or crowdsourc? The evolution and future of outsourcing</i>	Malhotra, N.K.; Uslay, C.	2018
	<i>A constrained Nash bargaining approach to the stock rationing problem in multi-echelon supply chains</i>	Roy, D.; Srinivasa Raghavan, N.R.	2014
	<i>B2C Mass Customization in the Classroom</i>	Visich, J.K.; Gu, Q.; Khumawala, B.M.	2012
	<i>Developing supply chain evaluation framework through performance assessment approach</i>	Tewari, S.K.; Misra, M.	2013
	<i>Measurement and Management of Supply Chain Performance: Practices in Today's Large Companies</i>	Lakri, S.; Dallery, Y.; Jemai, Z.	2015
	<i>Modelling Supply Chain Flexibility in the Indian Personal Hygiene Industry: An ISM-Fuzzy MICMAC Approach</i>	Singh, R.K.; Joshi, S.; Sharna, M.	2020
Risk	<i>Performing charlotte: A technique to bridge cultures in participatory design</i>	Light, A.; Kleine, D.; Holloway, R.; Vivent, M.	2010
	<i>Analyzing the supply chain risk issues for an Indian manufacturing company</i>	Kumar Pradhan, S.; Routroy, S.	2014
	<i>Evolving Information Systems and Technology Research Issues for COVID-19 and Other Pandemics</i>	O'Leary, D.E.	2020
	<i>On assessing the sensitivity to uncertainty in distribution network design</i>	Lalwani, C.S.; Disney, S.M.; Naim, M.M.	2006
	<i>Risk adjusted total cost of ownership model for strategic sourcing decisions</i>	Sharma, S.K.	2016
Technical	<i>Weak links in the supply chain: Measuring fragility and sustainability</i>	Stonebraker, P.W.; Goldhar, J.; Nassos, G.	2009
	<i>Develop Potential Solution to the Engineering Conflicts of Additive Manufacturing by Using the Theory of Solution of Inventive Problems (TRIZ)-The Case of Material Jetting Process</i>	Wang, Y.-H.; Trappey, A.J.; Hwang, S.-J.; Chen, K.-L.	2016
	<i>Industrial applications of virtual reality in architecture and construction</i>	Whyte, J.	2003
	<i>Managing the trade-off implications of global supply</i>	Stratton, R.; Warburton, R.D.H.	2006

Appendix 6: Article distribution according to the customer's roles

Table 20: Article distribution according to the customer's roles

Customer's role	Title	Author	Year
<i>Passive role</i>	<i>A constrained Nash bargaining approach to the stock rationing problem in multi-echelon supply chains</i>	Roy, D.; Srinivasa Raghavan, N.R.	2014
	<i>A hybrid framework based on SIPOC and Six Sigma DMAIC for improving process dimensions in supply chain network</i>	Mishra, P.; Sharma, R.K.	2014
	<i>A knowledge-based algorithm for supply chain conflict detection based on OTSM-TRIZ problem flow network approach</i>	Razmi, J.; Haghghi, D.; Babazadeh, R.	2018
	<i>A world-class continuous quality improvement program: The fastener supply corporation case</i>	Min, H.	1998
	<i>Analyzing the supply chain risk issues for an Indian manufacturing company</i>	Kumar Pradhan, S.; Routroy, S.	2014
	<i>AQUA: Analytical model for evaluation and selection of Third-Party Logistics service provider in supply chain</i>	Rajesh, R.; Pugazhendhi, S.; Ganesh, K.; Muralidharan, C.	2011
	<i>Automated bid ranking for decentralized coordination of construction logistics</i>	Soroor, J.; Tarokh, M.J.; Abedzadeh, M.	2012
	<i>Design improvement of supply chain information system of public transportation services (Case study: Trans Jogja)</i>	Mansur, A.; Janari, D.; Setiawan, N.; Suryoputro, M.R.; Albar, F.B.	2017
	<i>Designing a supply chain management academic curriculum using QFD and benchmarking</i>	Gonzalez, M.E.; Quesada, G.; Gourdin, K.; Hartley, M.	2008
	<i>Developing supply chain evaluation framework through performance assessment approach</i>	Tewari, S.K.; Misra, M.	2013
	<i>Environmental sustainability of logistics service provider: An ANP-QFD approach</i>	Lam, J.S.L.; Dai, J.	2015
	<i>Hybrid Zigbee RFID sensor network for humanitarian logistics centre management</i>	Yang, H.; Yang, L.; Yang, S.-H.	2011
	<i>Industry 4.0: a supply chain innovation perspective</i>	Hahn, G.J.	2020
	<i>Intelligent evaluation of supplier bids using a hybrid technique in distributed supply chains</i>	Soroor, J.; Tarokh, M.J.; Khoshalhan, F.; Sajjadi, S.	2012
	<i>Interpretive structural modelling and fuzzy MICMAC approaches for customer centric beef supply chain: application of a big data technique</i>	Mishra, N.; Singh, A.; Rana, N.P.; Dwivedi, Y.K.	2017
	<i>Laddered power</i>	Audin, L.	2007
	<i>Measurement and Management of Supply Chain Performance: Practices in Today's Large Companies</i>	Lakri, S.; Dallery, Y.; Jemai, Z.	2015
	<i>Modelling Supply Chain Flexibility in the Indian Personal Hygiene Industry: An ISM-Fuzzy MICMAC Approach</i>	Singh, R.K.; Joshi, S.; Sharma, M.	2020
	<i>Risk adjusted total cost of ownership model for strategic sourcing decisions</i>	Sharma, S.K.	2016
	<i>Strategising customer voice-based quality improvement for logistics service providers</i>	Lee, T.-R.; Lin, J.-H.; Lenny Koh, S.C.	2006
<i>Utilising quality function deployment to select customer voice-based quality improvement technique for 3PL companies</i>	Lee, T.-R.; Lin, J.-H.	2006	
<i>Web-enabled integration of the voice-of customer for continuous improvement and product development</i>	Gunasekaran, N.; Arunachalam, V.P.; Selva Kumar, A.V.	2006	
<i>Active role</i>	<i>B2C Mass Customization in the Classroom</i>	Visich, J.K.; Gu, Q.; Khumawala, B.M.	2012
	<i>Barriers in green lean six sigma product development process: An ISM approach</i>	Kumar, S.; Luthra, S.; Govindan, K.; Kumar, N.; Haleem, A.	2016
	<i>Breaking the Chains of open innovation: Post-blockchain and the case of sensorica</i>	Pazaitis, A.	2020
	<i>Cloud-based design and manufacturing: A new paradigm in digital manufacturing and design innovation</i>	Wu, D.; Rosen, D.W.; Wang, L.; Schaefer, D.	2015
	<i>Creating a living lab model for tourism and hospitality businesses to stimulate CSR and sustainability innovations</i>	Cigir, K.	2018
	<i>Crowdsourcing as a platform for digital labor unions</i>	Arora, P.; Thompson, L.H.	2019
	<i>Crowdsourcing Last Mile Delivery: Strategic Implications and Future Research Directions</i>	Castillo, V.E.; Bell, J.E.; Rose, W.J.; Rodrigues, A.M.	2018
	<i>Develop Potential Solution to the Engineering Conflicts of Additive Manufacturing by Using the Theory of Solution of Inventive Problems (TRIZ)-The Case of Material Jetting Process</i>	Wang, Y.-H.; Trappey, A.J.; Hwang, S.-J.; Chen, K.-L.	2016
	<i>Evolving Information Systems and Technology Research Issues for COVID-19 and Other Pandemics</i>	O'Leary, D.E.	2020
	<i>Industrial applications of virtual reality in architecture and construction</i>	Whyte, J.	2003
	<i>Logistics service triad for household waste: consumers as co-producers of sustainability</i>	Halldörsson, Á.; Altuntas Vural, C.; Wehner, J.	2019
	<i>Make, buy, borrow or crowdsource? The evolution and future of outsourcing</i>	Malhotra, N.K.; Usley, C.	2018
	<i>Managing the trade-off implications of global supply</i>	Stratton, R.; Warburton, R.D.H.	2006
	<i>On assessing the sensitivity to uncertainty in distribution network design</i>	Lalwani, C.S.; Disney, S.M.; Naim, M.M.	2006
	<i>Performing charlotte: A technique to bridge cultures in participatory design</i>	Light, A.; Kleine, D.; Holloway, R.; Vivent, M.	2010
	<i>Product design crowdsourcing in a dual-channel supply chain: joint reviews from manufacturer and consumers</i>	Li, J.; Yu, Y.; Liu, C.	2019
	<i>Systems thinking benefits in supply change management: an illustration of the viable systems model in a Supply Chain</i>	Chronéer, D.; Mirjamdotter, A.	2009
	<i>The Rise of Crowd Logistics: A New Way to Co-Create Logistics Value</i>	Carbone, V.; Rouquet, A.; Roussat, C.	2017
	<i>Weak links in the supply chain: Measuring fragility and sustainability</i>	Stonebraker, P.W.; Goldhar, J.; Nassos, G.	2009

Appendix 7: Article distribution according to methods

Table 21: Article distribution according to methods

Method	Title	Author	Year
VoC	<i>A constrained Nash bargaining approach to the stock rationing problem in multi-echelon supply chains</i>	Roy, D.; Srinivasa Raghavan, N.R.	2014
	<i>A hybrid framework based on SIPOC and Six Sigma DMAIC for improving process dimensions in supply chain network</i>	Mishra, P.; Sharma, R.K.	2014
	<i>A knowledge-based algorithm for supply chain conflict detection based on OTSM-TRIZ problem flow network approach</i>	Razmi, J.; Haghghi, D.; Babazadeh, R.	2018
	<i>A world-class continuous quality improvement program: The fastener supply corporation case</i>	Min, H.	1998
	<i>Analyzing the supply chain risk issues for an Indian manufacturing company</i>	Kumar Pradhan, S.; Routroy, S.	2014
	<i>AQUA: Analytical model for evaluation and selection of Third-Party Logistics service provider in supply chain</i>	Rajesh, R.; Pusazhendhi, S.; Ganesh, K.; Muralidharan, C.	2011
	<i>Automated bid ranking for decentralized coordination of construction logistics</i>	Soroor, J.; Tarokh, M.J.; Abedzadeh, M.	2012
	<i>Design improvement of supply chain information system for public transportation services (Case study: Trans Jogja)</i>	Mansur, A.; Janari, D.; Setiawan, N.; Suryoputro, M.R.; Albar, F.B.	2017
	<i>Designing a supply chain management academic curriculum using QFD and benchmarking</i>	Gonzalez, M.E.; Quesada, G.; Gourdin, K.; Hartley, M.	2008
	<i>Developing supply chain evaluation framework through performance assessment approach</i>	Tewari, S.K.; Mishra, M.	2013
	<i>Environmental sustainability of logistics service provider: An ANP-QFD approach</i>	Lam, J.S.L.; Dai, J.	2015
	<i>Hybrid Zigbee RFID sensor network for humanitarian logistics centre management</i>	Yang, H.; Yang, L.; Yang, S.-H.	2011
	<i>Industry 4.0: a supply chain innovation perspective</i>	Hahn, G.J.	2020
	<i>Intelligent evaluation of supplier bids using a hybrid technique in distributed supply chains</i>	Soroor, J.; Tarokh, M.J.; Khoshalhan, F.; Sajjadi, S.	2012
	<i>Interpretive structural modelling and fuzzy MICMAC approaches for customer centric beef supply chain: application of a big data technique</i>	Mishra, N.; Singh, A.; Rana, N.P.; Dwivedi, Y.K.	2017
	<i>Measurement and Management of Supply Chain Performance: Practices in Today's Large Companies</i>	Lakri, S.; Dallery, Y.; Jemai, Z.	2015
	<i>Modelling Supply Chain Flexibility in the Indian Personal Hygiene Industry: An ISM-Fuzzy MICMAC Approach</i>	Singh, R.K.; Joshi, S.; Sharma, M.	2020
	<i>Risk adjusted total cost of ownership model for strategic sourcing decisions</i>	Sharma, S.K.	2016
	<i>Strategising customer voice-based quality improvement for logistics service providers</i>	Lee, T.-R.; Lin, J.-H.; Lenny Koh, S.C.	2006
	<i>Utilising quality function deployment to select customer voice-based quality improvement technique for 3PL companies</i>	Lee, T.-R.; Lin, J.-H.	2006
<i>Web-enabled integration of the voice-of customer for continuous improvement and product development</i>	Gunasekaran, N.; Arunachalam, V.P.; Selva Kumar, A.V.	2006	
Crowdsourcing	<i>Crowdsourcing as a platform for digital labor unions</i>	Arora, P.; Thompson, L.H.	2019
	<i>Crowdsourcing Last Mile Delivery: Strategic Implications and Future Research Directions</i>	Castillo, V.E.; Bell, J.E.; Rose, W.J.; Rodrigues, A.M.	2018
	<i>Make, buy, borrow or crowdsource? The evolution and future of outsourcing</i>	Malhotra, N.K.; Uslay, C.	2018
	<i>Product design crowdsourcing in a dual-channel supply chain: joint reviews from manufacturer and consumers</i>	Li, J.; Yu, Y.; Liu, C.	2019
	<i>The Rise of Crowd Logistics: A New Way to Co-Create Logistics Value</i>	Carbone, V.; Rouquet, A.; Roussat, C.	2017
Brainstorming	<i>Barriers in green lean six sigma product development process: An ISM approach</i>	Kumar, S.; Luthra, S.; Govindan, K.; Kumar, N.; Haleem, A.	2016
	<i>Logistics service triad for household waste: consumers as co-producers of sustainability</i>	Halldórsson, Á.; Altuntas Vural, C.; Wehner, J.	2019
	<i>On assessing the sensitivity to uncertainty in distribution network design</i>	Lalwani, C.S.; Disney, S.M.; Naim, M.M.	2006
	<i>Weak links in the supply chain: Measuring fragility and sustainability</i>	Stonebraker, P.W.; Goldhar, J.; Nassos, G.	2009
User interface	<i>B2C Mass Customization in the Classroom</i>	Visich, J.K.; Gu, Q.; Khumawala, B.M.	2012
	<i>Cloud-based design and manufacturing: A new paradigm in digital manufacturing and design innovation</i>	Wu, D.; Rosen, D.W.; Wang, L.; Schaefer, D.	2015
	<i>Evolving Information Systems and Technology Research Issues for COVID-19 and Other Pandemics</i>	O'Leary, D.E.	2020
TRIZ	<i>Develop Potential Solution to the Engineering Conflicts of Additive Manufacturing by Using the Theory of Solution of Inventive Problems (TRIZ)-The Case of Material Jetting Process</i>	Wang, Y.-H.; Trappey, A.J.; Hwang, S.-J.; Chen, K.-L.	2016
	<i>Managing the trade-off implications of global supply</i>	Stratton, R.; Warburton, R.D.H.	2006
Lead user	<i>Industrial applications of virtual reality in architecture and construction</i>	Whyte, J.	2003
	<i>Systems thinking benefits in supply change management: an illustration of the viable systems model in a Supply Chain</i>	Chronéer, D.; Mirjamdotter, A.	2009
Participatory Design	<i>Performing charlotte: A technique to bridge cultures in participatory design</i>	Light, A.; Kleine, D.; Holloway, R.; Vivent, M.	2010
Living lab	<i>Creating a living lab model for tourism and hospitality businesses to stimulate CSR and sustainability innovations</i>	Cigir, K.	2018
Laddering	<i>Laddered power</i>	Audin, L.	2007
Innovation communities	<i>Breaking the Chains of open innovation: Post-blockchain and the case of sensorica</i>	Pazaitis, A.	2020

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Abstract

Climate change issues are now at the centre of everyday life for people, countries, governments and companies. The Internet of Things (IoT), microelectronics and nanotechnology industries constitute a fairly recent sector that has been widely targeted for its environmental and ethical impacts. The devices associated with this sector are present in many households and exchange information with each other; they can be phones, cars, watches, or headphones amongst many others. Nanotechnology also plays a role in the context of the ecological transition - it can be found in electric cars, solar panels and wind turbines. To manufacture such devices, numerous raw materials are required, including rare metals, critical metals, rare earths and conflict metals. All these metals have significant environmental and ethical impacts during extraction and throughout the manufacturing value chain of the IoT. Moreover, consumers and companies alike are increasingly aware of the significant effort required to address sustainability issues. Customers, consumers and users are increasingly playing a role in the supply chains of companies and are becoming actors of change by proposing more sustainable solutions for both products and processes. However, although it is relatively easy to integrate these consumers into B2C companies, who are close to consumers, this thesis focuses on supply chain integration in B2B companies, and more precisely, on leveraging downstream actors to address sustainability challenges in the context of the IoT. To deal with this problematic, an article-based thesis is proposed. The first article is a bibliometric analysis that attempts to observe the evolution of the literature concerning the integration of downstream actors into the SC, thereby allowing the sustainability dimension to be highlighted. The second article, presented in the form of a systematic literature review and presenting a comprehensive framework, seeks to find out how to integrate these downstream actors in relation to companies' objectives and processes. Finally, the third article is a case study on rare metals that aims to understand how companies in the nano- and micro-electronics sector that are evolving in a B2B system can integrate their downstream actors.


Keywords: Sustainable Supply Chain Management, Supply Chain Integration, Downstream actors, IoT

Résumé

Les problématiques liées au changement climatique sont désormais omniprésentes dans la vie quotidienne des personnes, des pays, des gouvernements et des entreprises. Un secteur assez récent, et largement visé pour ses impacts environnementaux et éthiques, est celui de l'Internet des objets (IoT). Ces appareils sont présents dans de nombreux foyers et échangent des informations entre eux. Il peut s'agir de téléphones, de voitures, de montres connectées, d'écouteurs connectés et bien d'autres. Les nanotechnologies, comprises dans les IoTs, jouent également un rôle dans le cadre de la transition écologique. Elles se retrouvent, à titre d'exemple, dans les voitures électriques, les panneaux solaires et les éoliennes. Pour fabriquer tous ces appareils, il est nécessaire d'utiliser de nombreuses matières premières, notamment des métaux rares, des métaux critiques, des terres rares et des minéraux de conflit. Tous ces métaux ont des impacts environnementaux et éthiques importants lors de leur extraction et tout au long de la fabrication de l'IoT. Aujourd'hui, les consommateurs comme les entreprises sont de plus en plus conscients de l'impact de ces activités et des efforts à fournir pour résoudre la problématique de durabilité de ces produits. Les clients, consommateurs et utilisateurs prennent de plus en plus part dans la chaîne d'approvisionnement des entreprises et deviennent des acteurs du changement en proposant des solutions plus durables tant pour les produits que pour les processus liés à leur cycle de vie. Cependant, il semble qu'il soit plus aisé d'intégrer ces consommateurs dans les entreprises B2C qui sont proches des consommateurs. Dans cette thèse, la problématique générale suivante « Intégration de la chaîne d'approvisionnement dans les entreprises B2B : Tirer parti des acteurs aval pour relever les défis de la durabilité dans le contexte de l'IoT » est soulevée. Pour répondre à cette problématique, une thèse basée sur des articles est proposée. Le premier article est une analyse bibliométrique qui tente d'observer l'évolution de la littérature concernant l'intégration des acteurs aval dans la chaîne d'approvisionnement, et permet de mettre en évidence la dimension de durabilité. Le deuxième article, présenté sous la forme d'une revue systématique de la littérature et présentant un cadre global, cherche à savoir comment et par quelles méthodes il est possible d'intégrer ces acteurs aval par rapport aux objectifs et aux processus des entreprises. Enfin, le troisième article est une étude de cas sur les métaux rares qui vise à comprendre comment les entreprises du secteur de l'IoT, évoluant en B2B, peuvent intégrer leurs acteurs aval et par quelles méthodes.

Mots clés : Gestion de la chaîne d'approvisionnement durable, intégration de la chaîne d'approvisionnement, acteurs en aval, IoT.



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Climate change issues are now at the centre of everyday life for people, countries, governments and companies. The Internet of Things (IoT), microelectronics and nanotechnology industries constitute a fairly recent sector that has been widely targeted for its environmental and ethical impacts. The devices associated with this sector are present in many households and exchange information with each other; they can be phones, cars, watches, or headphones amongst many others. Nanotechnology also plays a role in the context of the ecological transition - it can be found in electric cars, solar panels and wind turbines. To manufacture such devices, numerous raw materials are required, including rare metals, critical metals, rare earths and conflict metals. All these metals have significant environmental and ethical impacts during extraction and throughout the manufacturing value chain of the IoT. Moreover, consumers and companies alike are increasingly aware of the significant effort required to address sustainability issues. Customers, consumers and users are increasingly playing a role in the supply chains of companies and are becoming actors of change by proposing more sustainable solutions for both products and processes. However, although it is relatively easy to integrate these consumers into B2C companies, who are close to consumers, this thesis focuses on supply chain integration in B2B companies, and more precisely, on leveraging downstream actors to address sustainability challenges in the context of the IoT. To deal with this problematic, an article-based thesis is proposed. The first article is a bibliometric analysis that attempts to observe the evolution of the literature concerning the integration of downstream actors into the SC, thereby allowing the sustainability dimension to be highlighted. The second article, presented in the form of a systematic literature review and presenting a comprehensive framework, seeks to find out how to integrate these downstream actors in relation to companies' objectives and processes. Finally, the third article is a case study on rare metals that aims to understand how companies in the nano- and micro-electronics sector that are evolving in a B2B system can integrate their downstream actors.